Structural Shifts in the Global Economy

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Mr. Haltiwanger is a Distinguished University Professor of Economics at the University of Maryland. Before joining the Maryland faculty in 1987, he was on the faculty of the University of California, Los Angeles and Johns Hopkins University. In the late 1990s, he served as chief economist of the U.S. Census Bureau. He is a research associate of the National Bureau of Economic Research, a senior research fellow at the Center for Economic Studies at the U.S. Census Bureau, and a fellow of the Society of Labor Economics and the Econometric Society. Mr. Haltiwanger's work has focused on the development and study of U.S. longitudinal firm-level data in the United States. Using these data, he has developed new statistical measures and analyzed the determinants of firm-level job creation, job destruction and economic performance. The statistical and measurement methods he has helped develop to measure and study firm dynamics have been increasingly used by many statistical agencies around the world. He has published more than 100 academic articles and numerous books including *Job Creation and Destruction* with Steven J. Davis and Scott Schuh.

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Christine Lagarde, *President, European Central Bank*

Ms. Lagarde was named president of the European Central Bank in 2019. She previously served as 11th managing director of the International Monetary Fund from 2011-2019. Born in Paris, Ms. Lagarde graduated from law school at University Paris X, and obtained a master's degree from the Political Science Institute in Aix en Provence. After being admitted to the Paris Bar, Ms. Lagarde joined the international law firm of Baker McKenzie, becoming chairman of the Global Executive Committee of Baker McKenzie in 1999, and of the Global Strategic Committee in 2004. Ms. Lagarde joined the French government in 2005 as Minister for Foreign Trade. After a brief stint as Minister for Agriculture and Fisheries, in 2007 she became the first woman to hold the post of Finance and Economy Minister of a G-7 country.

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Ms. Ma is Associate Professor of Finance and Kathryn and Grant Swick Faculty Scholar at the Booth School of Business at the University of Chicago. Her main research interest is empirical studies at the intersection of finance and macroeconomics. Her work covers topics including debt contracts and macroeconomic implications, assets and production activities of nonfinancial firms, low interest rates and financial markets, and expectations in finance and macroeconomics. She has also worked on questions in real estate and urban economics. She is a faculty research fellow for the National Bureau of Economic Research and a research affiliate for the Center for Economic and Policy Research. She received a Ph.D. in Business Economics from Harvard University.

Ngozi Okonjo-Iweala, *Director-General, World Trade Organization*

Ms. Okonjo-Iweala is the seventh director-general of the World Trade Organization. She took office in 2021, becoming the first woman and first African to serve as director-general. Her term of office will expire in August 2025. She is a global finance expert, an economist and international development professional with over 30 years of experience working in Asia, Africa, Europe, Latin America

and North America. She twice served as Nigeria's finance minister (2003-2006 and 2011-2015) and briefly acted as foreign minister in 2006, the first woman to hold both positions. She had a 25-year career at the World Bank as a development economist, rising to the position of managing director-operations. Ms. Okonjo-Iweala was formerly chair of the board of Gavi, the Vaccine Alliance and also on the boards of Standard Chartered PLC and Twitter Inc.

Jerome Powell, *Chairman, Board of Governors of the Federal Reserve*

Mr. Powell is chair of the Board of Governors of the Federal Reserve System. Mr. Powell also is chair of the Federal Open Market Committee, the System's principal monetary policymaking body. Mr. Powell has been a member of the Board of Governors since 2012 and chairman since 2018. Prior to his appointment to the Board, Mr. Powell was a visiting scholar at the Bipartisan Policy Center in Washington, D.C., where he focused on federal and state fiscal issues. From 1997 through 2005, Mr. Powell was a partner at The Carlyle Group. Mr. Powell was an assistant secretary and undersecretary of the Treasury under President George H.W. Bush. Prior to joining the administration, he worked as a lawyer and investment banker in New York City.

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Ms. Reinhart is the Minos A. Zombanakis Professor of the International Financial System at the John F. Kennedy School of Government at Harvard University. From 2020-2022, she served as senior vice president and chief economist at The World Bank Group and was chief economist at the investment bank Bear Steans in the 1980s. Previously, she was a policy advisor and deputy director at the International Monetary Fund, a member of the Advisory Panel of the Federal Reserve Bank of New York, and on the Congressional Budget Office Panel of Economic Advisors. Her best-selling book with Kenneth S. Rogoff titled *This Time is Different: Eight Centuries of Financial Folly* documents the similarities of the recurring booms and busts that have characterized financial history. She is an elected member of the Group of Thirty and is a senior fellow at the Council of Foreign Relations.

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Ms. Richardson joined ADP as chief economist in 2020, where she leads economic research and is co-head of the ADP Research Institute. Prior to joining ADP, she was a principal and investment strategist at Edward Jones Investments. In that role, she analyzed and interpreted economic trends and financial market conditions and recommended investment strategies. She is the former chief economist at Redfin Corp., a real estate brokerage and technology company, where she led a team tracking trends in the housing market. Ms. Richardson also served as a senior economist for Bloomberg L.P., covering housing and financial markets, and has held research positions at the Commodity Futures Trading Commission, Harvard University's Joint Center for Housing Studies, and Freddie Mac. She was an adjunct professor at the Carey School of Business at John Hopkins University. She serves on the foundation boards for the U.S. Chamber of Commerce and the National Association of Business Economists.

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Ms. Romer is the Class of 1957-Garff B. Wilson Professor of Economics at the University of California, Berkeley, a position she has held since 1997. She joined the Berkeley faculty in 1988 and became a full professor in 1993. Ms. Romer has served as co-director of the Program in Monetary Economics at the National Bureau of Economic Research and is a member of the NBER Business Cycle Dating Committee. She is a fellow of the American Academy of Arts and Sciences and has received a John Simon Guggenheim Memorial Foundation Fellowship, the National Science Foundation Presidential Young Investigator Award, and an Alfred P. Sloan Research Fellowship. Ms. Romer has served as president and a member of the executive committee of the American Economic Association and chair of the Council of Economic Advisers. Prior to her appointment at Berkeley, she was an assistant professor of economics and public affairs at Princeton University from 1985-1988.

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Ms. Russ is professor of economics at the University of California, Davis. She has expertise in open-economy macroeconomics and international trade policy. She is a faculty research associate in the National Bureau of Economic Research International Trade and Investment Group and co-organizer of the International Trade and Macroeconomics Working Group. She is a non-resident senior fellow at the Peterson Institute for International Economics and served as senior economist for International Trade and Finance for the White House Council of Economics from 2015-2016. She has been a visitor at the central banks of Germany, Portugal and France, and the Federal Reserve Banks of St. Louis and San Francisco; a research advisor at the Halle Institute for Economic Research in Halle, Germany; and a research associate of the Institute for Globalization and Monetary Policy at the Federal Reserve Bank of Dallas.

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Mr. Stein is the Moise Y. Safra Professor of Economics at Harvard University, where he also is on the board of directors of the Harvard Management Company. From 2012 to 2014, he was a member of the Board of Governors of the Federal Reserve System. Mr. Stein is a fellow of the American Academy of Arts and Sciences and a research associate at the National Bureau of Economic Research. Mr. Stein's research has covered such topics as behavioral finance and market efficiency; corporate investment and financing decisions; risk management; capital allocation inside firms; banking; financial regulation; and monetary policy. He has been a co-editor of the Quarterly Journal of Economics and the Journal of Economic Perspectives.

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Ms. Stevenson is a professor of public policy and economics at the University of Michigan. She is also a faculty research associate at the National Bureau of Economic Research, a visiting associate professor of economics at the University of Sydney, a research fellow of the

Centre for Economic Policy Research, a fellow of the Ifo Institute for Economic Research in Munich, and serves on the executive committee of the American Economic Association. Her research explores women's labor market experiences, the economic forces shaping the modern family, and how these labor market experiences and economic forces on the family influence each other.

Chad Syverson, *Professor, University of Chicago*

Mr. Syverson is the George C. Tiao Distinguished Professor of Economics in the Booth School of Business at the University of Chicago. His research spans several topics, with a particular focus on the interactions of firm structure, market structure and productivity. His research has been published in several top journals and has earned multiple National Science Foundation Awards. He is a research associate of the National Bureau of Economic Research and has served on National Academies committees and as the chair of the Chicago Census Research Data Center Board. Prior to his appointment at the University of Chicago, Mr. Syverson was a mechanical engineer co-op for Loral Defense Systems and Unisys Corporation.

Kazuo Ueda, *Governor, Bank of Japan*

Mr. Ueda was appointed governor of the Bank of Japan in April 2023. He joined the faculty of the University of Tokyo as professor of economics in 1989, retiring in 2017 to become professor emeritus. He has written extensively on unconventional monetary policy, especially that of the Bank of Japan, and in the fields of monetary economics, macroeconomics and international finance. From 2011–2012, he was president of the Japan Economic Association, and was a member of the Policy Board of the Bank of Japan from 1998 to 2005. Previously, he was a faculty member at the University of British Columbia and Osaka University.

Structural Shifts in the Global Economy: An Introduction to the Bank's 2023 Economic Symposium

Joseph Gruber

After two decades of near-target inflation, low interest rates, and relatively steady growth, inflation has reemerged as a top economic concern, interest rates have increased significantly, and the outlook for global growth has become unsettled. The global economy has experienced several significant and potentially long-lasting disruptions in recent years. While the immediate effect of the pandemic has faded, both the shock of the pandemic and the unprecedented policy stimulus that it provoked will likely have long-lasting consequences for how economies are structured, domestically and globally.

The pandemic and its aftermath have structural implications for the organization of the global economy, as trade networks shift and global financial flows react. Rising geopolitical tensions are also likely to shift the structure of the global economy, as existing supply chains, production networks, and financial flows come under pressure. How are these developments likely to affect the context for growth and monetary policy in the coming decade?

The past few years have seen an extraordinary loosening of monetary policy, as central banks responded to the pandemic by cutting interests rates and expanding their balance sheets, followed by a rapid tightening of policy in response to the post-pandemic surge in inflation. While

policy has targeted the cyclical condition of the economy, could this historic shift in monetary policy have structural implications? Relatedly, will the large increases in the size of central bank balance sheets have a permanent effect on the conduct of monetary policy?

To contribute to the discussion around these issues, the Federal Reserve Bank of Kansas City sponsored a symposium titled "Structural Shifts in the Global Economy" on August 25 and 26, 2023. The symposium brought together a distinguished group of central bank officials and academic, policy, and business economists to discuss economic and policy developments. The symposium began with a keynote address followed by a morning session of two papers with discussants and a panel discussion. The afternoon session opened with another set of remarks followed by an additional two papers and a final panel discussion.

Opening Keynote Address

The symposium opened with a keynote address from Federal Reserve Chair Jerome Powell. Chair Powell discussed the progress that had been made lowering inflation over the previous year. Goods prices had decelerated most due to improvements in supply chains and curtailed demand from tighter monetary policy and higher interest rates. Declining rent inflation was expected to push down housing inflation in the official statistics, albeit with a lag due to technical factors. Inflation for non-housing services had remained elevated due to the continued tightness of the labor market and the relative insensitivity of consumption in this sector to higher interest rates. Despite these encouraging inflation developments, Chair Powell warned that sustainably returning inflation to 2 percent could require a period of below potential growth and the continued loosening of a tight labor market.

Chair Powell reaffirmed a commitment to Federal Reserve's 2 percent inflation objective while discussing some of the uncertainties contributing to the policy outlook. First, although monetary policy was restrictive by most measures, it was unclear how tight policy was due to uncertainty about the level of the neutral interest rate. Second, it was also uncertain whether the tightening that had already

occurred had fully passed through to the economy. In the face of such uncertainty, Chair Powell suggested that policy proceed carefully and remain guided by the data.

Has the Macroeconomic Environment Impacted Long-Run Shifts in the Economy?

The first paper — presented by Yueran Ma and Kaspar Zimmermann — empirically examines whether monetary policy actions can affect the long-term growth prospects of the economy. Generally, monetary policy is calibrated to address cyclical conditions within the economy, with most models and analysis assuming that policy is neutral for long-run growth. The authors consider that shifts in monetary policy and financial conditions can affect the amount of innovation that occurs within an economy, potentially altering an economy's long-run growth path.

In their empirical analysis, the authors find that tighter monetary policy has a significant negative effect on innovation in the United States. Higher interest rates lower research and development (R&D) spending and lead to cuts in venture capital financing, an important source of funds for early start-up companies. In addition, policy tightening lowers the number of patents registered, especially for what the authors define as important technologies. Overall, the authors estimate that tighter monetary policy can significantly lower long-run economic output through its negative effect on innovation.

The authors discuss how tighter policy decreases innovation both by lowering demand, and thereby decreasing the returns on innovation, as well as by increasing the cost of funding. Their analysis suggests that monetary policymakers should consider the impact of their actions on long-run growth as well as the cyclical state of the economy.

In the discussion of the paper, John Haltiwanger highlighted the difficulty in correctly measuring innovation. A particular point of difficulty is capturing innovation activity among young and small firms. The data for public firms is generally more complete, but much innovation occurs outside public firms. Additionally, patents and R&D spending only offer a limited view into innovation, and one that is skewed toward certain industries — primarily manufacturing.

Haltiwanger also discussed the relationship between periods of high start-up activity and productivity growth. High start-up periods are often associated with declining overall productivity but increased productivity dispersion. Productivity takes off at least six to nine years after increased start-ups.

Structural Changes in Financial Markets and the Conduct of Monetary Policy

The second paper, authored by Darrell Duffie, examines structural developments in the market for U.S. treasuries and suggests that long-run trends could impede liquidity in this crucial market. While liquidity in the Treasury market has been declining for some time, a "dash for cash" in the early days of the Covid-19 pandemic resulted in severe market dysfunction. Duffie attributes the stress in the Treasury market to regulatory limits on the size of dealer balance sheets that were eventually alleviated by the Federal Reserve's purchase of a large quantity of Treasuries and the temporary suspension of the supplementary leverage ratio (SLR). Over time, persistent fiscal deficits will continue to grow the stock of Treasuries relative to the size of dealer balance sheets, increasing the risk of episodes of market dysfunction and possibly threatening the appeal of Treasuries as a safe asset; this, in turn, would likely increase the government's funding costs.

The paper suggests several policy options that could lessen the risk of disruption in the Treasury market. The Federal Reserve could clarify its policy on using its balance sheet and asset purchases to address market disruptions. In theory, greater clarity on the Fed's response to illiquidity would make such episodes less likely and increase the willingness of investors to hold Treasuries. Moving a greater share of the Treasury market to central clearing could improve financial stability by lowering counterparty risk while also allowing a netting of trades, which would lessen the need for dealer balance sheet capacity.

In his discussion of the paper, Jeremy Stein broadly agreed with the premise and proposals of Duffie's paper. He advocated for a further reexamination of the leverage ratio as a constraint on dealer balance sheets and argued that relaxing the leverage ratio could reduce the chance of disruptions. He also suggested that broader access to the

Fed's Standing Repo Facility (SRF) would increase the robustness of the Treasury market by increasing the liquidity of Treasuries without relying on lending from primary dealers and banks. Stein saw Federal Reserve purchases of Treasuries as a less attractive option for addressing disruptions and one that would require careful communication to separate market functioning purchases from monetary easing purchases.

Panel: Structural Constraints on Growth

The first panel discussed the longer-term outlook for growth. Charles Jones led off the discussion, noting that economic growth is related importantly to the number of people searching for new ideas. Using this framework, Jones noted that a slowdown in the growth rates of educational attainment, R&D spending, and overall population growth could lower trend growth in the decades ahead. Conversely, increasing educational attainment globally, including in China and India, as well as reducing discrimination in employment could increase the number of people searching for new ideas and increase global growth.

Next, Nela Richardson discussed the post-pandemic labor market, highlighting ways that it had become more fragmented. Richardson noted increased demographic fragmentation as younger workers exhibited a greater willingness to shift professions in response to wage incentives. Richardson also noted the increased fragmentation between higher-skilled and lower-skilled workers, with professions with lower entry requirements generally seeing some of the largest wage gains. The pandemic was associated with a greater degree of labor market churn and an increase in the geographic dispersion of work, with upper management increasingly concentrating in large urban areas even as other workers migrated away from these same urban centers.

Chad Syverson closed the panel, stressing the importance of productivity for long-run economic growth. Syverson discussed the relatively tight correlation of weak output growth with higher inflation across industries, suggesting an important role for supply developments in the recent increase in inflation. Syverson noted that

productivity growth in the construction sector in particular had been abysmal for decades. More generally, Syverson discussed the productivity J-curve, where difficulties in measuring the productivity of new technologies can depress measured productivity in certain sectors before artificially boosting apparent productivity once the technologies reach maturity.

Afternoon Remarks

In the afternoon session, President Christine Lagarde discussed structural shocks affecting the global economy and their interaction with the conduct of monetary policy. She identified three significant changes in the global economy in recent years. First, she discussed a change in labor market dynamics brought on by the pandemic and influenced by hybrid work, including a fall in participation and a decline in hours worked, and raised the possibility that artificial intelligence could disrupt many occupations. Second, she argued that climate change required more investment in green technology. And third, she highlighted how increased geopolitical tensions engendering greater trade restrictions were changing the shape and efficiency of supply chain networks.

The changing structure of the global economy complicates our understanding of it, making historical models and relationships unreliable. President Lagarde discussed two ways in which structural change could shift important economic relationships. First, the nature of shocks affecting economics could change. Among other factors, trade frictions, climate change, and the green transition could increase the prevalence of supply shocks. The increased prevalence of these shocks could also increase the need for substantial investments to facilitate the energy transition as well as increased defense spending. Second, there could be a structural change in the way that shocks are transmitted through the economy. Shifts in the structure of production could require large relative price changes, adding urgency to central bank efforts to maintain anchored inflation expectations. President Lagarde discussed evidence that firms had adjusted their price-setting behavior, leading to large and more frequent updating of prices, but also that workers had gained pricing power, allowing for the possibility of more "catch-up" wage growth.

Responding to the changing economic environment, President Lagarde suggested that policymakers act with clarity, flexibility, and humility. For clarity, she urged central banks to remain focused on their price stability mandates so that monetary policy itself does not become a source of uncertainty. For flexibility, she warned against an overreliance on models and possibly stale relationships. And finally, she asked that policymakers show humility by acknowledging the limits of what can be achieved.

Global Production Networks

The third paper, presented by Laura Alfaro and Davin Chor, discusses the shifting structure of the United States' trade relationships. The dominant trend in trade and global growth over the past few decades has been increasingly specialized and fragmented production. More recently, however, economic actors have increasingly focused on supply chain risk, suggesting the globalization trend has largely played out. The vulnerabilities of far-flung supply chains became particularly acute during the pandemic, when a patchwork of production shutdowns and economy-wide lockdowns resulted in logistical snarls that took upwards of a year to unravel. In addition, the reemergence of geopolitical risk has led producers to reconsider supply chains, with some calling for increased "friendshoring," or concentrating production networks in countries with closer political ties.

The authors show that the United States' trading patterns have shifted in recent years, which they dub the "Great Reallocation." Although U.S. imports remain at all-time highs, the source of those imports has changed noticeably. In particular, the United States has seen a shift in import shares away from China and toward Vietnam and Mexico. However, the authors caution that such a shift may not lower overall U.S. dependence on China, given that the substituted imports from other countries retain a high share of value-added production from China. Relatedly, China has increased its investment into production in Mexico and Vietnam even as the U.S. has decreased investment in China.

In the discussion of the paper, Katheryn Russ reviewed how recent trade policy may benefit workers, ensure national security, and

achieve climate goals. From the worker's perspective, higher tariffs and an onshoring of input industries can increase costs and decrease employment in downstream sectors. As such, it is not clear that an onshoring of production benefits workers across the economy. On national security, a lack of good firm-specific data makes it difficult to truly assess the vulnerability of individual industries to disruption. On climate, there could be a benefit of shifting production of the most carbon-intensive industries to those countries with tighter environmental standards.

Global Financial Flows

The final paper, authored by Barry Eichengreen and Serkan Arslanalp, reviews the outlook for the global stock of sovereign debt. Fiscal stimulus during the pandemic added to already elevated stocks of government debt around the world. The authors outline several reasons why they are skeptical that government debt levels would fall anytime soon. First, they see little prospect that fiscal balances will move into surplus, especially given political considerations and the relatively slow pace of global growth. Second, an increase in interest rates increases pressure on government finances and makes fiscal consolidation more difficult. Third, governments are unlikely to be able to inflate away the real value of debt since only surprise inflation is effective in lowering debt-to-GDP ratios. And fourth, governments have less scope for financial repression than they did in the past — a meaningful development given the historical importance of this channel for reducing debt.

The authors suggest that the advanced economies are better situated for maintaining high debt levels given continued demand for their securities as safe assets. In contrast, despite starting with lower debt ratios in general, emerging markets could face greater difficulty finding buyers for their debt. As such, some emerging market economies could find their debt burdens unsustainable and in need of restructuring.

In discussing the paper, Carmen Reinhart agreed with the authors that high sovereign debt levels appeared unlikely to decline anytime soon. She highlighted that taking account of high private debt levels

could make the situation look even worse, since private debts often migrate to the public balance sheet during crises. However, she also noted that the authors did not lay out the argument for why high debt levels should concern policymakers.

Panel: Globalization at an Inflection Point

The second panel examined the outlook for globalization against a backdrop of pandemic disruptions and rising geopolitical tensions. Deputy Governor Ben Broadbent started the panel with a warning that increased trade restrictions come with a high economic cost. Shocks to the supply of imports can lower national income and increase domestic prices. This has been particularly true for energy shocks, as the effects of recent disruptions in the natural gas trade have affected some countries more than others.

Next, Director General Ngozi Okonjo-Iweala discussed the outlook for global trade and the importance of trade liberalization for economic development and the conduct of monetary policy. Director General Okonjo-Iweala suggested that falling trade costs, both for goods and services, would continue to support further globalization and that continued global integration would promote economic development in a wider range of countries and boost global productivity. Okonjo-Iweala also noted that the productivity enhancements resulting from globalization had been a source of disinflationary pressure, helping keep prices in check while dampening macro volatility.

Governor Kazuo Ueda discussed the pattern of trade and foreign direct investment (FDI) in Asia and the United States, noting that trade patterns can change both in response to trade restrictions and geopolitical tensions as well as to shifts in the pattern of relative wages. In response to trade tensions with the United States in the 1980s, Japan increased its FDI in the United States and expanded its production network throughout Asia; trade patterns with China came under similar pressure. Governor Ueda warned that these trends would have to be carefully monitored for their impact on global growth and monetary policy.

Welcoming Remarks

Good evening, and welcome to the 46th Jackson Hole Economic Policy Symposium. I'm Jeff Schmid, the President and Chief Executive Officer of the Federal Reserve Bank of Kansas City — since Monday, August 21. Apparently, this was the longest search for a Federal Reserve president in history. I may be biased but I think this is the best first week of work in the history of central banking.

I am a native of the state of Nebraska, having spent most of my 40-year career in financial services in Omaha. It is an honor to have been selected as the Bank's president, and a pleasure to be with you and meet so many Federal Reserve colleagues and guests from around the world.

I'm honored to host the Symposium. I will seek to uphold the best of the event by preserving the Symposium's reputation for identifying timely topics that are addressed with intellectual rigor in papers that inspire candid debate. Being a newcomer entrusted with this role, I owe a debt of gratitude to my predecessors, namely the late Roger Guffey, Thomas Hoenig, and Esther George for their vision and commitment to this event.

Yesterday, I was able to introduce myself to a group of local businesspeople in Jackson, and the most common question was "How is Esther George doing?" Esther has left a lasting impact across the Tenth Federal Reserve District that serves as an example to me of the connections that a Reserve Bank has to the region they serve. Esther's commitment to this event is so strong that she is here to ensure that this goes well. You might say she is here watching me like a hawk.

It is well known that topic selection for this Symposium begins as soon as the previous Symposium ends. In that regard, I offer my deep appreciation to our Director of Research Joe Gruber and his team for putting together what we believe will be a timely and insightful discussion related to "Structural Shifts in the Global Economy."

I particularly want to express my appreciation to those on the program for their preparation, and to all of you for your participation. Many of you traveled great distances to do so. We are pleased that you are here.

Jeffrey R. Schmid
President and Chief Executive Officer
Federal Reserve Bank of Kansas City

Opening Remarks: Inflation – Progress and the Path Ahead

Jerome H. Powell

Good morning. At last year's Jackson Hole symposium, I delivered a brief, direct message. My remarks this year will be a bit longer, but the message is the same: It is the Fed's job to bring inflation down to our 2 percent goal, and we will do so. We have tightened policy significantly over the past year. Although inflation has moved down from its peak — a welcome development — it remains too high. We are prepared to raise rates further if appropriate, and intend to hold policy at a restrictive level until we are confident that inflation is moving sustainably down toward our objective.

Today I will review our progress so far and discuss the outlook and the uncertainties we face as we pursue our dual mandate goals. I will conclude with a summary of what this means for policy. Given how far we have come, at upcoming meetings we are in a position to proceed carefully as we assess the incoming data and the evolving outlook and risks.

I. The Decline in Inflation So Far

The ongoing episode of high inflation initially emerged from a collision between very strong demand and pandemic-constrained supply. By the time the Federal Open Market Committee raised the policy rate in March 2022, it was clear that bringing down inflation would depend on both the unwinding of the unprecedented

pandemic-related demand and supply distortions and on our tightening of monetary policy, which would slow the growth of aggregate demand, allowing supply time to catch up. While these two forces are now working together to bring down inflation, the process still has a long way to go, even with the more favorable recent readings.

On a 12-month basis, U.S. total, or "headline," PCE (personal consumption expenditures) inflation peaked at 7 percent in June 2022 and declined to 3.3 percent as of July, following a trajectory roughly in line with global trends (Figure 1, panel A).[1] The effects of Russia's war against Ukraine have been a primary driver of the changes in headline inflation around the world since early 2022. Headline inflation is what households and businesses experience most directly, so this decline is very good news. But food and energy prices are influenced by global factors that remain volatile, and can provide a misleading signal of where inflation is headed. In my remaining comments, I will focus on core PCE inflation, which omits the food and energy components.

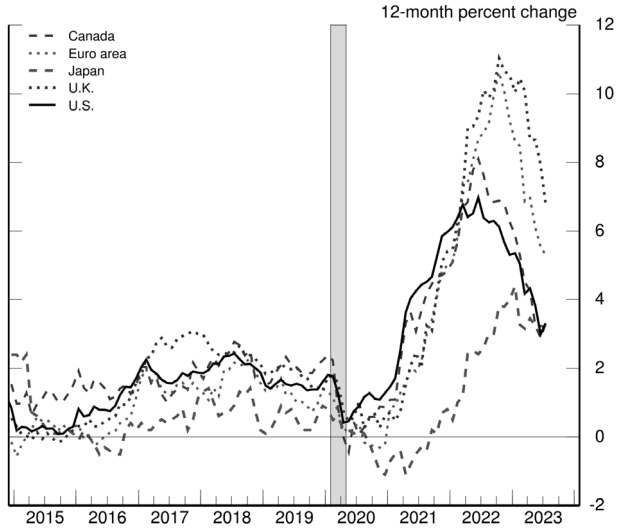
On a 12-month basis, core PCE inflation peaked at 5.4 percent in February 2022 and declined gradually to 4.3 percent in July (Figure 1, panel B). The lower monthly readings for core inflation in June and July were welcome, but two months of good data are only the beginning of what it will take to build confidence that inflation is moving down sustainably toward our goal. We can't yet know the extent to which these lower readings will continue or where underlying inflation will settle over coming quarters. Twelve-month core inflation is still elevated, and there is substantial further ground to cover to get back to price stability.

To understand the factors that will likely drive further progress, it is useful to separately examine the three broad components of core PCE inflation — inflation for goods, for housing services, and for all other services, sometimes referred to as nonhousing services (Figure 2).

Core goods inflation has fallen sharply, particularly for durable goods, as both tighter monetary policy and the slow unwinding of supply and demand dislocations are bringing it down. The motor vehicle sector provides a good illustration. Earlier in the pandemic,

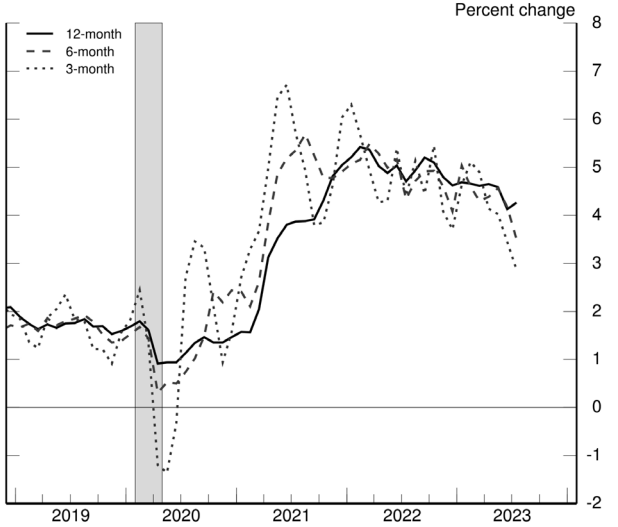
Figure 1

Panel A. Headline Inflation



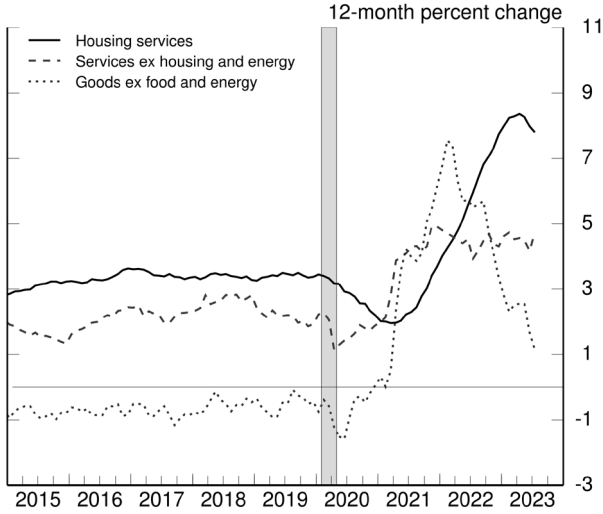
Note: The data are monthly and extend through July 2023. U.S. data are total PCE inflation and the data point for July 2023 is an estimate based on consumer price index and producer price index data. The shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020–April 2020. PCE is personal consumption expenditures.
Source: Haver Analytics; Bureau of Economic Analysis, PCE, via Haver Analytics.

Panel B. Core PCE Inflation



Note: The data are monthly and extend through July 2023. The data for July 2023 are estimates based on consumer price index and producer price index data. PCE is personal consumption expenditures. The shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020–April 2020.
Source: Bureau of Economic Analysis, PCE, via Haver Analytics.

Figure 2
Price Indexes for Core PCE Goods and Services



Note: The data are monthly and extend through July 2023. The data for July 2023 are estimates based on consumer price index and producer price index data. PCE is personal consumption expenditures. The shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020–April 2020.
Source: Bureau of Economic Analysis, PCE, via Haver Analytics.

demand for vehicles rose sharply, supported by low interest rates, fiscal transfers, curtailed spending on in-person services, and shifts in preference away from using public transportation and from living in cities. But because of a shortage of semiconductors, vehicle supply actually fell. Vehicle prices spiked, and a large pool of pent-up demand emerged. As the pandemic and its effects have waned, production and inventories have grown, and supply has improved. At the same time, higher interest rates have weighed on demand. Interest rates on auto loans have nearly doubled since early last year, and customers report feeling the effect of higher rates on affordability.[2] On net, motor vehicle inflation has declined sharply because of the combined effects of these supply and demand factors.

Similar dynamics are playing out for core goods inflation overall. As they do, the effects of monetary restraint should show through more fully over time. Core goods prices fell the past two months, but on a 12-month basis, core goods inflation remains well above

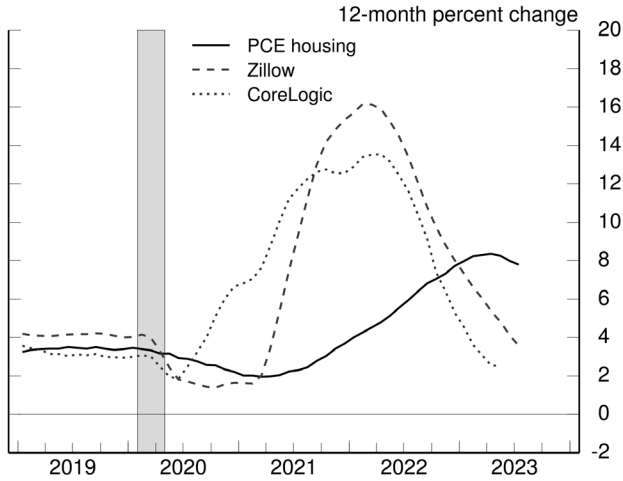
its pre-pandemic level. Sustained progress is needed, and restrictive monetary policy is called for to achieve that progress.

In the highly interest-sensitive housing sector, the effects of monetary policy became apparent soon after liftoff. Mortgage rates doubled over the course of 2022, causing housing starts and sales to fall and house price growth to plummet. Growth in market rents soon peaked and then steadily declined (Figure 3).[3]

Measured housing services inflation lagged these changes, as is typical, but has recently begun to fall. This inflation metric reflects rents paid by all tenants, as well as estimates of the equivalent rents that could be earned from homes that are owner occupied.[4] Because leases turn over slowly, it takes time for a decline in market rent growth to work its way into the overall inflation measure. The market rent slowdown has only recently begun to show through to that measure. The slowing growth in rents for new leases over roughly the past year can be thought of as "in the pipeline" and will affect measured housing services inflation over the coming year. Going forward, if market rent growth settles near pre-pandemic levels, housing services inflation should decline toward its pre-pandemic level as well. We will continue to watch the market rent data closely for a signal of the upside and downside risks to housing services inflation.

The final category, nonhousing services, accounts for over half of the core PCE index and includes a broad range of services, such as health care, food services, transportation, and accommodations. Twelve-month inflation in this sector has moved sideways since liftoff. Inflation measured over the past three and six months has declined, however, which is encouraging. Part of the reason for the modest decline of nonhousing services inflation so far is that many of these services were less affected by global supply chain bottlenecks and are generally thought to be less interest sensitive than other sectors such as housing or durable goods. Production of these services is also relatively labor intensive, and the labor market remains tight. Given the size of this sector, some further progress here will be essential to restoring price stability. Over time, restrictive monetary policy will help bring aggregate supply and demand back into better balance, reducing inflationary pressures in this key sector.

Figure 3
Rental Prices



Note: The data are monthly and extend, for Corelogic, through May 2023 and, for PCE and Zillow, through July 2023. For PCE, the data point for July 2023 is an estimate based on consumer price index and producer price index data. PCE is personal consumption expenditures. The shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Bureau of Economic Analysis, PCE, via Haver Analytics; Corelogic, Inc.; Zillow, Inc.

II. The Outlook

Turning to the outlook, although further unwinding of pandemic-related distortions should continue to put some downward pressure on inflation, restrictive monetary policy will likely play an increasingly important role. Getting inflation sustainably back down to 2 percent is expected to require a period of below-trend economic growth as well as some softening in labor market conditions.

Economic growth

Restrictive monetary policy has tightened financial conditions, supporting the expectation of below-trend growth.[5] Since last year's symposium, the two-year real yield is up about 250 basis points, and longer-term real yields are higher as well — by nearly 150 basis points.[6] Beyond changes in interest rates, bank lending standards have tightened, and loan growth has slowed sharply.[7] Such a tightening of broad financial conditions typically contributes to a slowing in the growth of economic activity, and there is evidence of that in

this cycle as well. For example, growth in industrial production has slowed, and the amount spent on residential investment has declined in each of the past five quarters (Figure 4).

But we are attentive to signs that the economy may not be cooling as expected. So far this year, GDP (gross domestic product) growth has come in above expectations and above its longer-run trend, and recent readings on consumer spending have been especially robust. In addition, after decelerating sharply over the past 18 months, the housing sector is showing signs of picking back up. Additional evidence of persistently above-trend growth could put further progress on inflation at risk and could warrant further tightening of monetary policy.

The labor market

The rebalancing of the labor market has continued over the past year but remains incomplete. Labor supply has improved, driven by stronger participation among workers aged 25 to 54 and by an increase in immigration back toward pre-pandemic levels.

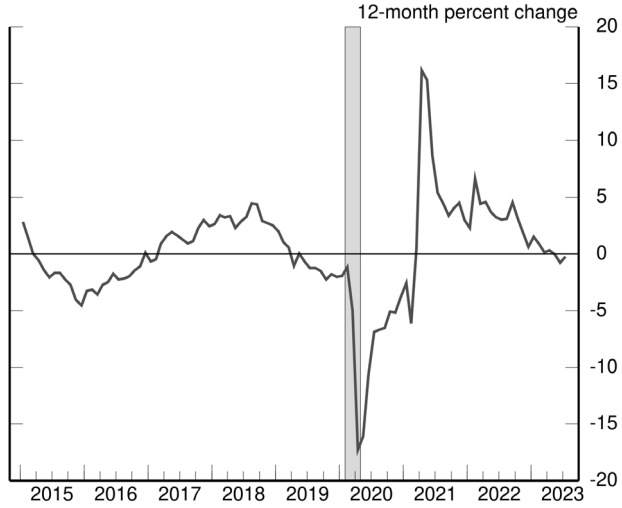
Indeed, the labor force participation rate of women in their prime working years reached an all-time high in June. Demand for labor has moderated as well. Job openings remain high but are trending lower. Payroll job growth has slowed significantly. Total hours worked has been flat over the past six months, and the average workweek has declined to the lower end of its pre-pandemic range, reflecting a gradual normalization in labor market conditions (Figure 5).

This rebalancing has eased wage pressures. Wage growth across a range of measures continues to slow, albeit gradually (Figure 6). While nominal wage growth must ultimately slow to a rate that is consistent with 2 percent inflation, what matters for households is real wage growth. Even as nominal wage growth has slowed, real wage growth has been increasing as inflation has fallen.

We expect this labor market rebalancing to continue. Evidence that the tightness in the labor market is no longer easing could also call for a monetary policy response.

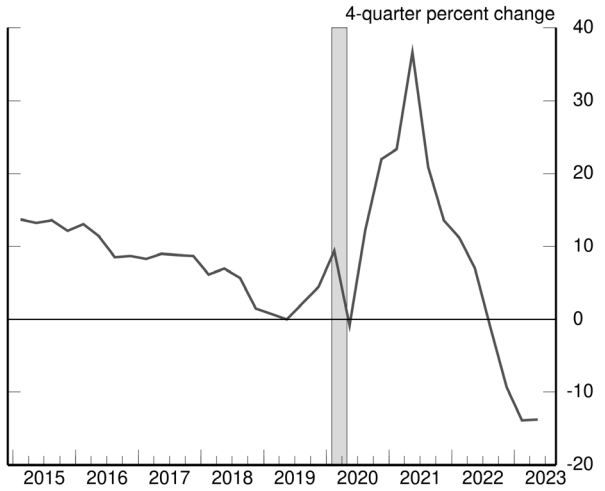
Figure 4

Panel A. Industrial Production



Note: The data are monthly and extend through July 2023. The shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Federal Reserve Board, Statistical Release G.17, "Industrial Production and Capacity Utilization."

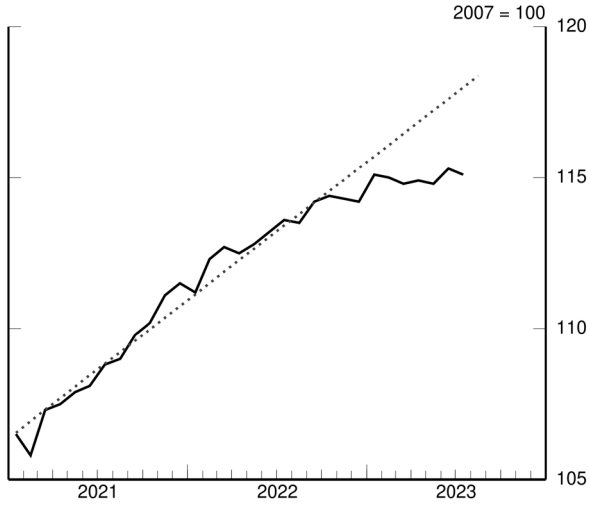
Panel B. Private Residential Investment



Note: The data are quarterly and extend through 2023:02. The shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Bureau of Economic Analysis via Haver Analytics.

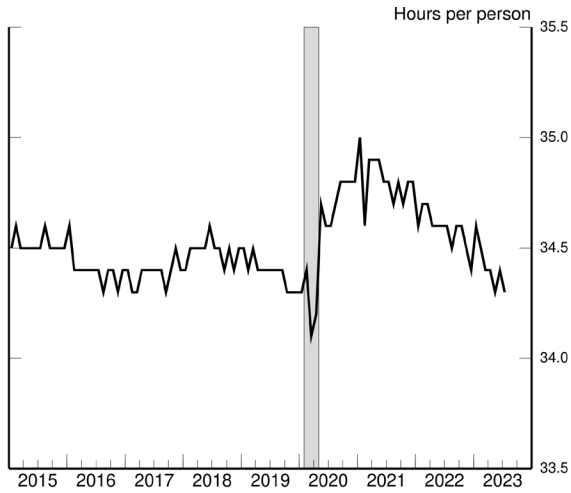
Figure 5

Panel A. Aggregate hours



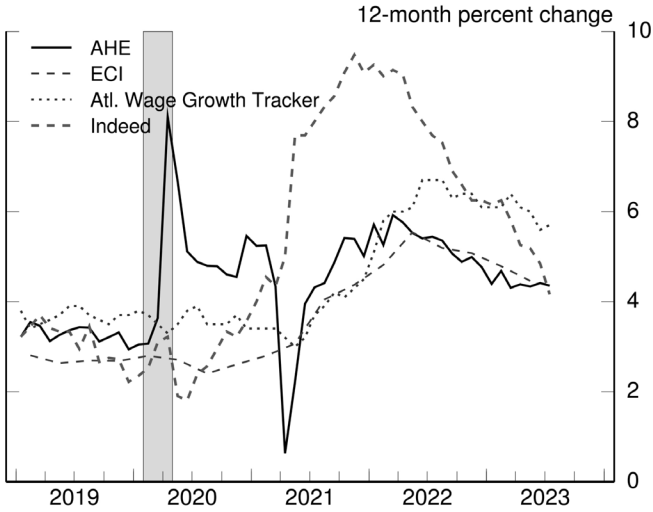
Note: Data are monthly and end in July 2023. The red dotted line is the 2021-2022 trend.
Source: Bureau of Labor Statistics.

Panel B. Workweek



Note: Data are monthly and end in July 2023. The gray shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020.
Source: Bureau of Labor Statistics.

Figure 6
Wage Growth



Note: The data for AHE, Atlanta Wage Growth Tracker, and Indeed are monthly and extend through July 2023. Atlanta Wage Growth Tracker data are shown as a 3-month moving average of the 12-month percent change. ECI change is over the 12 months ending in the last month of each quarter and starts in 2019:01 and extends through 2023:02. The shaded bar indicates a period of business recession as defined by the National Bureau of Economic Research: February 2020-April 2020. AHE is average hourly earnings; ECI is employment cost index.
Source: Bureau of Labor Statistics; Federal Reserve Bank of Atlanta, Wage Growth Tracker; Indeed; all via Haver Analytics.

III. Uncertainty and Risk Management along the Path Forward

Two percent is and will remain our inflation target. We are committed to achieving and sustaining a stance of monetary policy that is sufficiently restrictive to bring inflation down to that level over time. It is challenging, of course, to know in real time when such a stance has been achieved. There are some challenges that are common to all tightening cycles. For example, real interest rates are now positive and well above mainstream estimates of the neutral policy rate. We see the current stance of policy as restrictive, putting downward pressure on economic activity, hiring, and inflation. But we cannot identify with certainty the neutral rate of interest, and thus there is always uncertainty about the precise level of monetary policy restraint.

That assessment is further complicated by uncertainty about the duration of the lags with which monetary tightening affects economic activity and especially inflation. Since the symposium a year

ago, the Committee has raised the policy rate by 300 basis points, including 100 basis points over the past seven months. And we have substantially reduced the size of our securities holdings. The wide range of estimates of these lags suggests that there may be significant further drag in the pipeline.

Beyond these traditional sources of policy uncertainty, the supply and demand dislocations unique to this cycle raise further complications through their effects on inflation and labor market dynamics. For example, so far, job openings have declined substantially without increasing unemployment — a highly welcome but historically unusual result that appears to reflect large excess demand for labor. In addition, there is evidence that inflation has become more responsive to labor market tightness than was the case in recent decades.[8] These changing dynamics may or may not persist, and this uncertainty underscores the need for agile policymaking.

These uncertainties, both old and new, complicate our task of balancing the risk of tightening monetary policy too much against the risk of tightening too little. Doing too little could allow above-target inflation to become entrenched and ultimately require monetary policy to wring more persistent inflation from the economy at a high cost to employment. Doing too much could also do unnecessary harm to the economy.

IV. Conclusion

As is often the case, we are navigating by the stars under cloudy skies. In such circumstances, risk-management considerations are critical. At upcoming meetings, we will assess our progress based on the totality of the data and the evolving outlook and risks. Based on this assessment, we will proceed carefully as we decide whether to tighten further or, instead, to hold the policy rate constant and await further data.

Restoring price stability is essential to achieving both sides of our dual mandate. We will need price stability to achieve a sustained period of strong labor market conditions that benefit all.

We will keep at it until the job is done.

Endnotes

[1]Descriptions of PCE inflation include Board staff estimates of the July 2023 values based on available information, including the July 2023 consumer price index and producer price index data. The July 2023 PCE inflation data will be published by the Bureau of Economic Analysis on August 31, 2023.

[2]For example, 25 percent of respondents to the most recent University of Michigan Surveys of Consumers reported that it is currently a bad time to buy a new vehicle because of higher interest rates and tighter credit conditions, up from only 4 percent of respondents in 2021. For more information, see the preliminary results of the August 2023 survey, available on the University of Michigan's website at http://www.sca.isr.umich.edu.

[3]This slowing in rent growth has likely occurred for a combination of reasons. Some of it likely reflects higher interest rates and the softening in real household income growth over the past couple of years. But the normalization of dislocations due to the pandemic is likely playing a role here as well. For example, the shifts in housing preferences related to working from home likely contributed to the increase in housing demand reflected in the sizable earlier increases in rents. As the price effects of that demand shift played out, the growth rate of rents would naturally decline toward its earlier trend. Finally, multifamily construction is quite high by historical standards, and that supply coming on line has likely also taken some pressure off market rents.

[4]PCE prices for housing services include both the rents paid by tenants and an imputed rental value for owner-occupied dwellings (measured as the income the homeowner could have received if the house had been rented to a tenant). For additional details, see Bureau of *Economic Analysis (2022),* "Rental Income of Persons," in *NIPA Handbook: Concepts and Methods of the U.S. National Income and Product Accounts (Washington: BEA, December),* pp. 12-1–12-15, https://www.bea.gov/resources/methodologies/nipa-handbook/pdf/chapter-12.pdf.

[5]For an example of how tighter financial conditions affect economic activity, see the Federal Reserve Board staff's new index measuring U.S. financial conditions through their effect on the outlook for growth; the index is discussed in Andrea Ajello, Michele Cavallo, Giovanni Favara, William B. Peterman, John W. Schindler IV, and *Nitish R. Sinha (2023),* "A New Index to Measure U.S. Financial Conditions," FEDS Notes (Washington: Board of Governors of the Federal Reserve System, June 30), https://doi.org/10.17016/2380-7172.3281.

[6]Changes in real yields cited in this sentence refer to changes in yields on 2- and 10-year Treasury Inflation-Protected Securities.

[7]In addition, as the policy rate increased, nonbanking lending conditions changed as well. For example, beginning in 2022 and continuing into the first half of this year, net issuance of riskier debt — such as leveraged loans and speculative-grade and unrated corporate bonds — in public credit markets declined.

[8]The relationship between labor market slack and inflation, often called the Phillips curve relationship, is likely nonlinear, steepening in a tight labor market. If the Phillips curve has steepened in this way, a small change in labor market tightness could result in a more substantial change in inflation. It is difficult to know with precision how steep that relationship is in real time or how it might evolve as labor market tightness changes. For more information on nonlinearities in this relationship, see *Christoph E. Boehm and Nitya Pandalai-Nayar (2022),* "Convex Supply Curves," *American Economic Review,* vol. 112 (December), pp. 3941–69; *Pierpaolo Benigno and Gauti B. Eggertsson (2023),* "It's Baaack: The Surge in Inflation in the 2020s and the Return of the Non-Linear Phillips Curve," NBER Working Paper Series 31197 (Cambridge, Mass.: National Bureau of Economic Research, April), https://www.nber.org/system/files/working_papers/w31197/w31197.pdf; and *Nicolas Petrosky-Nadeau, Lu Zhang, and Lars-Alexander Kuehn (2018),* "Endogenous Disasters," *American Economic Review,* vol. 108 (August), pp. 2212–45.

Has the Macroeconomic Environment Impacted Long-Run Shifts in the Economy?

Yueran Ma and Kaspar Zimmermann

Abstract

We document that monetary policy has a substantial impact on innovation activities. After a tightening shock of 100 basis points, research and development (R&D) spending declines by about 1 to 3 percent and venture capital (VC) investment declines by about 25 percent in the following 1 to 3 years. Patenting in important technologies, as well as a patent-based aggregate innovation index, declines by up to 9 percent in the following 2 to 4 years. Based on previous estimates of the sensitivity of output to innovation activities, these magnitudes imply that output could be 1 percent lower after another 5 years. Monetary policy can influence innovation activities by changing aggregate demand and correspondingly the profitability of innovation, and by changing financial market conditions. Both channels appear relevant in the data. Our findings suggest that monetary policy may affect the productive capacity of the economy in the longer term, in addition to the well-recognized near-term effects on economic outcomes.

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I. Introduction

Since at least the influential American Economic Association presidential address by Milton Friedman in 1968 (*Friedman*, *1968)*, discussions about monetary policy have commonly focused on its short-run impact. The productive capacity of the economy in the longer term is often presumed to be separate from the conduct of monetary policy, which *Blanchard* (*2018)* refers to as the "independence hypothesis." A small and growing body of work has been interested in the possible longer-term consequences of monetary policy, which may operate through the influence of monetary policy on innovation and technological progress *(Stadler, 1990; Moran and Queralto, 2018; Grimm, Laeven, and Popov, 2022; Amador, 2022; Fornaro and Wolf, 2023; Jordà, Singh, and Taylor, 2023; Ma, 2023)*. For example, following monetary policy contractions, reductions in aggregate demand can decrease the profitability and incentives for innovation. Tighter financial conditions and lower risk appetite can decrease funding for innovation. A slower pace of innovation may then have lasting effects.

To date, there have been limited empirical analyses about the impact of monetary policy on innovation. This sparsity of systematic evidence is somewhat surprising. Casual observations suggest that shifts in the interest environment over the past decade have had noticeable effects on innovation funding such as VC investment. During the years of low interest rates, venture funding was abundant and startups expanded rapidly. As interest rates increased substantially since early 2022, venture funding fell sharply and startups struggled to survive *(National Venture Capital Association, 2023)*. In addition, there is accumulating evidence that innovation is affected by demand and financial conditions *(King and Levine, 1993; Barlevy, 2007; Brown, Fazzari, and Petersen, 2009; Ouyang, 2011; Huber, 2018; Anzoategui et al., 2019; Duval, Hong, and Timmer, 2020; Queralto, 2020)*, and that both demand and financial conditions respond to monetary policy *(Christiano, Eichenbaum, and Evans, 1999; Bernanke and Kuttner, 2005; Gertler and Karadi, 2015)*. It seems natural to piece together these separate lines of inquiry.

In this paper, we perform an extensive empirical investigation about the effects of monetary policy on innovation activities, using a variety of metrics of innovation. In addition to the aggregate investment in intellectual property products (including R&D) from the national accounts and the R&D spending of public companies, we utilize measures based on VC investment and patent filings. Venture capital is well known to invest in innovative companies, which account for many of the most successful enterprises in recent decades *(Gompers et al., 2020)*; previous work finds that a dollar of venture capital is about three times more potent in stimulating patenting than a dollar of traditional R&D *(Kortum and Lerner, 2000)*. Patenting is a widely used indicator for innovation output, which complements innovation expenditures like R&D spending and VC investment. We study this collection of measures for innovation, and identify the effects of monetary policy following the standard approach of local projection impulse responses to monetary policy shocks. Our baseline analyses use the *Romer and Romer (2004)* shocks, which are available for a long sample period from 1969 to 2007; the results are robust to other estimates of monetary policy shocks.

We observe meaningful changes in innovation activities in the years following monetary policy shocks. We normalize the shock to tightening by 100 basis points for illustration (the results are largely symmetric for tightening and easing shocks). First, investment in intellectual property products (IPP) in the national accounts (NIPA) declines by about 1 percent. The magnitude is comparable to the decline in traditional investment in physical assets. R&D spending in Compustat data for public firms declines by about 3 percent. Second, VC investment is more volatile, and declines by as much as 25 percent at a horizon of 1 to 3 years after the monetary policy shock. Third, patenting in important technologies measured by *Bloom et al. (2023)* declines by up to 9 percent 2 to 4 years after the shock. Interestingly, patenting in other technologies declines by less than patenting in important technologies according to the importance classification in *Bloom et al. (2023)*. An aggregate innovation index constructed by *Kogan et al. (2017)* using estimates of the economic value of patents also declines by up to 9 percent.[1] Based on estimates by *Kogan et al. (2017)* about the output and total factor

productivity (TFP) sensitivity to the aggregate innovation index, a 9 percent decline in the index can contribute to 1 percent lower real output and 0.5 percent lower TFP 5 years later. These magnitudes are in line with estimates of the social returns to innovation spending *(Hall, Mairesse, and Mohnen, 2010; Jones and Summers, 2020)*.[2] The high returns to innovation and the role of innovation in shaping the productive capacity of the economy can make fluctuations of innovation activities even more important than fluctuations of traditional investment in physical assets.[3]

For the transmission mechanism from monetary policy to innovation activities, we find indications that both demand conditions and financial conditions are relevant. First, by decreasing demand, monetary policy tightening can reduce the profitability of developing new products and the incentives to innovate *(Shleifer, 1986; Fatas, 2000; Comin and Gertler, 2006; Benigno and Fornaro, 2018)*. In the data, we observe a stronger decline in both R&D and patenting in more cyclical industries. We also observe that patenting declines after monetary policy tightening among both public and private companies, and among both large and small public companies. To the extent that large public firms have abundant financial resources, the slowdown of innovation activities among these firms is likely driven by reduced demand. Second, monetary policy tightening can affect financial conditions and reduce the appetite for risk taking *(Bauer, Bernanke, and Milstein, 2023; Kashyap and Stein, 2023)*. In the data, we observe that VC investment for both early stage and late stage startups declines after monetary policy tightening. To the extent that early stage startups are still in the product development phase and may not have products coming to the market immediately, reduced funding for them could reflect less appetite for investing in risky endeavors.

Our empirical analyses rely on a collection of innovation measures that can be obtained from existing data, which provide useful indicators of innovation activities in the economy. It is well recognized that capturing all innovation activities is challenging *(Council, 2004; Foster et al., 2019; Foster, Grim, and Zolas, 2020)*, but the mechanisms above can also apply to innovation activities that are more

difficult to measure. In addition, although our empirical analyses rely on monetary policy shocks for the purpose of identification, the mechanisms that make innovation activities sensitive to monetary policy shocks should be relevant for the systematic component of monetary policy as well.

Our work has focused on studying the effects of conventional monetary policy. The impact of unconventional monetary policy such as quantitative easing is another interesting question for the past decade. *Grimm, Laeven, and Popov (2022)* suggest that quantitative easing policies in Europe had a positive effect on the innovation activities of firms whose bonds were eligible for ECB's corporate bond purchases. At the same time, *Liu, Mian, and Sufi (2022)* suggest that when interest rates are very low, further easing may favor industry leaders and result in lower productivity growth. Future empirical work can provide more insights about how unconventional monetary policies and ultra-low interest rates affect innovation activities.

We then turn to the conditions in recent years. Since the rate hikes began in 2022, VC investment has declined substantially from the peak in 2021, by about 30 percent annually. The decline is present in all major sectors (not just in segments that are sometimes perceived as speculative bubbles such as crypto). Investment in generative AI has rebounded in 2023, but largely driven by Microsoft's $10 billion investment in OpenAI. Meanwhile, aggregate R&D in the national accounts has been steady. The real effects of the decrease in VC investment remain to be seen. It is widely recognized that overvaluation was present in the VC market before this downturn *(National Venture Capital Association, 2021)*. Whether venture funding will "return to normal" from overvaluation or experience a persistent slump will become clearer in the coming years. A common question is whether fluctuations in innovation are driven by the rise and fall of excessive investment in wasteful projects. *Nanda and Rhodes-Kropf (2013)* find that VCs invest more in risky and innovative companies in booms, not just low quality companies. We find that patenting in important technologies responds significantly to monetary policy, suggesting that monetary policy does not just affect the bubble component of innovation cycles.

Over the long run, technological waves can occur from time to time for a variety of reasons, and several major technological waves have survived through adverse macroeconomic environments. For example, during the Second Industrial Revolution and the age of electrification from around the 1890s to around the 1920s, the U.S. economy experienced several large and deep crises such as the panic of 1893 and the panic of 1907. During the Third Industrial Revolution and the age of computerization around the 1970s and the 1980s, the U.S. economy also experienced high inflation and high interest rates due to the oil crisis. Our analyses find that cyclical fluctuations affect innovation activities on an "evolutionary" basis. That said, when technological revolutions occur and innovation activities are several times higher than what takes place in an average decade, adverse macro conditions may not break such waves (even though their magnitude could have been affected on the margin).

Although the data suggest that monetary tightening reduces innovation activities, it is possible that downturns also have cleansing effects by eliminating weak companies *(Schumpeter, 1942; Caballero and Hammour, 1994; Foster, Grim, and Haltiwanger, 2016)*. To the extent that such companies are likely to be technologically underdeveloped and less innovative, the innovation measures above may not capture these potential cleansing effects. *Gopinath et al. (2017)* suggest that low interest rates worsened misallocation in Southern Europe as capital investment by large firms with high net worth increased by more, due to size-dependent borrowing constraints. Meanwhile, *Baqaee, Farhi, and Sangani (2023)* suggest that monetary easing can alleviate resource misallocation in a model with variable markups. Studies of business formation also find that economic downturns in the U.S. tend to suppress the emergence of firms with high potential *(Ouyang, 2009; Sedláček and Sterk, 2017; Moreira, 2016; Hamano and Zanetti, 2022; Davis and Haltiwanger, 2023)*. More empirical work on whether (and in which areas) monetary policy may have cleansing effects could be useful.

If monetary policy affects innovation, what are the implications for the conduct of monetary policy? A small and growing set of theoretical models consider the design of optimal monetary policy

with endogenous productivity *(Benigno and Fornaro, 2018; Ikeda and Kurozumi, 2019; Garga and Singh, 2021; Queralto, 2022; Fatás and Singh, 2022; Fornaro and Wolf, 2023)*. Our focus is to present empirical facts, and optimal policy analysis is beyond the scope of this paper. We summarize several questions about policy implications that often come up in light of our empirical evidence. More work in the future can help us better understand these issues.

First, should monetary policy be more accommodative on average if innovation is under supplied (due to high social externalities)? At the moment, we are mindful of the well known lesson that efforts seeking to perennially stimulate the economy with monetary easing may be ineffective or counterproductive *(Friedman, 1968; Lucas, 1976)*. Second, should monetary policy be more countercyclical to stabilize innovation? Several papers suggest that stabilizing innovation is beneficial *(Barlevy, 2004; Aghion, Farhi, and Kharroubi, 2012)*. We hope that our evidence on the sensitivity of innovation to monetary policy can inform future analyses. Third, given that monetary policy has easing and tightening periods, do their effects cancel out? As discussed above, monetary easing and tightening could be useful for stabilizing innovation in response to other shocks (e.g., demand or financial shocks), so the issue is not just about monetary policy actions in different directions offsetting themselves. In addition, as *Blanchard (2018)* writes, the objective is to study "the size and persistence of the effects of monetary policy on potential output, not their permanence" (permanent effects are inevitably difficult to pin down). Finally, can other policies address fluctuations in innovation so that monetary policy maintains a simpler focus? Fiscal policy is a standard option, but it may face budgetary constraints and implementation challenges (e.g., selecting the innovation activities to subsidize and making frequent adjustments).

In summary, the evidence shows that the effects of monetary policy on innovation activities and the potential longer-term consequences deserve more attention. Monetary policy can influence production activities in many important ways. In the minutes and transcripts of the FOMC, discussions about the impact of monetary policy on investment typically focus on traditional capital expenditures on

physical assets; in monetary economics, the word "innovation" typically occurs in the context of "monetary policy innovation." Given the significance of production innovation and technological advancement for economic progress, it would be valuable to consider this dimension, and to better understand its implications for the conduct of monetary policy.

II. Monetary Policy Shocks and Innovation Activities

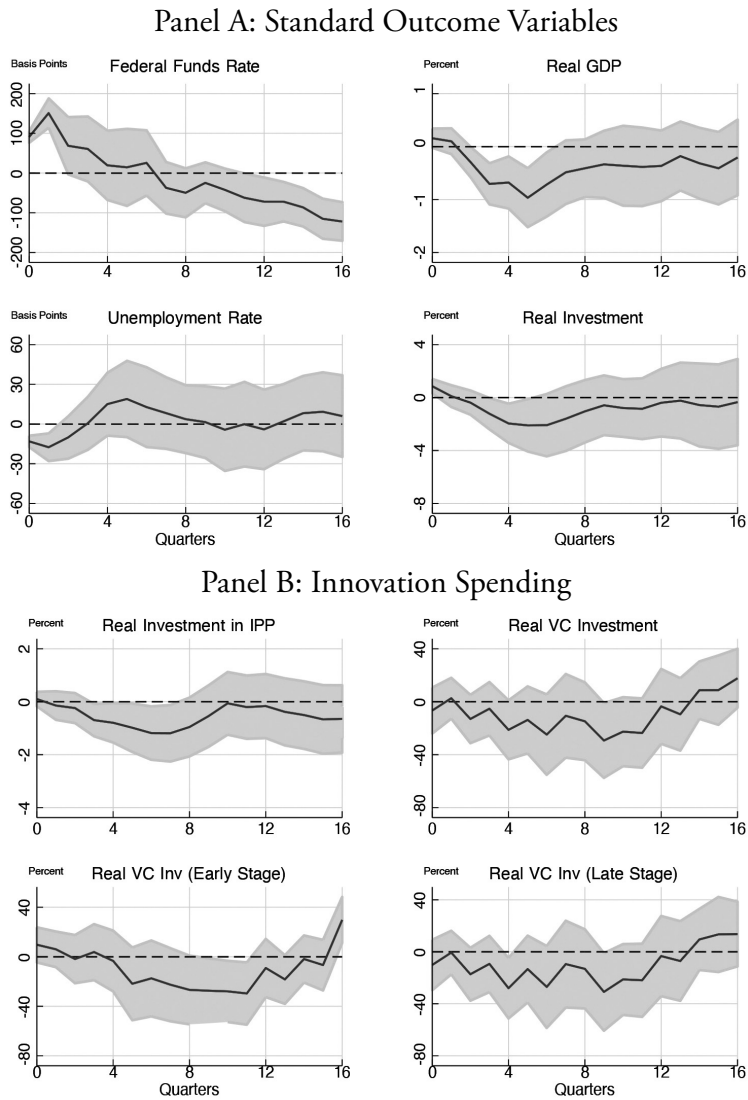
This section presents our main results about the effects of monetary policy on innovation activities. We provide the findings in Section 2.1, discuss the mechanisms behind the evidence in Section 2.2, and make a comparison with the effects of fiscal policy in Section 2.3.

II.A. Main Results

We examine the impulse response of innovation activities to monetary policy shocks. Our baseline tests use quarterly *Romer and Romer (2004)* shocks with updates by *Ramey (2016)* and *Wieland and Yang (2020)*, which cover a long time period from 1969 to 2007. The results are similar using the refinement of *Romer and Romer (2004)* shocks by *Aruoba and Drechsel (2023)*, or high frequency shocks (which start later in the 1990s). The monetary policy shocks aim to capture variations in the Federal Funds rate that are not explained by the prevailing economic conditions, in order to isolate the influence of monetary policy on subsequent economic activities. We use standard *Jordà (2005)* local projections, and the impulse response plots present the coefficients from regressing future outcomes on the monetary policy shock; our empirical specifications follow *Ramey (2016)*. We normalize the shock to tightening by 100 basis points for illustration; so far we do not find the results to be significantly asymmetric for tightening and easing shocks.

Figure 1, Panel A, begins with the impulse response of standard outcome variables, including quarterly real GDP, unemployment, and real investment in physical assets (nonresidential investment in structure and equipment plus residential investment) from the national accounts (NIPA).[4] Panel B studies several measures of innovation spending, including quarterly real investment in intellectual property products (IPP) from the national accounts (which includes spending

Figure 1
Impulse Response of Economic and Innovation Activities to Monetary Policy Shocks



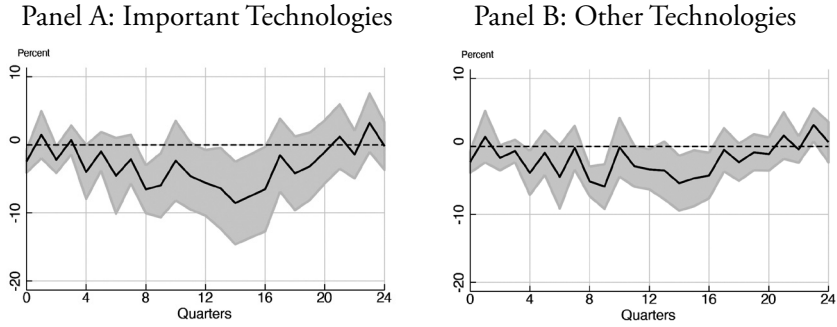
Notes: Panel A shows the impulse response of standard outcome variables, including quarterly Federal Funds rates, log real GDP, unemployment, and log real physical asset investment from the national accounts (nonresidential investment in structure and equipment plus residential investment), to a 100 basis point *Romer and Romer (2004)* monetary policy shock. Panel B shows the impulse response of innovation spending measures, including quarterly log real investment in Intellectual Property Products (IPP) from the national accounts, as well as log real total, early stage, and late stage venture capital (VC) investment. We estimate *Jordà (2005)* local projections $x_{t+h} = \alpha + \beta mps_t + \gamma z_t + \epsilon_t$, and plot the regression coefficient β on the monetary policy shock (the solid line). The control variables z_t include 4 lags of the outcome variable, 4 lags of the monetary policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, and the excess bond premium *(Gilchrist and Zakrajšek, 2012).* Standard errors are Eicker-Huber-White following *Montiel Olea and Plagborg-Møller (2021)*. The shaded area represents the 90% confidence interval.

on R&D), and quarterly real VC investment from VentureXpert (now in the Refinitiv Private Equity database).[5] We also separate VC investment into early stage deals and late stage deals. For all regressions in this section, we control for 4 lags of the outcome variable, the Federal Funds rate, log real GDP, log CPI, the unemployment rate, and the excess bond premium.

We observe that investment in IPP declines by about 1 percent in the following 2 years, broadly in line with the magnitude of the decline for traditional investment in physical assets. The NIPA measure of quarterly IPP investment may be overly stable since the underlying sources are annual surveys of firms' innovation activities (such as the Business R&D and Innovation Survey and the Survey of Industrial Research and Development), and NIPA then interpolates annual data to construct quarterly series *(Crawford et al., 2014)*.[6] In Panel A of Figure A1, we also provide impulse responses based on firm-level quarterly real R&D spending for public companies using Compustat data. Quarterly R&D spending in Compustat was sparse before 1990, so the time span is shorter. In addition, incomplete R&D reporting in financial statements can generate missing observations in Compustat data *(Koh and Reeb, 2015)*, so we use the Compustat analysis as supplementary information. We observe that R&D spending among Compustat firms declines by about 3 percent 2 to 3 years after the monetary policy tightening shock. The magnitude is broadly similar to the sensitivity of Compustat firm-level R&D spending to interest rates in *Döttling and Ratnovski (2023)*.[7] For VC investment, which is more volatile, the impulse response is even larger in magnitude. For up to 12 quarters after the tightening shock, quarterly VC investment declines by as much as 25 percent (though the coefficients are not estimated very precisely due to noise in historical VC investment data). The decline is observed for both early stage and late stage VC deals.

Figure 2 turns to technological diffusion and advancement measured using patent data. Recent work by *Bloom et al. (2023)* categorizes around 300 types of important technologies that emerged since 1976 (such as cloud computing and electric vehicles). They first classify different types of technologies using bigrams in patent text,

Figure 2
Impulse Response of Patent Filings in Important Technologies to Monetary Policy Shock



Notes: Panel A shows the impulse response of patent filings associated with the important technologies to a 100 basis point *Romer and Romer (2004)* monetary policy shock. Panel B shows the impulse response of patent filings associated with other technologies. We estimate *Jordà (2005)* local projections $x_{i,t+h} = \alpha_i + \beta mps_t + \gamma z_t + \epsilon_{i,t}$, and plot the regression coefficient β on the monetary policy shock (the solid line). The outcome variable $x_{i,t+h}$ is the log number of patents filed in technology i in quarter $t + h$. The control variables z_t include 4 lags of the outcome variable, 4 lags of the monetary policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, the excess bond premium *(Gilchrist and Zakrajšek, 2012)*. Technology fixed effects and technology age fixed effects (number of years since the earliest patent filing in the technology) are included. Standard errors are *Driscoll and Kraay (1998)* with a bandwidth of 20. The shaded arearepresents the 90% confidence interval.

and then select important technologies as those that are frequently mentioned in companies' earnings calls (by more than 100 times between 2002 and 2019). We calculate the number of patent filings associated with these important technologies each quarter, and use local projection regressions to study the impulse response to monetary policy shocks. In Panel A, we observe that patenting in these important technologies declines by as much as 9 percent about 3 to 4 years after the shock. This time frame is consistent with previous findings that the R&D process takes 2 to 3 years *(Mansfield et al., 1971; Ravenscraft and Scherer, 1982; Jones and Summers, 2020)*, and that the effects of other shocks (e.g., credit supply) on patent filings start to emerge after 1 or 2 years *(Amore, Schneider, and Žaldokas, 2013; Chava et al., 2013; Cornaggia et al., 2015)*.

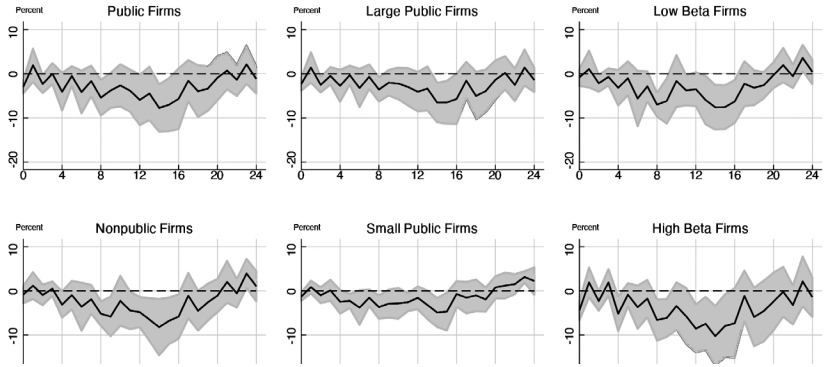
We also observe that patenting in important technologies appears more affected than patenting in general. In Panel B of Figure 2, we perform the same regressions in Panel A but for technologies that are outside of the set of important technologies. The decline we observe is only around half as much as that in Panel A. Similarly, we do not

find a clear response for the total number of all patents. One possibility is that patenting in these important technologies captures the adoption of new technologies. Companies may be less (more) eager to spend effort and resources to adopt them following monetary policy tightening (easing), due to changes in financial conditions and the profitability of innovation that we will discuss more in Section 2.2. In comparison, total patent counts for instance can be driven by refinement of old technologies or random explorations, which are less cyclical.

For patenting associated with the important technologies in *Bloom et al. (2023)*, Figure 3 provides a further breakdown for those filed by public and private firms, large public and small public firms (asset size above and below median), and patents in less and more cyclical industries (asset beta below and above median). We observe that patenting declines in all these cases, and the decline is larger in more cyclical industries. These patterns are consistent with the impulse response of R&D spending in Compustat data for different types of firms, shown in Panel B of Figure A1. There we also observe a stronger response for firms that are more cyclical. We will use these results to shed further light on the underlying mechanisms in Section 2.2.

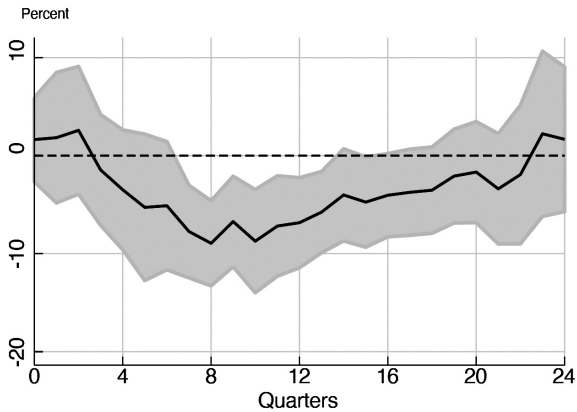
Finally, Figure 4 examines the aggregate innovation index constructed by *Kogan et al. (2017)*. In this case, we also observe a decline in the innovation index by up to 9 percent 2 to 3 years following the shock. Based on the estimates in *Kogan et al. (2017)*, a 9 percent decline in the innovation index for over a year could lead to lower output by 1 percent and TFP by 0.5 percent 5 years later.[8] These magnitudes are consistent with estimates of the social returns to innovation spending *(Hall, Mairesse, and Mohnen, 2010; Jones and Summers, 2020)*. For instance, many studies estimate that 1 dollar of innovation spending generates about 10 dollars of social return. R&D spending is about 2.5 percent of GDP, and VC investment is about 0.75 percent of GDP. A 2 percent decrease in R&D spending and a 25 percent decrease in VC investment would imply lower output by over 2 percent.[9] The high returns to innovation and the role of innovation in shaping the productive capacity of the economy can make fluctuations of innovation activities more important than

Figure 3
Impulse Response of Different Types of Patents to Monetary Policy Shock



Notes: This figure shows the impulse response of patents associated with the important technologies filed by the public and private firms, large public and small public firms, and patents in less and more cyclical industries (based on estimates of asset beta by scaling equity beta from stock returns with leverage), to a 100 basis point *Romer and Romer (2004)* monetary policy shock. We estimate *Jordà (2005)* local projections $x_{i,t+h} = \alpha_i + \beta mps_t + \gamma z_t + \epsilon_{i,t}$, and plot the regression coefficient β on the monetary policy shock (the solid line). The outcome variable $x_{i,t+h}$ is the log number of patents filed in technology i in quarter $t + h$. The control variables z_t include 4 lags of the outcome variable, 4 lags of the monetary policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, the excess bond premium *(Gilchrist and Zakrajšek, 2012)*. Technology fixed effects and technology age fixed effects (number of years since the earliest patent filing in the technology) are included. Standard errors are *Driscoll and Kraay (1998)* with a bandwidth of 20. The shaded area represents the 90% confidence interval.

Figure 4
Impulse Response of Innovation Index to Monetary Policy Shock



Notes: This figure shows the impulse response of the aggregate innovation index by *Kogan et al. (2017)* to a 100 basis point *Romer and Romer (2004)* monetary policy shock. We estimate *Jordà (2005)* local projections $x_{t+h} = \alpha + \beta mps_t + \gamma z_t + \epsilon_t$, and plot the regression coefficient β on the monetary policy shock (the solid line). The control variables z_t include 4 lags of the outcome variable, 4 lags of the monetary policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, and the excess bond premium *(Gilchrist and Zakrajšek, 2012).* Standard errors are Eicker-Huber-White following *Montiel Olea and Plagborg-Møller (2021)*. The shaded area represents the 90% confidence interval.

fluctuations of traditional investment in physical assets. As *Blanchard (2018)* explains, lower capital stock after monetary tightening has a relatively limited impact on potential output in standard models. For example, a 100 basis point monetary policy shock may affect output after 5 years by around 0.1 percent through changes in traditional investment.[10]

It is econometrically challenging to directly estimate the impact of monetary policy shocks on output and productivity over 8 years afterwards (3 years lag for the innovation index and another 5 years lag from innovation to output). In addition, there are a number of other transmission mechanisms of monetary policy that affect the output response *(Christiano, Eichenbaum, and Evans, 2005; McKay and Wieland, 2021; Baqaee, Farhi, and Sangani, 2023)*. Accordingly, our focus is to directly trace out the effects of monetary policy shocks on innovation activities, and we rely on previous work about the aggregate implications of innovation to infer the longer-term output impact of this channel.

One possible concern is that monetary policy shocks are not fully exogenous. If the shocks have endogenous elements, these imperfections can bias against finding significant real effects. For example, if monetary policy tightens when the economy overheats, it would be harder to find negative real effects. In the appendix (Figures A2 to A4), we also present analyses using the *Aruoba and Drechsel (2023)* refinement of the *Romer and Romer (2004)* shocks. *Aruoba and Drechsel (2023)* use textual analyses of FOMC documents to further remove the responses of the Federal Funds rate to economic conditions. We observe similar results with slightly larger magnitude. In general, further refinement of monetary policy shocks tends to generate stronger real effects *(Bauer and Swanson, 2023)*.

II.B. Mechanisms

Research on innovation activities points to at least two mechanisms for the impact of monetary policy on innovation. First, by decreasing demand, monetary policy tightening can reduce the profitability of developing new products and the incentives to innovate. Second, monetary policy tightening can affect financial conditions and reduce

the appetite for risk taking. The empirical results above suggest that both mechanisms are relevant.[11]

For the relevance of demand, we observe in Figure 3 a stronger response of patenting to monetary policy shocks for more cyclical industries (i.e., industries with higher asset beta), where demand is likely more sensitive to economic conditions. Their R&D spending also declines by more as shown in Panel B of Figure A1. In addition, we see that the decline in innovation activities occurs among both public and private firms, and among both large public and small public firms. To the extent that large public firms are less affected by financial conditions, the slowdown in technological development among these companies is likely driven by reduced demand.

For the relevance of financial conditions, Panel B of Figure 1 shows that early stage VC investment declines after monetary policy tightening. To the extent that early stage startups are still in the product development phase and may not have products coming to the market immediately, the reduction of funding for them could reflect less appetite among investors for risky undertaking. Figure A5 shows that the excess bond premium is higher by up to 10 basis points for a year after the tightening shock, and the NASDAQ index is lower by 8 percent for 3 to 4 years. Figure A6 shows that when the excess bond premium increases by 100 basis points, innovation activities in the following years decline significantly. Based on these magnitudes, a 10 basis point change in the excess bond premium following our baseline monetary policy shock can partly account for the changes in innovation activities.[12]

Our empirical analyses need to rely on the readily measurable metrics of innovation, which serve as useful indicators of innovation activities in the economy. It is challenging to measure all innovation activities, but these mechanisms can also apply to innovation activities that are more difficult to measure. We also rely on monetary policy shocks for empirical identification. The mechanisms that make innovation activities sensitive to monetary policy shocks should be relevant for the systematic component of monetary policy as well. In particular, the systematic component of monetary policy affects

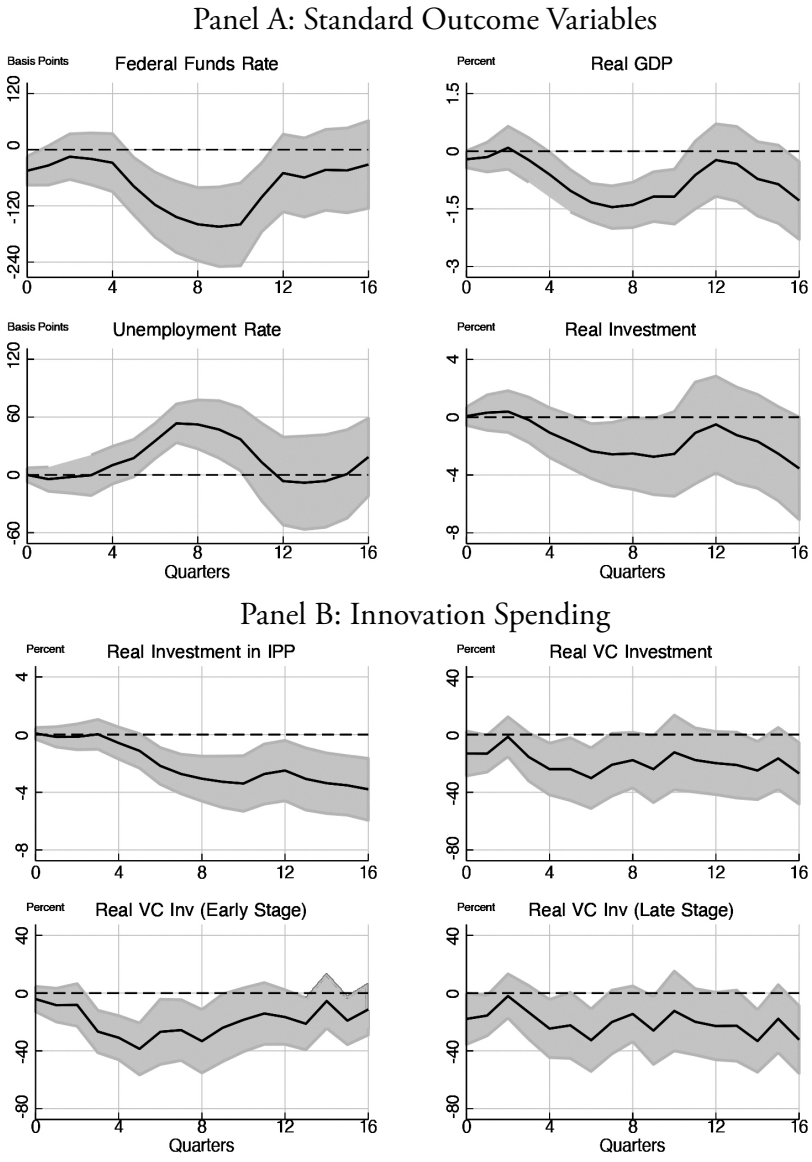
both aggregate demand and financial conditions, which may then transmit to innovation activities.

II.C. Comparison with Fiscal Policy Shocks

To provide further perspectives on the magnitude of the changes in innovation activities following monetary policy shocks, we present a comparison with the response of innovation to fiscal policy shocks. Although empirical analyses of how monetary policy affects innovation are scarce, a large literature has investigated the impact of fiscal policy on innovation, covering tax changes, military spending, and specific government programs *(Bloom, Griffith, and Van Reenen, 2002; Howell, 2017; Azoulay et al., 2019; Akcigit et al., 2022; Myers and Lanahan, 2022; Kantor and Whalley, 2022; Cloyne et al., 2022; Antolin-Diaz and Surico, 2022)*. Many of these studies document that fiscal policy has significant effects on innovation. For parsimony, we provide a simple comparison of the impulse response of innovation activities to monetary policy shocks documented above with the response to fiscal policy shocks in the form of tax changes. Tax changes can directly affect a large set of firms, facilitating the comparison with monetary policy shocks, whereas the direct effect of military spending and particular government programs may concentrate on a subset of firms. We use the aggregate fiscal shocks due to tax changes constructed by *Romer and Romer (2010)*, who read historical records to classify exogenous tax changes that are not related to the current state of the economy. We present the results in Figures 5 and 6 using the same empirical specification and the same sample period as the corresponding analyses in Section 2.

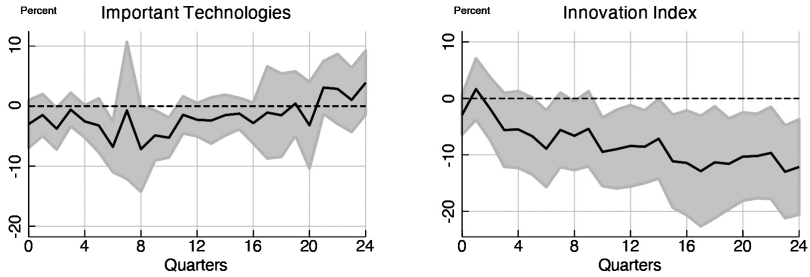
With a tax change that increases tax liabilities by 1 percent of GDP, we observe that real GDP declines by about 1.5 percent after 2 to 3 years, and investment in both traditional physical assets and intellectual property declines by around 3 percent. VC investment (in both early stage and late stage deals) declines by about 25 percent for several years. Patenting in important technologies and the innovation index decline by 5 to 10 percent. Overall, the magnitude is similar to a 100 basis point monetary policy shock shown in Section 2.1. These results further help us put into perspective the effect of monetary policy shocks on innovation activities.

Figure 5
Impulse Response of Economic and Innovation Activities to Fiscal Policy Shock



Notes: Panel A shows the impulse response of standard outcome variables, including quarterly Federal Funds rates, log real GDP, unemployment, and log real physical asset investment from the national accounts, to a 1 percent increase in tax liabilities to GDP from *Romer and Romer (2010)*. Panel B shows the impulse response of innovation spending measures, including quarterly real investment in Intellectual Property Products (IPP) from the national accounts, as well as real total, early stage, and late stage venture capital (VC) investment. The control variables include 4 lags of the outcome variable, 4 lags of the fiscal policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, and the excess bond premium *(Gilchrist and Zakrajšek, 2012)*. Standard errors are Eicker-Huber-White following *Montiel Olea and Plagborg-Møller (2021)*. The shaded area represents the 90% confidence interval.

Figure 6
Impulse Response of Patenting and Innovation Index to Fiscal Policy Shock



Notes: This figure shows the impulse response of patent filings associated with the important technologies and the aggregate innovation index constructed by *Kogan et al. (2017)* to a 1 percent increase in tax liabilities to GDP from *Romer and Romer (2010)*. The control variables include 4 lags of the outcome variable, 4 lags of the fiscal policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, the excess bond premium *(Gilchrist and Zakrajšek, 2012)*. The regressions using the panel of important technologies include technology fixed effects and technology age fixed effects (number of years since the earliest patent filing in the technology). Standard errors are *Driscoll and Kraay (1998)* with a bandwidth of 20 for patenting in important technologies, and Eicker-Huber-White for the innovation index. The shaded area represents the 90% confidence interval.

III. Discussion

We discuss three sets of additional topics in this section. First, we present an overview of the current conditions for innovation investment in Section 3.1. Second, we summarize the long-run evolution of innovation activities in Section 3.2. Third, we discuss potential policy implications related to the effects of monetary policy on innovation in Section 3.3.

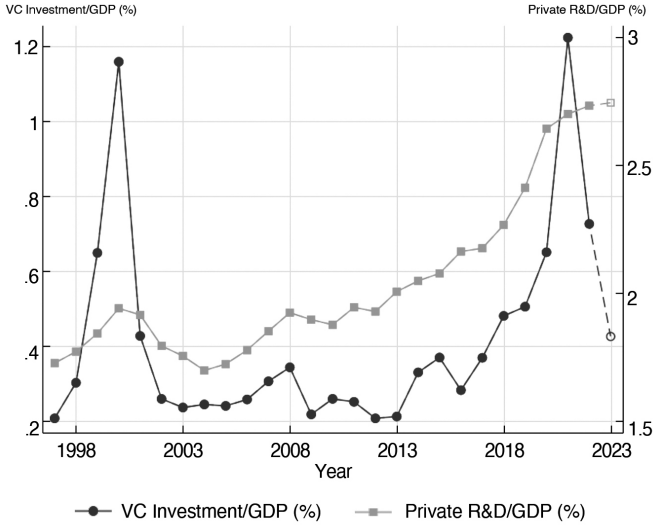
III.A. Current Conditions

Since the start of rate hikes in 2022, the venture capital market has cooled down substantially. In the following, we discuss recent developments in innovation investment.

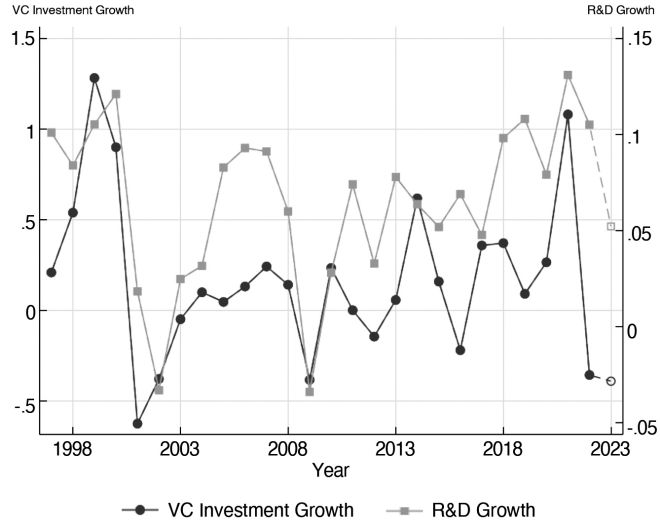
Figure 7 presents the general trends in the past few decades. Panel A shows VC investment, as well as R&D investment in the national accounts, as a share of GDP. Panel B shows the annual growth rate of VC investment and R&D investment in the national accounts. Both series increased around 2000, declined in the early 2000s, and rose steadily in the past decade until 2022. Since 2022, VC investment has fallen by around 30 percent annually. R&D in the national accounts

Figure 7
Recent Trends in Innovation Investment

Panel A: Annual VC Investment and R&D Investment as a Share of GDP



Panel B: Annual Growth of VC Investment and R&D Investment



Notes: Panel A shows VC investment as a share of GDP, as well as R&D investment in the national accounts as a share of GDP. Panel B shows the annual growth rate of VC investment and R&D investment in the national accounts. Data for 2023 use annualized rates based on Q1 and Q2.

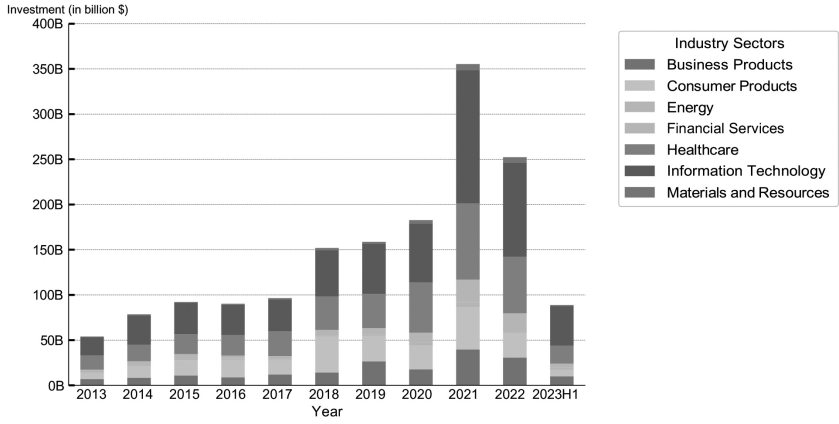
has continued to grow. Overall, the growth of VC investment and R&D spending in NIPA are 60% correlated, but VC investment is much more volatile, in line with higher sensitivity of startup activities to business conditions. Figure 8 presents the trends in VC investment by industry segment based on PitchBook data. Panel A shows that the recent decline is observed in all major industry groups (not just in segments that are sometimes perceived as speculative bubbles such as crypto). Panel B shows that the area of generative AI in 2023 is one exception, but the increase is largely driven by Microsoft's $10 billion investment in OpenAI.

It remains to be seen whether the recent slowdown in VC activities will be transitory or persistent like in the early 2000s. One common question is whether these episodes represent declines of socially valuable innovation, or corrections of bubbles and excessive investment. On the one hand, economics research generally holds the view that innovation is under supplied due to high externalities *(Jones and Williams, 1998; Bloom, Schankerman, and Van Reenen, 2013)*. Previous work also finds that innovation downturns have negative effects. *Bianchi, Kung, and Morales (2019)* suggest that the 2001 recession could have contributed to persistent growth slowdown. *Nanda and Rhodes-Kropf (2013)* suggest that VCs fund companies that are riskier but more innovative in hot markets, instead of systematically making wasteful investment. On the other hand, many examples point to overvaluation during the dotcom boom, and at least some companies without viable businesses received abundant financing. In our data, monetary policy affects important technologies more than ordinary technologies, as shown in Figure 2. In other words, shifts in monetary policy appear to influence innovation activities that are socially relevant rather than simply the bubble component.

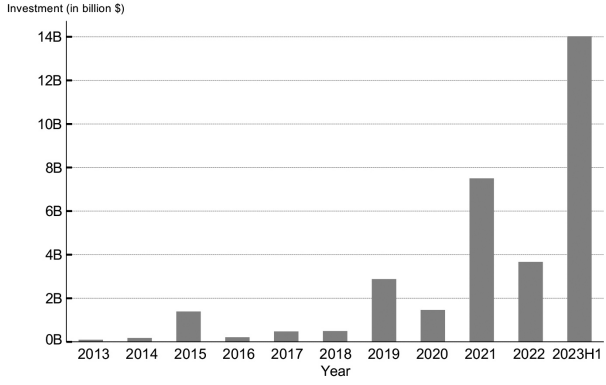
Our analyses in Section 2.1 study the effects of conventional monetary policy using monetary policy shocks data up to 2007. The impact of unconventional monetary policy such as quantitative easing is another interesting question for the past decade. *Grimm, Laeven, and Popov (2022)* suggest that quantitative easing in Europe had a positive effect on the innovation activities of firms whose bonds were eligible for the ECB's corporate bond purchases. At the

Figure 8
Recent Trends in VC Investment by Industry

Panel A: VC Investment in Major Industry Groups



Panel B: VC Investment in Generative AI



Notes: Panel A shows annual VC investment in major industry segments. Panel B shows annual VC investment in generative AI. Data come from PitchBook. Data for 2023 include Q1 and Q2.

same time, *Liu, Mian, and Sufi (2022)* suggest that when interest rates are very low, further easing may favor industry leaders and result in lower productivity growth. Future empirical work can shed more light on how unconventional monetary policy and ultra-low interest rates affect innovation activities.

III.B. Long-Run Evolution of Innovation Activities

Our analyses in Section 2.1 find that monetary policy can influence innovation activities. At the same time, technology may progress for a variety of other reasons, and from time to time technological advancement may experience revolutionary waves. Over the past 150 years, adverse macroeconomic shocks happened to have hit during several technology waves, but these waves appeared to be able to withstand difficult times. For example, during the Second Industrial Revolution and the age of electrification from around the 1890s to around the 1920s *(Jovanovic and Rousseau, 2005)*, the U.S. economy experienced the panic of 1893 and the panic of 1907. Rapid electrification and industrialization still took place despite these negative shocks. During the Third Industrial Revolution and the age of computerization around the 1970s and the 1980s, the U.S. economy experienced high inflation and high interest rates due to the oil crisis, but substantial advancement in information technology still took place. According to some analyses of productivity as well as patenting activities, innovation activities were vibrant in the 1930s even during the Great Depression *(Field, 2003; Kelly et al., 2021)*.

Although it is challenging to precisely measure the magnitude of the technological waves, it seems plausible that the eras of technological revolutions witnessed changes that are several times larger than what happens in an average decade. Adverse economic conditions may reduce the magnitude of activities by some fraction, but the waves remain substantial. Given that revolutionary episodes are infrequent and difficult to quantify, we do not formally test the factors that could predict technological waves. It is an interesting question to better understand the extent to which cyclical conditions play a role in technological revolutions. At the moment, our reading of the evidence is that monetary policy can affect innovation activities on an "evolutionary" basis, and it remains to be seen whether it has any role in innovation activities on a "revolutionary" basis.

III.C. Policy Implications

If monetary policy affects innovation, what might be the policy implications? A small set of theoretical models analyze optimal

monetary policy with endogenous innovation and productivity. Several questions may emerge in light of the connection between monetary policy and innovation. First, should monetary policy be more accommodative on average, to the extent that innovation is under supplied (due to high social externalities)? Recent analyses suggest that, depending on the properties of shocks, optimal policy may follow inflation targeting outside the zero lower bound, or may set inflation above target when subsidies for innovation fall short of the externalities *(Garga and Singh, 2021; Queralto, 2022)*. More work in the future can better understand this issue, and we are also mindful of the well known lesson that efforts seeking to perennially stimulate the economy with monetary easing may be ineffective or counterproductive *(Friedman, 1968; Lucas, 1976)*.

Second, should monetary policy be more countercyclical? An earlier study by *Aghion, Farhi, and Kharroubi (2012)* postulates that countercyclical stabilization is especially important when cyclical fluctuations affect innovation and growth. They conduct cross-country empirical analyses and find that countries with more countercyclical monetary policies experience higher growth, especially in industries that appear to be more financially constrained. Several models that examine endogenous productivity and hysteresis also highlight the significance of output stabilization for optimal monetary policy *(Ikeda and Kurozumi, 2019; Fatás and Singh, 2022; Galí, 2022)*. Our empirical evidence on how much innovation activities respond to monetary policy can provide more information for future analyses about the effects of output stabilization.

Third, monetary policy has easing and tightening periods; do their effects on innovation cancel out? As discussed above, monetary easing and tightening could be useful for stabilizing innovation in response to other shocks (e.g., demand shocks or financial shocks); several studies emphasize that facilitating recoveries from crises that reduce innovative capacity is beneficial for the medium term. The issue is not just about monetary policy actions in different directions offsetting themselves. In addition, as *Blanchard (2018)* writes, the objective is to understand "the size and persistence of the effects of monetary policy on potential output, not their permanence." Our work also

focuses on the potential persistent effects, not necessarily permanent effects in the very long run (which would be difficult to pin down).

Finally, can other policies address fluctuations in innovation activities instead of monetary policy, or in response to the impact of monetary policy? For example, as recent research points to the impact of monetary policy on financial stability, many studies analyze the feasibility of using macroprudential policy to target financial stability while monetary policy focuses on macroeconomic stability. For innovation activities, an analogous question is whether other tools can support and stabilize innovation activities. A number of measures may support innovation activities during economic downturns. Standard toolbox points to various programs that can provide grants or subsidies. Recent work suggests that fiscal policies could push the economy out of a stagnation trap *(Benigno and Fornaro, 2018)*, or support business investment and relax supply side constraints in light of monetary policy tightening during disinflations *(Fornaro and Wolf, 2023)*. Relaxing supply side constraints may also reduce marginal costs and inflationary pressures. A well-functioning system for restructuring viable companies in financial distress can be useful too, especially given the importance of specialized physical, human, and organizational capital that make liquidating these firms especially costly. Future work can shed more light on whether innovation-related issues can be addressed fully with other policies, so that monetary policy can be insulated from considering its effects on innovation.

Overall, given the significance of innovation activities for economic progress, it would be valuable to investigate the role of monetary policy in this domain in academic research and policy analyses, and to better understand the implications for the conduct of monetary policy.

IV. Conclusion

We document the response of innovation activities to monetary policy using a collection of measures for innovation. The results suggest that monetary policy could have a persistent influence on the productive capacity of the economy, in addition to the well-recognized

near-term effects on economic outcomes. Developments in the past several years highlight the relevance of these issues. Rising interest rates since 2022 have been accompanied by a substantial decline in venture capital investment. Meanwhile, recent breakthroughs in AI raise the hope that another technological revolution could be on the horizon, and maximizing the benefit of the technological breakthroughs is important.

We do not think our findings necessarily imply that monetary policy should be more dovish. It is well recognized that efforts seeking to perennially stimulate the economy with monetary easing can be ineffective or counterproductive *(Friedman, 1968; Lucas, 1976)*. In addition, as recent research points to the effects of monetary policy on a growing list of economic outcomes, it seems challenging for monetary policy alone to balance all these dimensions. One possibility is to apply other policies that relax supply side constraints and support innovation during economic downturns (e.g., in light of financial crises) or when monetary policy tightening is needed (e.g., in light of inflationary pressures). More work in the future can illuminate the implications that arise from the effects of monetary policy on innovation.

Endnotes

[1]We also compare the impact of monetary policy shocks to that of fiscal policy shocks to provide further perspectives on the magnitude. We use aggregate fiscal shocks due to tax changes constructed by *Romer and Romer (2010)*. We observe that a tax liability increase of 1 percent of GDP is associated with declines in all measures of innovation activities by about the same magnitude as 100 basis point monetary policy tightening.

[2]It is econometrically challenging to directly estimate the impact of monetary policy shocks on output and productivity more than 8 years afterwards (3 years lag for the innovation index and another 5 years lag from innovation to output). In addition, there are a number of other transmission mechanisms of monetary policy that affect the overall impulse response of output to monetary policy shocks. Accordingly, our focus here is to directly trace out the impact of monetary policy shocks on innovation activities, and we rely on previous work about the aggregate implications of innovation to infer the possible long-term output impact.

[3]See *Blanchard (2018)* for a discussion about how lower capital stock after monetary tightening has limited effects on potential output in a standard model. For example, a 100 basis point monetary policy shock may affect output after 5 years by 0.1 percent through reductions in traditional investment.

[4]We use Eicker-Huber-White standard errors following the recommendations of *Montiel Olea and Plagborg-Møller (2021)*. *Newey and West (1994)* standard errors produce similar results.

[5]We use VC investment data starting in 1980 because VC was rare before then. The results are stronger if we include earlier data from VentureXpert.

[6]Before 1990, the quarterly estimates are interpolated assuming no quarterly patterns. For 1991 to 2007, current-dollar business R&D is interpolated using a seasonally adjusted composite series from the quarterly census of employment and wages (QCEW) from the Bureau of Labor Statistics (BLS). The composite quarterly indicator is constructed by weighting three-quarter moving averages of industry-specific QCEW wage data. After 2008, quarterly business R&D is interpolated using seasonally adjusted R&D expenses reported on publicly traded companies' quarterly financial statements. The quarterly investment in equipment and structures does not have this interpolation issue because such investment can be directly measured using shipment and construction data *(Holt, 2014).*

[7]Intangible investment studied in *Döttling and Ratnovski (2023)* also includes Selling, General and Administrative Expenses (SG&A), which may capture other types of intangible investment that are not necessarily related to innovation (e.g., branding).

[8]The output response to the innovation index analyzed in *Kogan et al. (2017)* does not specify the sources for the variations in the innovation index. Accordingly,

our imputations assume that the changes in innovation due to monetary policy have similar output consequences as the typical changes in innovation.

[9]*Jordà, Singh, and Taylor (2023)* perform long-run cross-country analyses to identify exogenous monetary policy fluctuations using the trilemma, where a country that pegs its currency needs to follow interest rates set by the base country. They estimate that a 100 basis point tightening shock (induced by interest rate changes of the base country) leads to 5 percent lower output after 8 years. The magnitude can be larger in their analyses because they do not focus just on the innovation channel for the long-run effects of monetary policy on output. It is also possible that the effects are larger outside of the U.S.

[10]Some innovation expenditures, such as VC investment, seem much more volatile than traditional investment in physical assets. Meanwhile, other innovation expenditures, such as R&D spending, seem to fluctuate less, which could be due to economic properties *Crouzet and Eberly (2019)* or measurement (see footnote 6). For the same amount of fluctuation, changes in innovation activities appear to contribute to more persistent effects of monetary policy, given the long time frame of innovation and the potential impact of innovation on productivity.

[11]One might also ask about the relevance of the user cost channel. Previous studies of traditional investment in physical assets have found limited effects of the plain vanilla user cost channel *(Bernanke and Gertler, 1995; Caballero, 1999),* and there are reasons to think that some innovation spending that depreciates more quickly (e.g., R&D) could be less responsive to user costs *(Crouzet and Eberly, 2019; Döttling and Ratnovski, 2023).* In addition, Panel A of Figure 1 suggests that the monetary policy shocks are temporary. In the absence of changes in financial conditions, the user costs would only change by about one year.

[12]The excess bond premium may have a forward-looking component, so there can be caveats for interpreting it as a pure shock to financial conditions.

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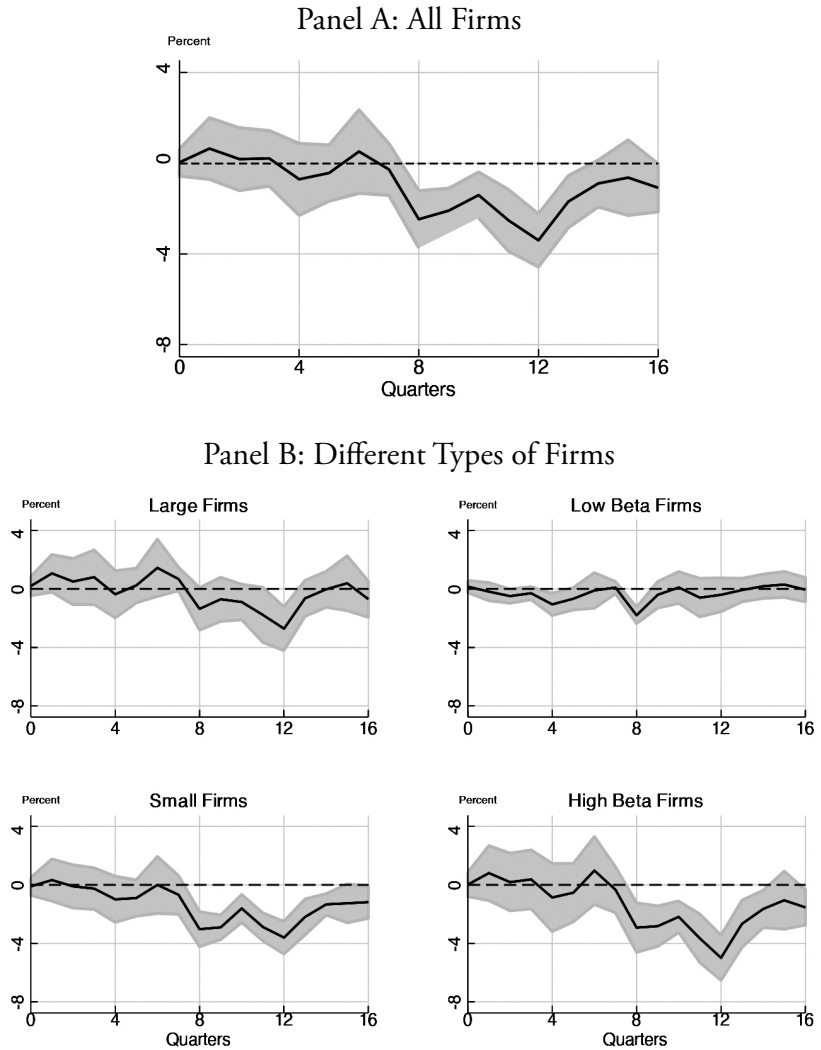
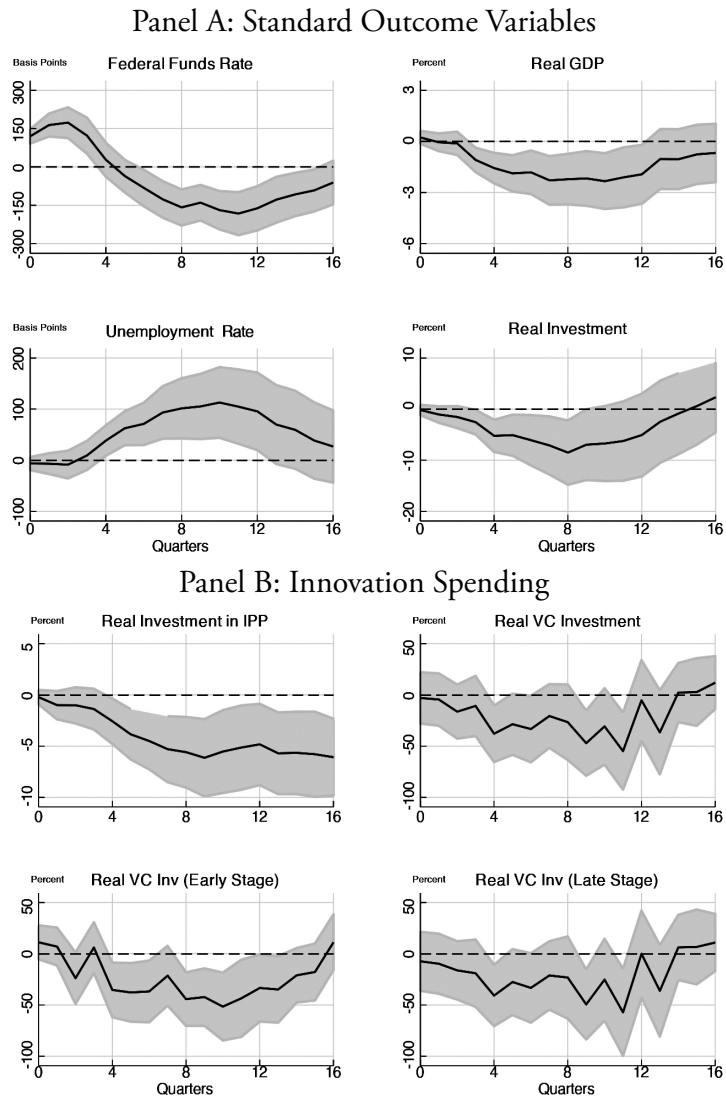
Additional Figures

Figure A1
Impulse Response of R&D Spending among Public Firms to Monetary Policy Shock



Notes: Panel A shows the impulse response of R&D spending for all firms in Compustat to a 100 basis point *Romer and Romer (2004)* monetary policy shock. Panel B shows the impulse response of large and small firms and firms in less and more cyclical industries. We estimate *Jordà (2005)* local projections $x_{i,t+h} = \alpha_i + \beta mps_t + \gamma z_t + \epsilon_{i,t}$, and plot the regression coefficient β on the monetary policy shock (the solid line). The outcome variable $x_{i,t+h}$ is log real R&D spending of firm i in quarter $t + h$. The control variables z_t include 4 lags of the outcome variable, 4 lags of the monetary policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, the excess bond premium *(Gilchrist and Zakrajšek, 2012).* Firm fixed effects are included. Standard errors are *Driscoll and Kraay (1998)* with a bandwidth of 20. The shaded area represents the 90% confidence interval.

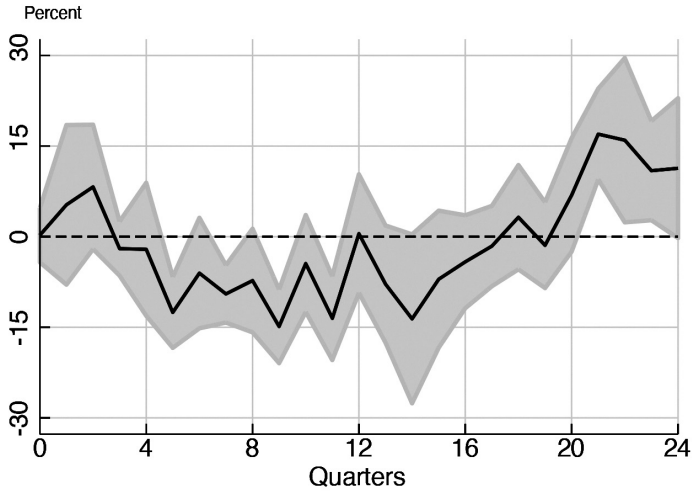
Figure A2
Impulse Response using *Aruoba and Drechsel (2023)* Monetary Policy Shock



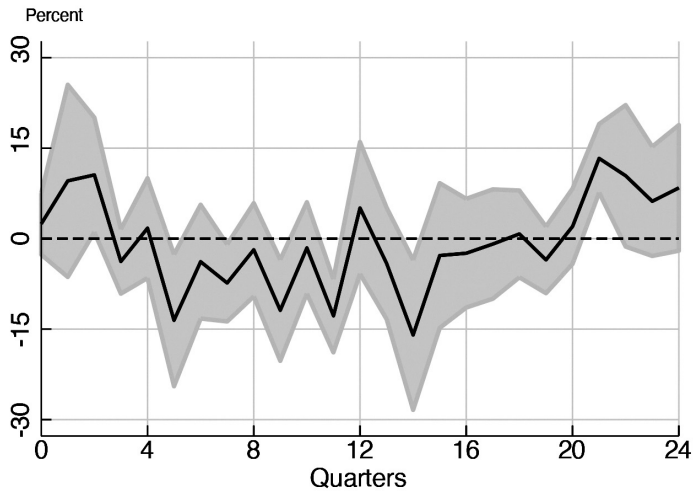
Notes: Panel A shows the impulse response of standard outcome variables, including quarterly Federal Funds rates, log real GDP, unemployment, and log real physical asset investment from the national accounts, to a 100 basis point monetary policy shock from *Aruoba and Drechsel (2023)*. Panel B shows the impulse response of innovation spending measures, including quarterly log real investment in Intellectual Property Products (IPP) from the national accounts, as well as log real total, early stage, and late stage venture capital (VC) investment. The specification is the same as the impulse response in Figure 1. Standard errors are Eicker-Huber-White following *Montiel Olea and Plagborg-Møller (2021)*. The shaded area represents the 90% confidence interval.

Figure A3
Impulse Response of Patenting to *Aruoba and Drechsel (2023)* Monetary Policy Shock

Panel A: Important Technologies

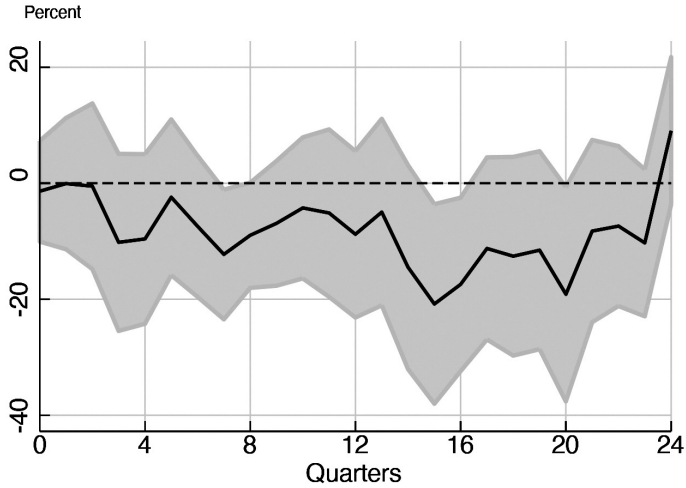


Panel B: Other Technologies



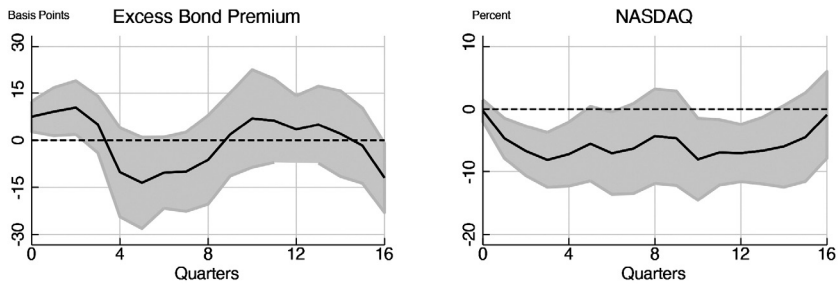
Notes: Panel A shows the impulse response of patent filings associated with the important technologies to a 100 basis point monetary policy shock from *Aruoba and Drechsel (2023)*. Panel B shows the impulse response of patent filings associated with other technologies. The specification is the same as the impulse response in Figure 2. Standard errors are *Driscoll and Kraay (1998)* with a bandwidth of 20. The shaded area represents the 90% confidence interval.

Figure A4
Impulse Response of Innovation Index to *Aruoba and Drechsel (2023)* Monetary Policy Shock



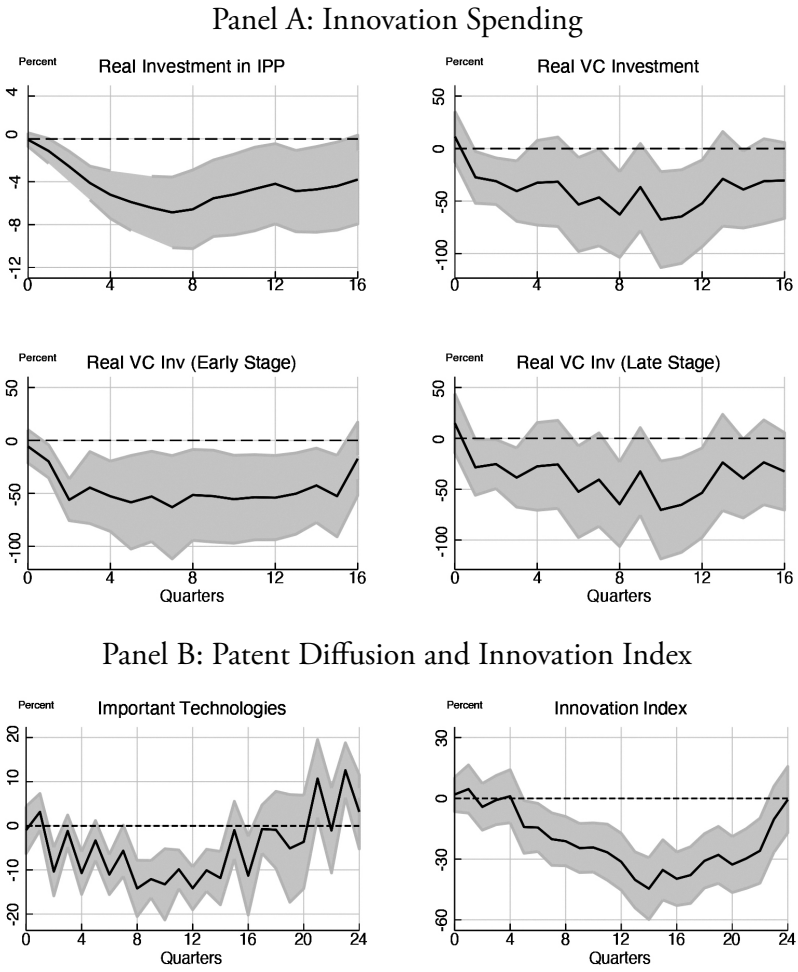
Notes: This figure shows the impulse response of the aggregate innovation index constructed by *Kogan et al. (2017)* to a 100 basis point monetary policy shock from *Aruoba and Drechsel (2023)*. The specification is the same as the impulse response in Figure 4. Standard errors are Eicker-Huber-White following *Montiel Olea and Plagborg-Møller (2021)*. The shaded area represents the 90% confidence interval.

Figure A5
Impulse Response of Asset Prices to Monetary Policy Shock



Notes: This figure shows the impulse response of the excess bond premium and the NASDAQ index to a 100 basis point *Romer and Romer (2004)* monetary policy shock. We estimate *Jordà (2005)* local projections $x_{t+h} = \alpha + \beta mps_t + \gamma z_t + \epsilon_t$, and plot the regression coefficient β on the monetary policy shock (the solid line). The control variables z_t include 4 lags of the outcome variable, 4 lags of the monetary policy shock, and 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, and the excess bond premium *(Gilchrist and Zakrajšek, 2012)*. Standard errors are Eicker-Huber-White following *Montiel Olea and Plagborg-Møller (2021)*. The shaded area represents the 90% confidence interval.

Figure A6
Impulse Response of Innovation Activities to Excess Bond Premium



Notes: Panel A shows the impulse response of innovation spending measures, including quarterly log real investment in Intellectual Property Products (IPP) from national accounts, as well as log real total, early stage, and late stage venture capital (VC) investment, to a 100 basis point increase in the excess bond premium *(Gilchrist and Zakrajšek, 2012).* Panel B shows the impulse response of patent filings associated with the important technologies and the aggregate innovation index *(Kogan et al., 2017).* The control variables include 4 lags of the outcome variable, 4 lags of the Fed Funds rate, log real GDP, log CPI, unemployment rate, and the excess bond premium *(Gilchrist and Zakrajšek, 2012).* Standard errors are Eicker-Huber-White following *Montiel Olea and Plagborg-Møller (2021)*, except the panel regression on important technologies uses *Driscoll and Kraay (1998)* standard errors with a bandwidth of 20. The shaded area represents the 90% confidence interval.

Commentary: Has the Macroeconomic Environment Impacted Long-Run Shifts in the Economy?

John Haltiwanger

This paper explores an important and interesting question. In some respects, it is a relatively novel question as the authors have pointed out. Usually, when we talk about monetary policy, we're talking about price stability and short run economic fluctuations. For the most part, one does not hear the word innovation in the same discussion. In this context, this paper asks this really important question, does monetary policy have an impact on innovation? Their tentative answer is yes! Part of the reason the answer is tentative is that this is a difficult question to answer. Part of the reason that this is difficult is that measurement of innovation and measurement of monetary policy are difficult to measure. In addition, they seek to address this question with aggregate time series variation. This makes the challenge even greater given limited degrees of freedom. In their key charts, they find economically significant effects of monetary policy on innovation but the effects are not very precisely estimated.

The focus of my comments will be on the challenges of measurement, particularly on the challenges of measuring innovation. One limitation is that some of the key measures are only for publicly traded firms. I think we need to move beyond publicly traded firms for this kind of analysis. I think we know this much better now than we knew it 10 years ago or certainly 20 years ago. We've now integrated lots of the innovation measures that are discussed here

into the large comprehensive economy-wide databases at the U.S. Census Bureau to try to understand the process of innovation and using exactly the same kind of measures: patents and research and development (R&D), but not just for publicly traded firms. Publicly traded firms play a vital role in the economy. They are relatively small in number (less than 1% of firms) but account for a large fraction of activity. And indeed, they made amazing innovations in order to become publicly traded firms, but typically before they were publicly traded firms. So that's the big limitation. So, if we only look at them, we're going to miss most of the story.

Interestingly, publicly traded firms are doing lots of R&D and lots of patenting. Indeed, they dominate R&D and patenting to such an extent that one might think they must be accounting for most of the innovation. However, the careful work of a range of scholars including Ufuk Akcigit and William Kerr (see, e.g., *Akcigit and Kerr, 2019)* show that large publicly traded firms strategically have an incentive to do more incremental or defensive innovations. Such firms have a large customer base for their current products and they don't want to cannibalize their current product base. In turn, the finding is that the more radical innovations come from young and small firms. The inference is that in order to track innovation, it is critical that we track the dynamics of young and small firms.

The second thing is, even for young and small firms, our measures are quite limited. Patents are great, they're a fantastic resource for certain types of innovation, but they offer a very narrow window into overall innovation. It's useful to recognize that less than 1% of firms ever issue a patent and most patents don't get commercialized. Partly this reflects the right-skewed nature of successful innovation. However, patents tend to be highly concentrated in particular sectors, particularly manufacturing and in some parts of information services, but not more generally across the economy.

R&D measures have a similar kind of problem. Less than 3% of firms in the United States report any R&D. R&D expenditures are also concentrated in manufacturing. In manufacturing, a small share of firms report R&D but they account for a very large share of manufacturing activity, easily over 50%. That's not true in non-manufac-

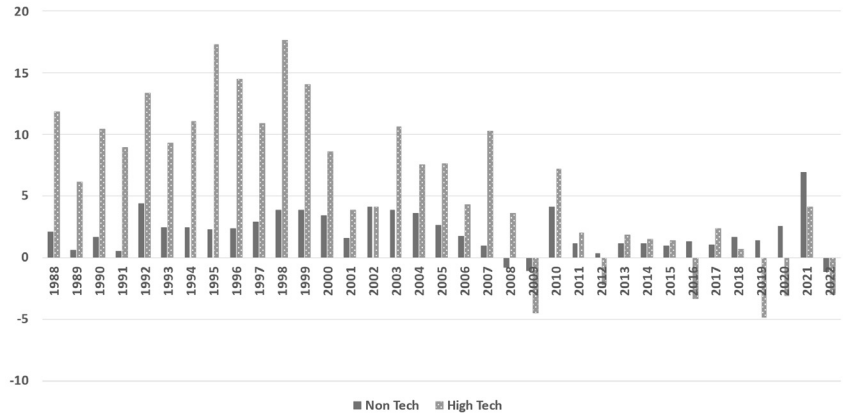
turing. The small share of firms that do R&D account for less than 15% of U.S. economic activity in the entire U.S. economy.[1]

These concerns are related to my earlier point. Young firms are inherently engaged in what lots of us like to call intangible capital investment. That is, they are engaged in investing in their future products, processes and customer base. This is especially true in the innovative intensive sectors. If you go into the innovative intensive sectors and you ask what they're doing, they're not so much producing current products, they're working on developing future products and services. And we don't capture that very well, both given sample design issues. It takes a while to get the young firms into the R&D and other related surveys. Relatedly, the surveys are stratified by firm size but not firm age. A survey that is representative by firm size is not inherently representative by firm age since while young firms are small, many small firms are not young. Also, the questions asked are better suited to large, mature firms. A young tech startup of only 10 employees doesn't have an R&D division and isn't able to answer the questions in quite the same way.

Given these issues (and also challenging questions for identification of monetary policy shocks), does this mean that the results in this paper are understating or overstating out of these results? I don't think we know yet but my prior is that they may be understating. To make this case, I am going to turn to a few patterns in the data.

Figure 1 reports annual labor productivity statistics from the BLS where 4-digit NAICS industries have been aggregated into two broad groups. One group is the high-tech industries of the economy (the STEM intensive sectors as defined by *Hecker (2005)*). This set of industries is dominated by Information and Communication Technology (ICT) industries. The second group combines all other industries. As we know productivity surged dramatically in the United States in the 1990s, through the early 2000s, and then has been quite anemic since then, particularly post 2010. The surge was very much accounted for by the high-tech sectors of the economy. In the productivity growth slowdown, the high-tech sectors have not done well, particularly in the post 2010 period.

Figure 1
Annual Labor Productivity Growth Rates for Industries in High-Tech and Non-Tech



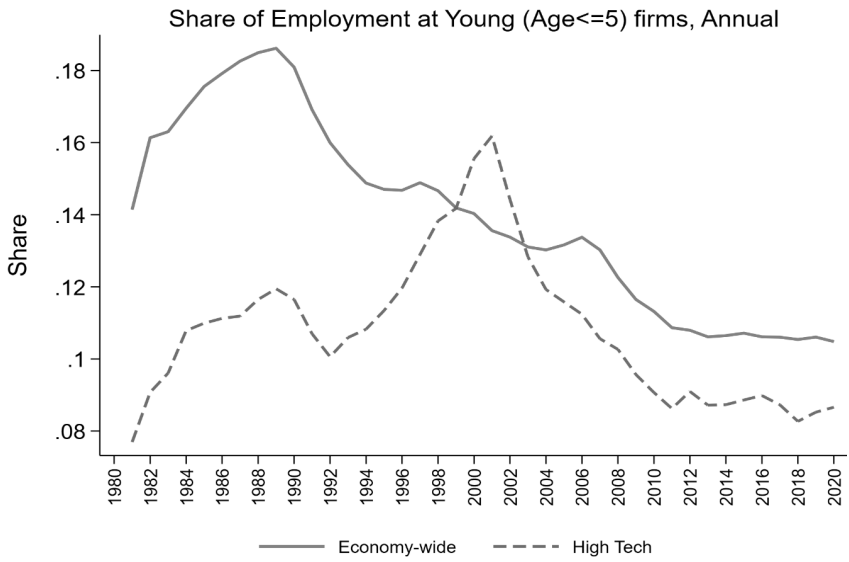
Source: BLS, Industry Productivity

A question suggested by the patterns here is the role of the Great Financial Crisis (GFC) in the productivity growth slowdown. Research has shown and it is evident from this figure that the productivity growth slowdown began before the GFC *(see Gordon 2016).* However, it may be that the GFC has played a role in the persistence of the slowdown in productivity growth slowdown. To explore this, I want to return to the critical role that young businesses play in innovation and productivity growth. There is a rich literature on this and I am only going to provide a few suggestive teasers in these comments.

To start, Figure 2 depicts the share of employment accounted for by young firms in both the overall U.S. economy and the high-tech sectors. And you can see, interestingly, just even from this aggregate data, that there was a surge in young business activity in the high-tech sectors in the 1990s but it's fallen considerably over this period of time.

In research, we've used the detailed micro-data that I've talked about to try to help us understand the role of startups in innovation. I think the causality likely runs both ways. I think startups are induced to innovation and they induce innovation, they're drawn

Figure 2
Share of Employment at Young Firms



Source: U.S. Census Bureau, Business Dynamic Statistics

to it. This perspective is very much related to the seminal work of *Gort and Klepper (1982).* They found a surge in startups is part of the early stages of innovation. They are drawn to the innovation and contribute to it. In research, see *Foster et al. (2019),* we examined the dynamic patterns of startups and innovation in the tech sectors in the 1990s. Interestingly, we found that the leading indicator, about six to nine years before productivity started taking off, is a surge in entry. Entry is kind of like a "canary in the mine" as an early signal for innovation.

The findings indicate that what happened first following the surge in entry was not an increase in productivity growth, it was actually a decrease in productivity growth in those sectors. Instead, the next phase following a surge in startups is an increase in productivity dispersion, consistent with the view that this is a period of experimentation and creative destruction. Six to nine years later, productivity growth emerged.

As an aside, in the Ma and Zimmerman paper there is some evidence that the Venture Capital (VC) market was recovering in the post 2010 period, but this increase has not shown up in the productivity statistics. The question is whether the connection between the VC industry and innovation has changed over this period (post 2010) of time.

Turning back to the theme of this session, the core question is what financial market conditions have to do with the pace of innovation. In recent work with Steven Davis *(Davis and Haltiwanger, 2023),* we have examined the role of financial conditions for fluctuations in entrepreneurship. We found that in the GFC, housing prices and credit supply collapsed in some places much more than others. The latter we found is because some banks in some parts of the country were in much more trouble than other parts of the country. We used that variation for identification and found that the large decline in young firm activity in the GFC and its aftermath is largely accounted for by the changing financial market conditions.

Putting the pieces together, young businesses are critical for innovation. Startups surged in the innovative intensive sectors in the 1990s but have been on decline in the post 2000 period (at least pre-pandemic). Young businesses are incredibly cyclically sensitive and relatedly they're very sensitive financial market conditions. I think that this suggests that the very interesting results in this paper may be understating the role of financial market conditions in innovation.

What about current conditions? The paper presents results that suggest VC industry financing has been taking a hit, particularly in late 2022 and early 2023. I think that's something we should be paying attention to. But I think when we look at that, we need to remember that the tech sector has been going through some fundamental restructuring over the last couple of years. We know big tech isn't doing so well, at least parts of big tech. Twitter/X, Facebook, and other big tech firms are struggling a bit with associated layoffs. Perhaps relatedly the Crypto industry has shown of collapse? Do I think the problems that Facebook, X/Twitter, and Crypto are associated with the monetary policy correction? I don't think so primarily as it looks like big tech was due for restructuring. While there might be

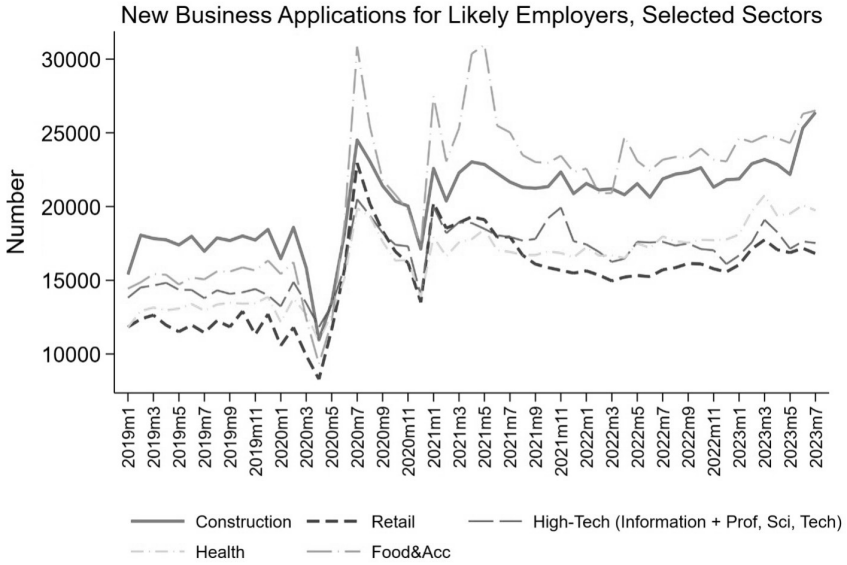
some connection in terms of timing but I think the restructuring in big tech reflects structural factors.

To close, consider a different perspective related to my earlier remarks. I have argued that startups more broadly are important, and it is not sufficient to just look at what is happening in the VC industry. Recall one of the points above is that a surge in business formation is an early signal of innovation. On this point, the U.S. Census Bureau has a new data product called the Business Formation Statistics (BFS). The BFS tracks essentially in real time applications for new businesses and new businesses. The form includes information on the intent of the application. For example, "Do you intend to be an employer?"

In Figure 3, the time series for selected sectors through July 2023 are depicted. Quite interestingly, in the pandemic itself, and through 2023, in spite of the monetary policy contraction, there has been a surge in business formation. In collaborative work with Ryan Decker for the September 2023 Brookings Papers on Economics Activity, we have been attempting to glean what we are learning from this new data product. One of the patterns we have detected is there is spatial reallocation within major cities of business activity. This is related to the daytime working population spending time in a different place than they used to pre-pandemic. The BFS shows a surge in business formation and business activity in the areas immediately around the downtown center. So, for example, Brooklyn's doing much better in terms of business formation than is Manhattan.

While this spatial restructuring is interesting, it is not clear that this will have much of an impact on innovation and productivity growth. However, Figure 3 shows that that the high-tech sectors of the economy that played such a dominant role in the 1990s, have had a considerable surge in the pandemic through July 2023. To conclude, I will end with a very incredibly speculative remark, and then a caution, of course. The last time we had a surge in high-tech startups like this was in the 1990s. That was an amazing decade for innovation and productivity growth. Is it possible we are on the cusp of another surge in innovation and productivity — perhaps fueled by Artificial Intelligence (startups in AI will show up in the high-tech

Figure 3
Applications for New Businesses During the Pandemic



Source: U.S. Census Bureau, Business Formation Statistics.

sectors in Figure 3). What's the caution? Two reasons. First, it is very difficult to predict surges in innovation and productivity especially since there are often long lags between potential innovations and implementation on a large scale. Second, young businesses are very sensitive to cyclical conditions. The current monetary policy contraction may derail this surge in business entry. Does this suggest that young business activity should be one of the indicators the FOMC examines as they track the economy. The answer I think is yes. This answer is based on the interesting analysis in this paper and also on the remarks that I have made extending the perspective.

Endnotes

[1]Dinlersoz et al. (2023) have a useful discussion of the alternative measures of innovation with associated references.

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General Discussion: Has the Macroeconomic Environment Impacted Long-Run Shifts in the Economy?

Chair: Betsy Stevenson

Betsey Stevenson: Thank you so much. I'm going to take three to four questions and then give Yueran Ma a chance to respond to them. We're just going to keep doing that in batches. And so, I'm going to remind you that lots of people have both statements and questions. It would be useful if your statements are kept to around a minute so that we can get in as many of those statements as possible.

Amir Yaron: This is a very nice paper. Regarding empirical identification, it seems that it takes time for agglomeration, especially in venture capital (VC) innovation structure, because it takes them time to manifest themselves into an ecosystem. I would think the duration of the tightening cycle is very important in your identification. As a suggestion, perhaps interact the monetary policy innovation with the duration of the cycle. Also, as John Haltiwanger was mentioning, we had a long QE period and that affects investments. In addition, recall that the VCs data here is for a relatively short sample.

Regarding the cost benefit question, it turns out we've had the phenomenon of zombies. There was a long period of growth firms with many technology zombies, and it is just not obvious that accommodative measure that you're talking about doesn't lead to that. Thus, mean-variance cost-benefit is hard to apply.

The last question is the magnitude that you find in terms of growth. You mentioned Lucas, Lucas had told us the cost of business cycles are tiny, and growth is everything. While you don't have to buy into that, the nice thing here is you are connecting these two things; but at the end of the day you're getting a 1% growth effect in five years, that's a huge number. And it would be nice to really understand that. Is that a persistent number that's going to affect trend-growth for longer periods? Finally, we've looked at a similar analysis for Israel, a technology intensive economy. It turns out the Fed's monetary innovations have primary effect on local VC and startup related activity. So, one way to extend your work is to look at the cross section of countries, because the VC industry is a global industry that is very much affected by the United States.

Betsey Stevenson: Great. Let me turn to Lisa Cook.

Lisa Cook: I was doing this kind of research earlier and I really appreciate this important paper and these important questions. I'd like to make a very, very quick statement about other limitations. Copyright would've been much more important with respect to software innovation, and I think that's very important now, and I think that this is also a lower bound with respect to your paper, these estimates may be lower bounds. But I think it would be interesting to have more information about copyrights included in the paper. But I'd also like to ask a question. You found the effect of monetary policy shocks to be symmetric, and you looked at fiscal policy shocks, and you only reported one side of that, the 100 basis points and the decline in innovation. But did you find also symmetry in the impact of shocks to fiscal policy?

Yueran Ma: Can I very briefly respond to that clarification question? It's fiscal tightening as an illustration for the impulse response figure. Our regressions include both fiscal tightening and easing shocks measured by Romer and Romer.

Kristen Forbes: In the era of very low interest rates, there was a nice literature, a number of papers that argued that having interest rates very low for an extended period contributed to lower productivity growth, and lower productivity of investment. That is not the

only factor, but could contribute to the low productivity growth John showed us in the 2010s. So, I was wondering if you had thought about whether that could interact with the effects you find and lead to some non-linearities. More specifically, could there be a different effect when you raise interest rates from low levels (say, zero to 1%), where there's a little less investment, but you knock out a lot of the very bad ideas that generate low productivity, some of the zombies?

In other words, you get slightly lower investment, but much more productive investment. So then raising rates from zero to one wouldn't lead to the negative effects on the innovation you find. But, if you are raising from 5 to 6%, by then you've knocked out all the crazy ideas, so you're just getting less investment with minimal impact on the productivity of investment. Then some of the effects you document could be much stronger. Can you estimate if these non-linearities matter in the context of your model?

Betsey Stevenson: Why don't I give you a chance now to respond to the three you've heard?

Yueran Ma: Sure. I would like to combine some of the themes. One theme that Kristen Forbes and Amir Yaron both mentioned is the potential cleansing effects. We have a paragraph on that in the paper. So of course, going back to Schumpeter, there's the idea of the cleansing effects of recessions, and there can be weak firms that can be eliminated by recessions. And of course, these weak firms are very unlikely to be innovation intensive, they're very unlikely to be captured by our data. And there's separate work on the impact of monetary policy on reallocation. And recent work, for example, by David Baqaee and co-authors, tends to find that easing helps with reallocation and that's building on their work. But I think non-linearity is very interesting, duration is very interesting. We would love to do that if the Romer shocks have enough power. And also, as we observe, there is impact on important technologies, and if there's enough power, we'd also like to see whether there's non-linearity to important technologies versus other technologies. These are all great suggestions for future work.

And then, for the cost of business cycles, there have been work, for example, by Gadi Barlevy at the Chicago Fed, that the cost of business cycle could be higher with endogenous growth. And then finally, both John Haltiwanger and Amir Yaron mentioned about the various dimensions of VC investment. I think the suggestion to look at global VC investment is very useful. The recent decline in VC investment, if we look at the data, affects things like healthcare, hardware, semiconductors, not just software and crypto. And anecdotally, I've talked to startups doing smart ovens. I know of startups doing mining on the moon, and all these types of very diverse startups seem to be having a difficult time.

Betsey Stevenson: Great. Aysegul.

Aysegul Sahin: A fantastic topic and it's really important, I think, to think about long-term effects of monetary policy. And obviously, I couldn't agree more with John, that startup activities probably the best proxy that we have for innovation. But there's another important input, that's labor supply, because we need human capital to be able to innovate. And I think your work opens this interesting box of looking deeper into how monetary policy's affecting innovation also through labor supply growth. And we know that labor supply is affected by monetary policy shocks both in the intensive and extensive margin. So, why not look at labor supply growth rate, immigration, as well as education and college enrollment as well as advanced degrees? I think this will help open up the mechanism more.

Arvin Krishnamurthy: Yueran, I have a question about the mechanism behind your new finding. One way you rationalize the finding is through the impact of monetary policy on risk premia, such as the excess bond premium effect you outline. One aspect of innovation activities is more risk, another aspect is long duration. For example, we think of tech stocks as long-duration assets. So, another channel behind your results could be through changes in long-term discount rates having a large impact on the value of innovation activities. There's been work recently suggesting that monetary policy has surprisingly large effects on long-term real rates suggesting such a duration-innovation channel may be present. I'm thinking, for example, of Sam Hanson and Jeremy Stein's work. And that would be

interesting to examine, particularly in the light of one of the points that Chair Powell mentioned, which is that real rates have gone from negative .5% to 2% in the last year.

Yuriy Gorodnichenko: A very important question. I was wondering if you or maybe John Haltiwanger looked into other margins of adjustment. We see that spending on R&D is declining, but I think it's important to know if it's purchases of equipment that declined or if it's investment in structures or if it's employment or wages. What kind of employment is declining in skill and skill labor, this kind of sense?

Sebnem Kalemli-Ozcan: Very interesting paper and very admirable work. I would like to ask on the role of heterogeneity in relaxing and tightening of financial constraints. So, Kristin Forbes and Amir Yaron asked this question about zombies and cleansing effect, but I think the issue is deeper than that, and we now have extensive evidence from European experience how lower rates in early 2000 as part of the European integration process, increased misallocation, and decreased productivity in southern European countries. And that's not just about low rates, high rates, but it is about financial constraints being relaxed and tightened heterogeneously across large firms and SMEs.

Going back to John's point, SMEs are the engines of innovation. And if you're in a low-interest-rate environment where SMEs' financial constraints are not relaxed, and then it can easily be exact opposite result where easy monetary policy, increasing misallocation, and lowering productivity. So did you somehow look at that, not just the lower or higher rates in terms of monetary policy shocks, but also how financial constraints are relaxing across forms heterogeneously or homogeneously? Because the productivity implications will be exactly the opposite in that case, as we learn from the European experience.

Betsey Stevenson: Do you want to take a second to respond?

Yueran Ma: Sure. First, I would like to respond to a collection of questions about data. And I also want to thank John for the great discussion and for all the information that he puts together. And, of

course, we would like to have better data to measure all more types of innovation activities, and John is one of the best people in the world to supply us with such data. And so on the data note, I think, actually, there was a point about labor supply is quite interesting. I was looking at whether we can measure the number of R&D researchers as well, and I wasn't able to find direct data at high enough a frequency. If you know better data, I would love to know.

And then also to Yuriy Gorodnichenko's question about the margins of adjustments. So typically the current measurement of R&D expenditures come heavily from spending on the salaries and payments to R&D employees. For example, people have actually inverted these two in both directions. And early on, Lisa Cook mentioned there's also the dimension of copyrights, which we could look at, and if we can find good data to measure that, we would be very interested in doing that as well.

And then the second set of questions, for example, Arvind Krishnamurthy raised a point about changes in long-term discount rates. I think those are really interesting questions. And also when we look at the potentially innovative companies, it looks like the ones that are currently having negative earnings, those that haven't proved their profitability are hit particularly hard both in this cycle and in earlier cycles as well. For example, now if you look at NASDAQ, it has rebounded much more, but then if you zoom in on the components of NASDAQ that have negative earnings, those have not rebounded at all.

And similarly, VC-funded firms are more like those firms. They may have upside potential but haven't proved themselves currently. And that's an aspect I don't think we have fully understood: why risk appetites shift in these particular ways. But these are super-interesting questions. And finally also on the note of financial constraints, that also connects to Sebnem's question. Yes, I think, one, financial constraints and how they shift for different types of firms is very interesting, as we just discussed. And, second, the heterogeneity across countries, the financial markets in the U.S. and Europe have many differences, and understanding these institutional differences as we know can be quite important.

Betsey Stevenson: Great. Don Kohn?

Don Kohn: Really interesting paper. Led me to reflect a little bit on the relationship of the Great Moderation to the surge in productivity in the last half of the 1990s. And it seems to me the fact that we had one small recession in the middle of that 1980s, 1990s period and consistent progress towards price stability, and inflation staying below the level where people had to take it into account, the old Greenspan definition, really gave the stable background for the innovation and surge in productivity that we saw in the late nineties. And in that regard, I think the Fed's contribution to innovation is to achieve the dual mandate. So price stability, maximum employment, consistent with price stability as much as possible. I think innovation would then be an externality, a positive externality from achieving that. And it shouldn't come into the objective function separately. It's enough to achieve the dual mandate.

And in that regard, I'd like to push back a little bit on the discussion from the floor of low interest rates inhibiting innovation, because if raising interest rates prevents or slows progress towards the price-stability goal and the employment goal and creates uncertainty about when you're going to get there and how you're going to get there, that's not going to be good for innovation. So raising interest rates because it might encourage more productive investment, I think, is not consistent with getting to the goals, which is what the central banks are trying to do, of course, and would not be good for innovation.

Betsey Stevenson: Thank you. I am actually going to take the prerogative here as the moderator to throw in my own question because it follows up on that, which is I think one of the things I was surprised about when you asked can another policy substitute for monetary policy, what you were asking was should fiscal policy be working to support innovation? Which I think the answer to that is an obvious yes. But does your work actually speak more as a warning to fiscal policy that when central banks have to tighten to correct the missed actions of fiscal policy, that it comes at costs, like maybe a reduction in innovation. Heather Boucshey?

Heather Boushey: My question actually follows on what you just said, Betsy. So first of all, what a wonderful paper. Thank you so much. I think that I was really struck by your comment that this deserves more attention, and the notes on how this looks in the Fed conversations, I thought, was a really interesting insight. Right now on the fiscal side, we are working so hard to make sure that we are fostering the right kind of innovation, particularly in clean energy. And I think everyone in this room understands that that is key to making sure that we do not surpass by too much the 1.5-degree increase in temperatures that we're seeing globally due to climate change.

And so I wanted to know a little bit more if you could disaggregate the different kinds of technologies, to understand what in this current moment when fostering innovation is so important for a particular segment of our economy, and yet it does seem like there are questions as to how the fiscal and monetary are working together at a moment when you need very rapid innovation. And to your point, so much of what we need is not just the original R&D, but it is actually the commercialization at scale where so many of these firms are really struggling. So I wanted to know more about that interaction at this particular moment, which may not be generalizable to all different kinds of technologies but because of the urgency of this particular kind of innovation.

Betsey Stevenson: Austan Goolsbee?

Austan Goolsbee: There was an older literature and argument many years ago that was very similar, which was about physical investment. And it went, "When the interest rate is high and there is less physical investment, does that lower the productivity growth rate in the future?" And I thought the conclusion for this room, that is to say of monetary policy makers, was that's a little too hard. It's a little too speculative and too far in the future. Our bread and butter is about stabilization. And in a way the bad news is, when major sectors of the economy are not interest-rate-sensitive, then the stabilization job is harder.

I wonder if in this case, you may have buried the lead a little bit in that one of the findings is that this new kind of investment

is interest-rate-sensitive. If true, then the stabilization job of central bankers remains not easy to do, but remains - for our dual mandate - still doable. The reason that central banks' target investment is because that's an interest-rate-sensitive part of the economy. So as Chair Powell's remarks began this morning, if everything becomes like the service sector, i.e., is not interest-rate-sensitive, then our job gets a lot harder. So is there an element of good news in this story?

Betsey Stevenson: Do you want to respond? Then I'll take another batch.

Yueran Ma: So one theme that came up in both Austan Goolsbee's comment and Don Kohn's comment is how we think about stabilization. Let me summarize what the literature, with less than half a dozen papers so far on optimal policy analysis, broadly indicates, which is, loosely speaking, it could make monetary policy more powerful, in a way, in stabilizing against demand shocks or financial shocks. And several papers hold the view that doing so is important. I think more work, beyond the current less than half a dozen paper, would be helpful. It could make stabilization against supply shocks harder. And there was recent work saying that if there's a supply shock and one tightens against supply shock, if that decreases innovation, that can make marginal cost elevated for a longer period of time and inflation more persistent. Of course, that's a theoretical possibility, and I think further investigation would be useful.

And, second, there are several questions that raised the issue of fiscal policy. Of course, there is a long literature about the effects of fiscal policy on innovation, and I think the interaction between fiscal policy and monetary policy will be interesting. In this paper we looked at the effect of fiscal policy, again building on Romer-Romer shocks, and monetary policy using Romer-Romer shocks separately. Future work can look at their possible interactions. And for specifically investment in clean energy, thanks to the recent work by Nick Bloom and co-authors who categorized and named and labeled the industry codes of different technologies.

Yes, we can look at technologies in different sectors, different types of technologies, and I'll be curious to look at that as well. And, finally,

you touched on the point of commercialization. And commercialization is ultimately very important for translating technological innovations into output impact. And this commercialization step can be particularly cyclical and sensitive to economic conditions. But still, from technological development to ultimate productivity statistics, that's a very long way. And productivity statistics are very difficult to construct, very difficult to measure. So there can be very long lags until we see the productivity impact in the statistics.

And, finally, to Don Kohn's point about monetary policy regimes and the conduct of monetary policy, I absolutely agree that the effects of monetary policy on innovation can be very rich. For example, there's indication that volatility is also bad for innovation, and stabilizing and lowering productivity is certainly helpful. And we hope to start the conversation given the very little work that has thought about this so far. And certainly it's not the end of the conversation and there's a lot more to be done.

Justin Wolfers: I wanted to follow up on one of your throwaway lines. You joked that the Fed largely ignored innovation. If that's right, it opens up a really neat econometric possibility. And I hesitate to say this, given where I'm sitting, but you don't always need the Romers. Why is it we use Romer-Romer dates? If you ran a regression of output on interest rates, you're worried that that's infected by the Fed's reaction function, where interest rates depend on output. And so now you need an instrument and now you need the Romers.

But you said the Fed ignores innovation. If that's true, you can just run a regression of innovation on interest rates. Now, VCs actually care about the economy as well, so you might want a condition on that. But the Fed has a lot of private information. We think probably that big corporations don't. And so that gives you a completely different research design, which is a super-unsexy selection on observables. And you can run OLS. And the thing that this is going to do for you, is the biggest problem with using the Romer dates is you've got so little variation, and the confidence intervals are wide. Now you get a whole lot more variation and you might have much more precise results.

Betsey Stevenson: Thank you. Roger Ferguson?

Roger Ferguson: Can you help me a little bit with an intuition? So the theory of the case, at least in the United States for those who invest in VCs, you've got to be an ultra-high-net-worth accredited investor, etc. The thought that a relatively small movement in interest rates, for an institution worth billions of dollars, is going to change your appetite for this kind of risk strikes me as something I'd like to understand a little bit better. And the second, at least if one looks at the current environment, and this may be part of your financial conditions, part of the argument for what's going on is the IPO market has shut temporarily but may open up again as soon as next year, et cetera. And that might drive a whole new dynamic around VC investments, which may be potentially very sensitive to interest rates but maybe totally removed from it. So any intuition about the results that you find versus who the folks in the real world who are doing this might be helpful.

Betsey Stevenson: Diane Swonk?

Diane Swonk: Thanks for a great paper. And also, John Haltiwanger, I've read all of your work as well. I actually just did the same chart that you presented on high-propensity business formation, and if you see where the biggest gains are, they're in food services and construction, which tend not to have a lot of productivity associated with them. But also we've seen a major uptick according to at least ADP and some other measures of small business hiring relative to large business hiring. And I wondered what you thought that meant for both innovation, and I think about it in terms of Chairman Powell's speech today in terms of the service sector.

Betsey Stevenson: Agustin?

Agustin Carstens: A very interesting paper, although I have some problems with the link to monetary policy per se and its policy relevance. I have, as Don Kohn has implied, problems with the evidence. First, I think after a period of very low for long interest rates in the last decade we probably should have seen far more innovation by now. Second, I would say a lot of the exercise depends on simulating what the effect of a monetary policy shock is coming from a central

banker's point of view, we central banks don't shock our economies. What we try to do is to smooth the business cycles, and where many, many different dynamics are in place.

Therefore, I think this type of exercise, it's important to understand the transmission mechanism of monetary policy, but not to identify, let's say, a different avenue or a different objective for monetary policy. We have to remind ourselves, monetary policy is extremely blunt. And at some point, you have to establish priorities. And I think the priorities are very clear, with very high-level objectives, which are inflation and unemployment, in the case of the United States, but they're very broad. We cannot micromanage how we get there. Therefore, I think that yes, it's important, this type of research, to understand the transmission mechanism, but I find it very difficult to read something out of it, for monetary policy implementation or design.

Betsey Stevenson: I think one of the things you're hearing from several people is the important role of monetary policy in impacting potential GDP is maintaining price stability, which maximizes potential GDP. The thing about Justin's point is, if you could get some more variation. A question, I think, many people are thinking about right now, is monetary policy working better by raising rates higher or keeping them high for longer? And maybe it's not tight, but if you could actually try to shed some light on how monetary policy achieves its goals and how that impacts innovation differently, that could be potentially really powerful. Why don't I let you respond to everybody's comments?

Yueran Ma: Sure. I will start with the theme around monetary policy shocks. To Justin Wolfer's point, even if the Fed did not historically necessarily include innovation in its policy decisions, higher interest rates can still be correlated, for example, with higher output, better economic conditions. And that can confound the empirical analysis if high interest rate is correlated with higher output, which is true for much of the sample. That will offset the potential negative effect of higher interest rate on innovation activities. So the Romer-Romer shocks are still useful, and we've learned many lessons from the Romer-Romer studies. And similarly, the intention of having

these shocks is to isolate movements in the Fed funds rate that are not explained and confounded by the prevailing economic conditions. And they are a tool to see the effects of monetary policy, and typically underlying the monetary policy shocks are changes in the regimes and preferences of central banks. They're a useful empirical tool. And if I missed any important points, the Romers can fill in.

I also want to clarify that we do not intend to say that the FOMC historically necessarily ignored innovation. Actually, we've done textual analysis of FOMC transcripts and minutes and everything to pick up what are the discussions about innovation occasionally does come up, but I've not been in FOMC meetings. I do not want to mischaracterize any of these discussions. And for the policy implications, again, we do not intend to argue for either higher or lower rates at this point. I think more analysis would be necessary. We are presenting the basic empirical facts about how interest rates appear to affect innovation activities. And if you think about the underlying mechanisms, these are mechanisms that we're familiar with. We know that monetary policy affects financial conditions, and we know that financial conditions affect innovation activities. So if we connect the dots, then what we see in the empirical results follow from these well-known mechanisms.

And then for the effect about one of the mechanisms, which is why monetary policy affects financial conditions if VC investors are wealthy individuals, that's a fascinating question. I don't think we fully understand that yet. But as we see in reality, VC investment is quite sensitive and quite volatile, too, in general. So that's worked for my asset pricing colleagues to understand changes in risk premium and risk-taking behavior. And I think there was a question for John about business formation.

John Haltiwanger: I'll take it real briefly. So, Diane Swonk, I agree with you. We should be paying attention to the shifting share of activity by young and small versus large, mature businesses. I think that's a critical thing to follow. We know that, pre-pandemic, all the movement was towards large, mature. I think you're exactly right. We're starting to see a dent and reversal in the last few years, I want to say. Have we changed things? Is most activity still overwhelmingly

concentrated in large, mature businesses? You betcha. And there's lots of discussion about the potentially adverse impact of that concentration on imperfect competition, markups, on innovation, and so on. And the question is, are we seeing a reversal? There's a dent, I think, in the data.

Structural Changes in Financial Markets and the Conduct of Monetary Policy

Darrell Duffie

Abstract

The resilience of the U.S. Treasury market is limited by dealer balance sheets that are not sufficiently large and flexible to effectively intermediate this market in a "dash for cash," as when COVID became a global pandemic in March 2020. Since 2007, the total size of primary dealer balance sheets per dollar of Treasuries outstanding has shrunk by a factor of nearly four. This trend continues because of large U.S. fiscal deficits and regulatory capital constraints, which are necessary for financial stability but reduce the flexibility of dealer balance sheets. I review approaches for increasing the intermediation capacity of the market and for backstopping Treasury market liquidity with official-sector market-function purchase programs.

I am grateful for comments or advice from Daron Acemoglu, Wenxin Du, Peter Glynn, Linda Goldberg, Michael Harrison, Ben Hébert, Frank Keane, Arvind Krishnamurthy, Tiff Macklem, Andrew Metrick, Tyler Muir, Sungjin Park, Chang Yong Rhee, Im`ene Rahmouni-Rousseau, Jeremy Stein, Peter Van Tassel, and Annette Vissing-Jorgensen. This paper draws in part on work with Michael Fleming, Jean-Sébastien Fontaine, Frank Keane, Claire Nelson, Or Shachar, and Peter Van Tassel. I am thankful for research assistance from Hannah Firestone, Renhao Jiang, Rosemary Jiang, Isabel Krogh, Boyang Mu, and Tyler Ratcliffe. This paper relies in part on work in Duffie (2022), Duffie and Keane (2023), and Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023). All opinions are my own.

I. Introduction

On September 1, 1939, the opening of conflict in World War II triggered a surge of sales of U.S. Treasury securities that threatened the ability of dealers to make orderly markets. New York Fed First Vice President Allan Sproul met with dealers at 9:30 am, telling them that the Bank was "prepared to see that no disorder develops" and that "we are willing to clean up the dealers' net positions at a price 1/8 below last night's late closing prices."[1] The Federal Open Market Committee authorized purchases of up to $500 million "toward maintaining orderly market conditions."

In this paper, I describe new empirical evidence, with supporting theory, that the current intermediation capacity of the U.S. Treasury market impairs its resilience. The risks include losses of market efficiency, higher costs for financing U.S. deficits, potential losses of financial stability, and reduced save-haven services to investors.

After investigating these implications, I discuss improvements in Treasury market structure and other measures that could increase the market's intermediation capacity under stress. These include broader central clearing, all-to-all trade, post-trade transaction reporting, substituting the Supplementary Leverage Ratio rule with higher risk-based capital requirements, and official-sector market-function purchase programs.

Central banks have occasionally had to rescue their government securities markets from dysfunction by relieving dealers of some of their inventories so that dealers can intermediate the market more effectively. Notably, on March 12, 2020, when the World Health Organization declared COVID-19 to be a global pandemic, some government securities markets became dysfunctional as investors flooded dealers with demands for liquidity. In the U.S. Treasury market, dealers' gross bond inventories and daily purchases of bonds from customers surged to over ten times their 2017-2022 medians.[2] The Fed responded by offering virtually unlimited Treasury financing to dealers and by purchasing nearly a trillion dollars of Treasury securities from them over the next three weeks, among other major actions.[3] It took several more weeks for normal Treasury market functioning to resume. In the meantime customers of dealers

faced bid-offer spreads reaching more than ten times normal and interdealer market depth nearly disappeared at some points.[4] Treasury market prices were unstable and settlement failures soared.[5]

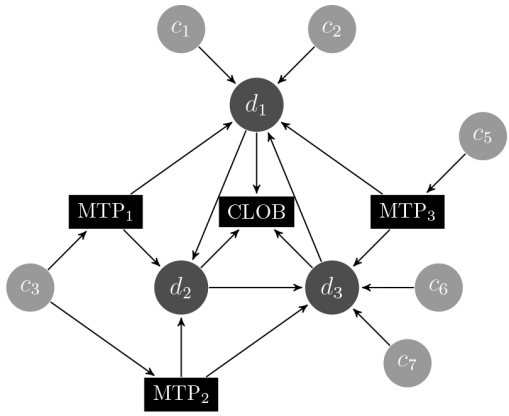
Figure 1 illustrates that normal investors in the U.S. Treasury market trade Treasuries exclusively with dealers. Dealers trade with each other bilaterally or on a limit-order-book market for on-the-run securities. (High-frequency trading firms also participate on the limit order book market.) Since 2007, as illustrated in the bar chart in Figure 2, the amount of Treasuries outstanding has grown by a factor of nearly four relative to the total size of primary dealer balance sheets. The trend of declining relative market capacity continues because of large U.S. deficits and regulatory capital constraints that keep banks safe but reduce the flexibility of their balance sheets. Entry into the market for providing dealer services is limited.[6] In describing what happened in March 2020, the Federal Reserve Board wrote: "As investors sold less-liquid Treasury securities to obtain cash, dealers absorbed large amounts of these Treasury securities onto their balance sheets. It is possible that some dealers reached their capacity to absorb these sales, leading to a deterioration in Treasury market functioning."[7] The situation in March 2020 raises concerns over the capacity of dealers to intermediate this market under future stressed economic conditions. Safe-haven investors face a wrong-way risk if Treasury market intermediation capacity limits could plausibly bind just when these investors have an emergency need to liquidate their positions.[8]

II. Market Resilience and Safe-Haven Demands

U.S. Treasury securities are the primary safe haven of global capital markets. A safe-haven asset has two distinct roles. First, in a "flight to quality," many investors sell riskier assets and buy the safe-haven asset. U.S. Treasury security prices therefore tend to rise in a crisis, leading investors to own Treasuries as a crisis hedge.

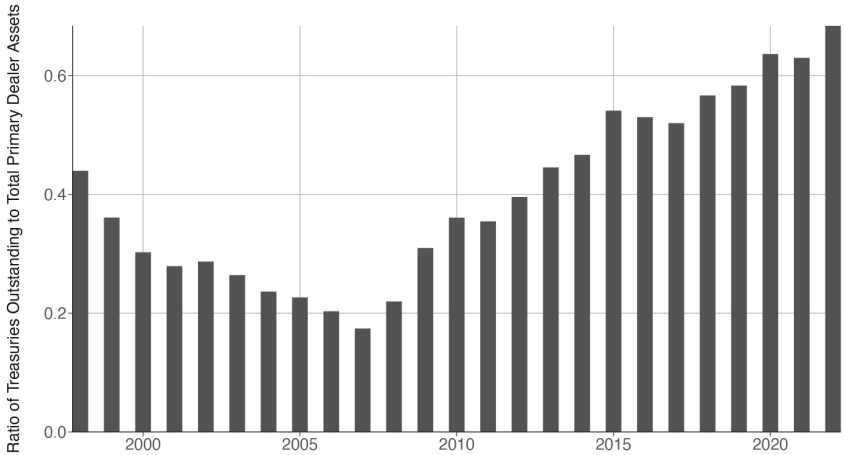
The second role of a safe-haven asset is manifest when a crisis induces investors to *sell* the asset in order to raise cash.[9] U.S. Treasuries are expected to provide excellent safe-haven services in a "dash for cash" because of the anticipated depth and liquidity of the market in

Figure 1
Schematic of the Structure of the Secondary Market for Trading U.S. Treasury Securities



Note: Light gray dots represent investors c_1 through c_7. Dark gray dots represent dealers d_1 through d_3. Black rectangles represent trading venues. The Brokertec central limit order book (CLOB) market is for dealers and a selection of high frequency trading firms. Multilateral trade platforms (MTPs) are arranged by firms such as Bloomberg and Tradeweb.

Figure 2
The Ratio of U.S. Treasury Securities Outstanding to Primary Dealer Assets Over the Period 1998–2022



Data: The Federal Reserve and company filings. Assets are measured at the holding company level.

which they are traded, even during a crisis when many large investors are simultaneously liquidating their Treasuries *(Das, Gopinath, Kim, and Stein, 2022)*. However, this dash-for-cash safe-haven service gen-

erates a negative demand complementarity. During normal times, each investor who anticipates a need to raise cash in a future crisis prefers to own *less* of a particular asset as a safe haven, other things equal, to the extent that other safe-haven-seeking investors own more of that asset. Investors don't want to suffer a cost of liquidation that is magnified by the price impact of simultaneous sales of many other investors, especially if the underlying market is not sufficiently resilient to efficiently intermediate a flood of demands for liquidity. Until now, despite this negative complementarity,[10] U.S. Treasury securities remain the world's clear go-to safe haven, not only because they are safe if held to maturity, but also because of the expected depth and liquidity of Treasury markets.

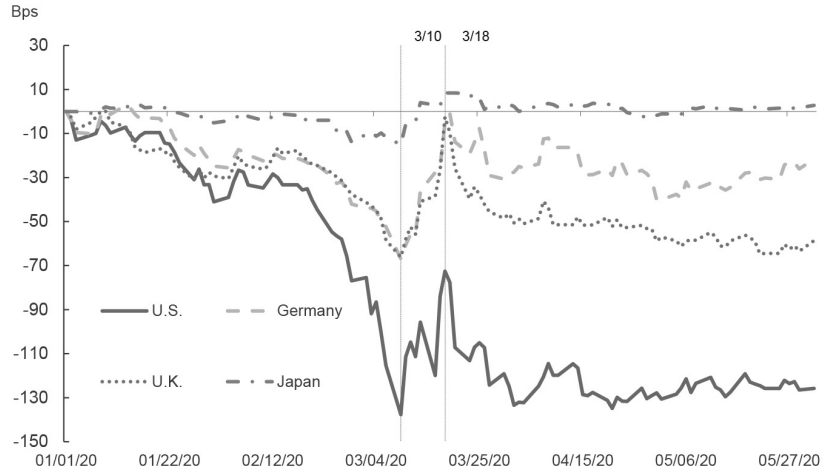
In 2020, both of the safe-haven roles of U.S. Treasuries were tested. With the heightening risk of a global pandemic leading up to March 2020, a flight to quality caused U.S. Treasury yields to decline more than the yields of other developed-market government securities, as shown in Figure 3. Then, once the onset of a severe global pandemic was clear by mid-March, a dash for cash caused severe *selling* of Treasuries. The resulting illiquidity in the U.S. Treasury market was worse than that of most other major government securities markets *(Barone et al., 2022)*. The March 2020 dash for cash also had a significant adverse impact on liquidity in the UK gilt market, out of proportion to the extent to which gilts are held in foreign exchange reserves and perhaps related to the level of stressed demand for liquidity in gilts relative to the intermediation capacity of the underlying market.

In short, for U.S. Treasuries to maintain the high level of safe-haven services that they have normally provided to global investors, the intermediation capabilities of the underlying market must be sufficiently resilient to crisis-level selling.

III. Dealer Capacity and Liquidity: Evidence

The global financial crisis (GFC) led to a major strengthening of capital requirements for large bank holding companies, further tightened in 2014 with the introduction of the enhanced Supplementary Leverage Ratio, followed by requirements under "GSIB scoring" *(Tarullo, 2023)*. While high capital requirements are necessary for

Figure 3
Cumulative Changes in 10-year Government Securities Yields, in Basis Points, from January 1, 2020 to May 30, 2020, for Germany, Japan, the United Kingdom, and the United States

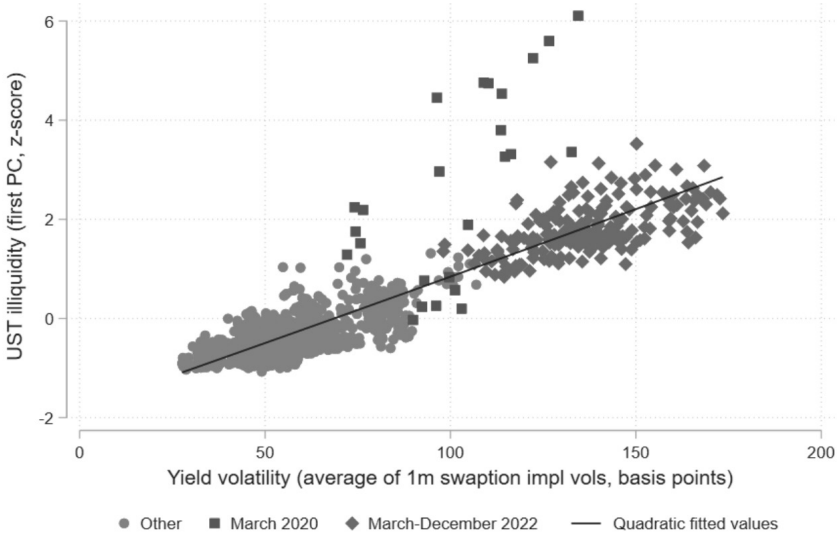


Source: Barone, Chaboud, Copeland, Kavoussi, Keane, and Searls (2022).

financial stability, these capital regulations have reduced the short-run flexibility of liquidity provision to the U.S. Treasury market, given its heavy reliance on bank-affiliated dealers.[11] The long-run rate of growth of the balance sheets of the largest dealers has also slowed dramatically since the GFC, especially in comparison with the size of the U.S. Treasury market *(Duffie, 2020).* The underlying incentive is debt overhang: dealers often refrain from issuing new equity or debt to undertake profitable expansions of their balance sheets because this can adversely impact shareholder return.[12] For example, since the GFC (but not before the GFC), dealers subject to quarter-end capital requirements forego significant profits at quarter ends that could be obtained by arbitraging cross-currency bases in the foreign exchange market *(Du, Tepper, and Verdelhan, 2018).*

Beyond the impacts of regulation and funding costs on the provision of liquidity by dealers, the flexibility of space on dealer balance sheets for intermediating the Treasury market is also reduced by the complexity of internal capital allocation processes and by agency

Figure 4
A Scatter Plot and Estimated Relationship between the Principal-Component Composite Measure of Treasury Market Illiquidity and a Composite Measure of Implied Volatility



Note: Measured by the average of the standard deviations of benchmark swap rates, in basis points, implied by swaptions on 2-year, 5-year, and 10-year swaps with one-month expirations. The plotted ordinary-least-squares fit, for July 10, 2017 to December 31, 2022 (T = 1, 336), is the second-order polynomial $y = -1.81 + 0.026x + 0.000005x2$, where volatility x is in basis points, R2 = 79.5%. The constant and linear coefficient estimates have p-values of less than 1% under standard assumptions. Source: Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023).

costs, including the risk aversion and career concerns of their traders and managers.

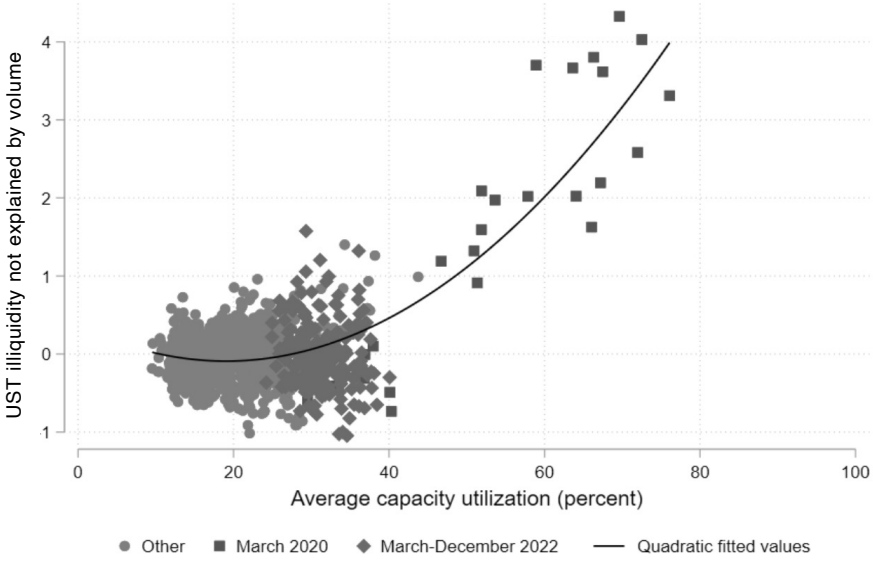
On typical trading days, *Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023)* show that illiquidity in the U.S. Treasury market is well and simply explained by yield volatility. Figure 4 illustrates this nearly linear relationship. The scatter plot shows daily observations of a composite measure of illiquidity versus the average volatility of 2-year, 5-year, and 10-year yields. The yield volatilities are one-month swaption-implied volatilities. The composite illiquidity measure is the first principal component[13] of the *z*-scores of 18 metrics covering, for each of the 2-year, 5-year, and 10-year maturity sectors of the Treasury market, six different measures of illiquidity. These illiquidity measures are: interdealer market price impact, lack of interdealer market depth (the negative logarithm of depth),[14]

interdealer market bid-ask spreads,[15] the yield spread between off-the-run and on-the-run Treasuries, the within-security dispersion of off-the-run transaction yields,[16] and the root mean squared error (RMSE) of yield-curve fitting noise.[17]

Volatility alone explains about 80% of the variation in Treasury market illiquidity. When volatility is higher, dealers tend to reduce their provision of liquidity for a range of reasons unrelated to capacity limits, including the typical risk-versus-return incentives of their traders and the fear of having their quotes adversely selected by informed counterparties, which tends to rise with volatility. The total demand by investors for liquidity provision from dealers, and by dealers for liquidity provision from other dealers, is expected to rise with volatility. As volatility rises, higher demands for liquidity and a reduced supply of liquidity at any given level of dealer compensation imply that the cost or ease of obtaining liquidity rises.[18]

Although yield volatility explains most of the variation in Treasury market illiquidity, *Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023)* also show that dealer balance-sheet loading plays an important role, but only when balance sheets are heavily loaded — a highly nonlinear effect. This supports the proposition that dealer balance-sheet capacity constrains Treasury market intermediation during a dash for cash. When dealer balance sheets are sufficiently loaded, the propensity of dealers to supply liquidity is reduced and the demand for liquidity that dealers request from other dealers rises. Both effects increase illiquidity, and this is consistent with the data. Figure 4 shows that during March 2020 Treasury market illiquidity was at times over three standard deviations worse than predicted by volatility. Figure 5 shows that a significant fraction of this excess illiquidity can be explained by much heavier-than-normal loading of dealer balance sheets. *Duffie et al. (2023)* estimate dealer capacity utilization based on dealer gross positions, dealer net positions, gross dealer-customer volume, and net dealer-customer volume, all adjusted for risk. When the estimated capacity utilization of dealers is around 20%, Figure 5 shows little estimated marginal impact of increases in capacity utilization on Treasury market illiquidity. However, when dealer capacity utilization rises from 40% to 80%, Trea-

Figure 5
The Relationship Between the Average Dealer Capacity Utilization and the Residual Component of Treasury Market Illiquidity



Note: The relationship between the average dealer capacity utilization and the residual component of Treasury market illiquidity that remains after controlling for average swaption-implied volatility (the residuals associated with the fitted relationship in Figure 4). The average capacity utilization is the average of the dealer capacity utilization measures based on dealer gross positions, dealer net positions, gross dealer-customer volume, and net dealer-customer volume. The plotted ordinary-least-squares fit, for July 10, 2017 to December 31, 2022, is the second-order polynomial $y = 0.363 - 0.048x + 0.0013x^2$, with $R^2 = 43.6\%$. All three coefficient estimates have p-values of less than 1% using NeweyWest standard errors. *Source: Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023).*

sury market illiquidity is estimated to increase by roughly three standard deviations beyond the level of illiquidity predicted by volatility. The scatter plot reveals a striking nonlinear relationship between balance sheet utilization and market liquidity.

Volatility is likely to be the primary driver of illiquidity in most financial markets, under normal operating conditions. One might therefore view illiquidity that is significantly in excess of the level predicted by volatility to be a sign of market dysfunction. Despite some limitations, this "excess illiquidity" may be viewed as a index of market dysfunction.

Using quantile regressions, *Duffie et al. (2023)* also show that extreme levels of illiquidity are predicted to depend heavily on dealer capacity utilization, before or after controlling for volatility. For example, in a univariate quantile regression, the 99th percentile of daily Treasury market illiquidity is predicted to rise 1.2 standard deviations[19] for each one-standard-deviation increase in estimated utilization of dealer capacity, as measured by risk-adjusted gross positions. The pseudo-R^2 measure of this fit is 70%. The 50th percentile of Treasury market illiquidity, on the other hand, has a much more muted dependence on dealer capacity utilization, especially after controlling for yield volatility. This again supports the concept of capacity constraints. Marginal changes in balance-sheet loading have only small effects on Treasury market liquidity on normal days, but the same marginal changes in balance-sheet loading have large predicted effects when illiquidity is very high.

Some of the increase in Treasury market illiquidity in March–April 2020 can likely be ascribed to the increased willingness of investors to pay for immediacy from dealers. This increase in the demand for liquidity could be caused not only by a heightened need for cash but also heightened yield volatility or by macroeconomic factors that increase with volatility, consistent with the evidence in Figure 4. An additional increase in illiquidity can be caused by a change in the propensity of dealers to supply immediacy. Some of that change in dealers' supply of liquidity is likely to be related to heightened costs of taking or holding customer positions, which increase with yield volatility, again consistent with the evidence in Figure 4. Additional shifts in the supply of immediacy by dealers could be caused by higher likelihoods of hitting balance-sheet limits in the near future, consistent with the effects shown in Figure 5.

In his analysis of Treasury market liquidity during March and April of 2020, Goldberg (2020a) estimates both an outward shift in the investor demand curve for liquidity and an inward shift in dealers' supply of liquidity.[20] A shift in the supply curve is assumed to lead to opposite-sign changes in price and quantity, proxied by weekly changes in dealer gross positions (FR2004 data). A shift in the demand curve is assumed to lead to same-sign changes in the

same two variables. The increase in demand for liquidity in March 2020 is estimated at about 26%, the largest such shift in the sample period, 1990 to 2020. The estimated 17% reduction in the supply of liquidity is the fifth largest of the sample period, the largest being the 29% estimated reduction in liquidity supply that occurred in October 2008, following the Lehman bankruptcy.

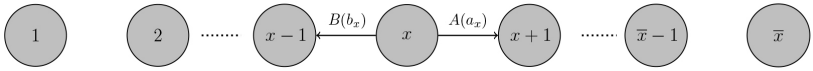
Huang et al. (2023) find that transactions costs in the foreign exchange market rise when variables that are correlated with the cost of dealer balance sheet space rise, after controlling for dealer-provided volume.

The implications of dealer capacity limits for Treasury market resilience may worsen in future years because the quantity of Treasury securities that investors may wish to liquidate in a crisis is growing far more rapidly than the size of dealer balance sheets. In 2020 alone, the stock of marketable U.S. Treasuries held by the public increased from about $17 trillion to about $21 trillion. In July 2023, The U.S. *Congressional Budget Office (2023)* projected that the total amount of Treasury security debt will rise from 98% of U.S. gross domestic product (GDP) in 2023 to 177% of GDP in 2052, far above the previous peak of 106% of GDP in 1946. Yet the dealer balance sheets are not even keeping up with GDP. For example, from 2010 to 2022, the ratio of total primary-dealer assets, at the holding company level, to GDP went down by 18.5%.[21] The stress on dealer balance sheets of handling future surges in trade demands could also be magnified by increases in the volatility of Treasury prices.

IV. Dealer Capacity and Liquidity: Theory

As the basis for a theoretical exploration of the impact of dealer capacity limits on market liquidity and the benefits of a "buyer of last resort," this section extends the dealership model of *Amihud and Mendelson (1980)*.[22] The main theoretical findings are: (1) a dealer's bid and offer prices "bend down" sharply when their bond inventories near capacity; (2) simultaneously, the rate at which the dealer purchases bonds from customers suffers a sharp decline as inventory limits approach; and (3) both of these effects are mitigated by an official-sector market-function purchase program.

Figure 6



Mean dealer purchase rate $A(a_x)$ and sale rate $B(b_x)$ from the current inventory level x at the dealer's chosen ask price a_x and bid price b_x. The dealer's upper bound on inventory is $\overline{x}$. The lower bound of zero, chosen for simplicity, could be replaced with any integer less than $\overline{x}$, including a negative lower bound.

The time discount rate is $r > 0$. A dealer's inventory x of a given asset must remain below some integer capacity $\overline{x} > 0$ and above some minimum level, which is taken to be zero without loss of generality for our purposes. With an inventory of x, the total dividend paid to the dealer, net of dealer holding costs, is $d(x)$. For example, if the asset is a perpetual bond that pays one per unit of time, then $d(x) = x$, unless the dealer has holding costs.

At each ask price a, the intensity (mean arrival rate) at which customers arrive and agree to sell a unit to the dealer is $A(a)$. At each bid price b, the intensity at which customers arrive and agree to buy a unit from the dealer is $B(b)$. These intensity functions A and B, which are assumed to be differentiable, reflect trading motives that can arise from investor liquidity shocks, changes in risk preferences, and frictions such as attention and search costs. This setup is illustrated in Figure 6. This model does not incorporate general-equilibrium effects stemming from dealer competition[23] and endogenous changes in the asset holdings of each type of non-dealer investor.

Some of the price elasticity embedded in the mean supply and demand rates, $A(a)$ and $B(b)$, could arise from the cross-sectional distribution of willingness-to-pay of investors and some could stem from the ability of investors to trade with other dealers under imperfect competition *(Ho and Stoll, 1983).* For example, suppose that investors hoping to buy contact the dealer at some mean frequency $\lambda(b)$ that could depend on the dealer's posted bid b. For any such investor, let ρ be the larger of *(i)* the investor's preference-based value of owning the asset and *(ii)* the lowest alternative bid quote available (or prospectively available) to the investor from other intermediaries. The cumulative probability distribution function of this reservation price ρ is denoted by F. In this example, investors accept a bid b

with probability $F(b)$, so the mean frequency of investor purchases is $B(b) = \lambda(b)F(b)$.

At each initial inventory level x, the dealer's maximum expected present value $V(x)$ of future discounted cash flow is achieved by an optimal price quotation policy.[24] At any inventory level x other than the boundary points[25] 0 and $\bar{x}$, the dealer's optimal present value $V(x)$ of inventory and intermediation profits satisfies the Hamilton-Jacobi-Bellman (HJB) optimality condition[26]

$$\max_{a,b} \{-rV(x) + d(x) + B(b)(b + V(x-1) - V(x)) + A(a)(V(x+1) - V(x) - a)\} = 0.$$

The first-order necessary condition for an interior optimal ask price a is

$$A'(a)(V(x+1) - V(x) - a) - A(a) = 0, \quad 0 \le x < \bar{x}, \tag{1}$$

Similarly, an optimal interior bid price b satisfies

$$B'(b)(V(x-1) - V(x) + b) + B(b) = 0, \quad 0 < x \le \bar{x}. \tag{2}$$

Example 1. Exponential supply and demand. Suppose

$$A(a) = ke^{\alpha a}, \quad B(b) = ce^{-\beta b}, \tag{3}$$

for positive parameters k, α, c, and β. In this case, we can verify optimality and compute optimal dealer quotes given a solution V of the HJB equation.

The optimal bid and ask at inventory level x are

$$b = V(x) - V(x-1) + \frac{1}{\beta}, \qquad a = V(x+1) - V(x) - \frac{1}{\alpha}, \tag{4}$$

The bid b is the sum of the dealer's indifference price $V(x) - V(x-1)$ and the direct markup β^{-1}. The indifference price $V(x) - V(x-1)$ embeds the present value of future markups from other investors and future dividends (net of dealer holding costs). Similarly, the optimal offer a reflects the direct rent α^{-1} taken from a seller. The bid-ask spread is

$$\alpha^{-1} + \beta^{-1} + 2V(x) - V(x+1) - V(x-1). \tag{5}$$

The first two terms of the bid-ask spread are the rents taken directly from sellers and buyers, respectively. The remainder of the bid-ask spread, $2V(x) - V(x+1) - V(x-1)$, is the concavity of the value function V at inventory level x, in a discrete sense. The concavity of the dealer's value for inventory naturally increases as the inventory x nears the capacity $\bar{x}$ because of the increasing marginal cost to the dealer of using up its shrinking balance-sheet space. This is consistent with the empirical results of *Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023)* summarized in Section III and with solved numerical examples found below.[27]

Example 2. Isoleastic supply and demand. An alternative special case is isoelastic demand and supply,

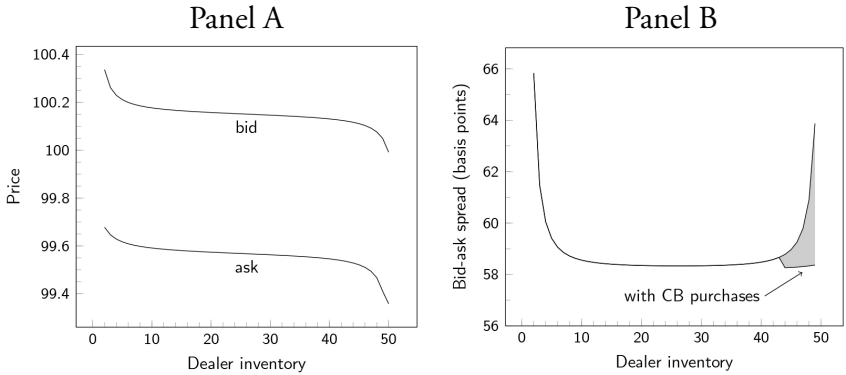
$$A(a) = ka^{\upsilon}, \quad B(b) = cb^{-\gamma}, \tag{6}$$

for positive constants c, k, υ, and γ. In this case, the dealer quotes are proportional to the dealer's indifference prices, in that

$$a = \frac{\upsilon}{\upsilon + 1}\left(V(x+1) - V(x)\right), \quad b = \frac{\gamma}{\gamma + 1}\left(V(x) - V(x-1)\right). \tag{7}$$

For example, with $\upsilon = \gamma = 400$ and at the median inventory level, the bid-ask spread is about 50 basis points of the dealer's indifference price. Because actual bid-ask spreads in the Treasury market are even smaller, higher elasticities would be needed to calibrate the model to the relatively high degree of competition that normally obtains in the wholesale Treasury market. A large investor's decision to trade with a particular dealer is highly sensitive to the dealer's quotes because of the investor's outside option to search for a better price from another dealer. For the 10-year customer-to-dealer sector of the U.S. Treasury market, for example, *Duffie et al. (2023)* estimate yield dispersion, a proxy for bid-ask spread in the off-the-run market, at roughly 0.5 basis points on average across days during their sample period, July 2017 to December 2022, and about 1.2 basis points at the 95th percentile. For large elasticities, the bid-ask spread of the isoelastic model is approximately[28] to the concavity of the value function, as for the exponential model.

Figure 7
Dealer Pricing for an Isoelastic Model

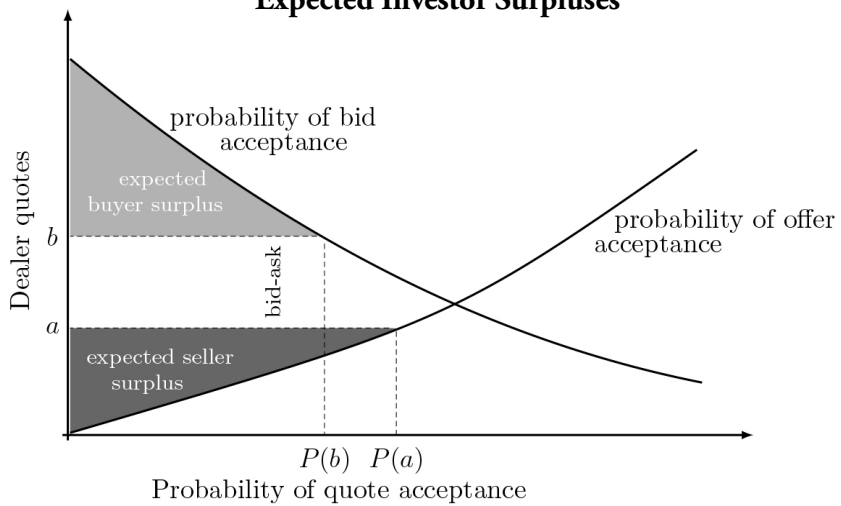


(a) Bid and ask prices for an isoelastic model. Buyer elasticity is $y = 400$. Seller elasticity is $v = 300$. The trade-rate constants are $c = 100{,}000$ and $k = 50{,}000$. The discount rate is $r = 0.1$. The bond dividend rate is $d(x) = 0.1x$, implying a perfect-markets bond price of $0.1/r = 1$. The prices shown are scaled by 100.

(b) Bid-ask spreads for the isoelastic model shown in Panel (a), with and without a central-bank market-function purchase program. The height of the blue shaded area is the reduction in bid- offer spread caused by the central-bank market- function purchase program through its impact on the shape of the dealer's value function V.

Note: The central-bank market-function purchase program whose effect on bid-ask spread is shown in Panel (b) is active whenever the inventory level x is at or above $\underline{x} = 45$. Central bank purchases from the dealer are at the mean rate $\lambda(x) = 0.1B(b_x)$ and executed at the mid-price $(a_x + b_x)/2$.

Figure 8
Expected Investor Surpluses



Note: An illustration of the expected buyer surplus (the light shaded area) and expected seller surplus (the dark shaded area) at dealer bid b and ask a quotes, respectively.

Panel (a) of Figure 7 illustrates the solution of the optimal quotation policy for a completely specified isoelastic model. Consistent with the empirical results of *Du, Hébert, and Li (2022),* bid and offer prices are declining in dealer inventory. Moreover, when the dealer's inventory nears its capacity $\overline{x}$, bids and offers decline more rapidly, as the dealer's marginal value of remaining balance sheet space rises, discouraging investor sales and encouraging investor purchases. As inventory rises toward the boundary, the bid-ask spread also widens as a reflection of the increasing marginal indirect cost to the dealer of balance-sheet space.

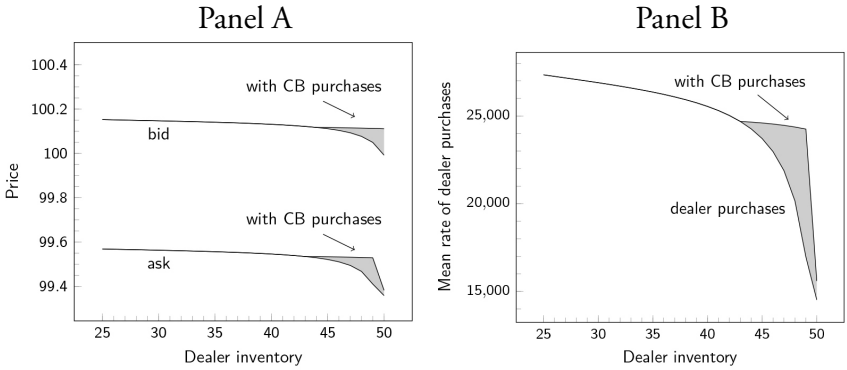
Consumer surplus is reduced in this setting by dealer pricing power, captured by the elasticity-dependent markups relative to the dealer's indifference price $V^t(x)$. Surplus is also reduced by the effect of dealer rationing of balance-sheet space through pricing, reflected in the concavity of the value function. Figure 8 illustrates expected investor surpluses added by trades.

For example, suppose the value u to a potential buyer of owning the asset is distributed exponentially with parameter μ, identically and independently across buyers. At a dealer bid b, the expected surplus of a buyer conditional on a trade is $E(u-b \mid u > b) = 1/\mu$. The expected time rate of buyer surplus at inventory level x is $B(b_x)E(u-b_x \mid u > b_x)$. The case of a selling investors is analogous.[29]

The value to a buyer of owning the asset may be much higher than the trade reservation price of the buyer when facing a given dealer because the buyer's reservation value reflects not only the value of owning the asset, but also expected cost of obtaining the asset from an alternative dealer, including delay and search costs *(Duffie, Dworczak, and Zhu, 2017).*

To illustrate how a buyer of last resort can increase the dealer's capacity to absorb customer sales, suppose the central bank purchases units of the asset from the dealer at mean frequency $\lambda(x)$, paying the mid-price $m(x) = (a_x + b_x)/2$. When facing the central bank, the dealer takes $m(x)$ as given, not influenced by dealer quotes.[30]

Figure 9



(a) Bid and ask prices for the isoelastic model described in the caption of Figure 7. The between the quotes with a central-bank market-function purchase program and without are the height of the shaded area.

(b) Mean time rate of dealer purchases from customers for the isoelastic model. The difference between the dealer purchase rate with a central-bank market-function purchase program and without is the height of the shaded area.

Note: Dealer quotes and purchase rates for the isoelastic model described in the caption of Figure 7. The central-bank purchase program is active whenever the inventory level x is at or above $\underline{x} = 45$. Central bank purchases from the dealer are at the mean rate $\lambda(x) = 0.1B(b_x)$ and at the mid-price $(a_x + b_x)/2$.

The theoretical impact of a central bank market-function purchase program on dealer pricing at high inventory levels is illustrated in Panel (b) of Figure 7 and in Figure 9. For this parametric example, the central bank purchases a unit from the dealer at the mean frequency $\lambda(x) = KB(b_x)$, for some constant K, whenever the dealer's inventory x exceeds some threshold $\underline{x}$. The central bank's purchases liberate space on dealer balance sheets to handle more customer sales. That is, with the prospect of these central-bank purchases, the dealer expects to be less constrained in the future by balance-sheet space. The concavity of the dealer's value function therefore declines, and at high levels of inventory the dealer optimally raises its quotes to more socially efficient levels than would apply without the market-function purchase program. (I am ignoring the welfare effect of increasing the size of the central bank's balance sheet.) For the illustrated example, the central bank purchases at a mean rate equal to $K = 10\%$ of the rate of purchases of other investors whenever the dealer's inventory is within 90% of its capacity. Although buyers pay a higher price than would be the case without a buyer of last resort, the total surplus is improved whenever the mean rate of gain from trade of

sellers is raised sufficiently relative to the lost mean rate of gain from trade of buyers, which is to be expected when prices would otherwise be depressed by elevated inventory levels.

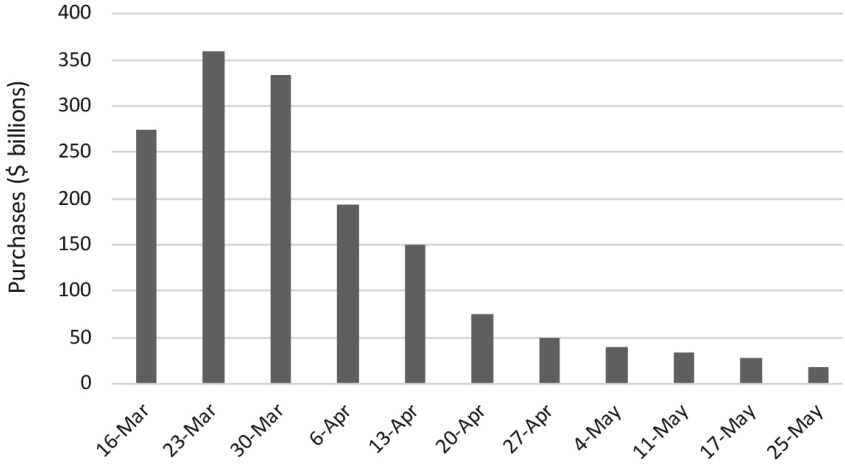
V. Market-Function Purchase Programs

Consistent with the theory in Section IV, empirical research supports the effectiveness of central-bank government-securities purchases in March-April 2020 in support of market functionality.[31] These official-sector purchases reduced the inventories of dealers, liberating space on dealer balance sheets to handle more investor demands for liquidity. For example, *Boneva et al. (2020)* show that in reverse auctions conducted by the Bank of England, dealers sell gilts more aggressively when they have unwanted inventory, or when they took additional gilt positions just before the reverse auctions, or when they are more constrained by the leverage-ratio rule. They find that "by acting as a backstop in the secondary market for gilts, the BoE's QE purchases have played a role in helping to alleviate market dysfunction and reducing price volatility."

In his Presidential address to the American Economics Association, *Bernanke (2020)* said: "A possible interpretation is that the initial [2008-2009] rounds of QE were particularly effective because they were introduced, and provided critical liquidity, in a period of exceptional dysfunction in financial markets." *Busetto et al. (2022)* write that "In exceptionally stressed circumstances, when dealers' capacity to intermediate trades is limited, large-scale asset purchases can improve wider market liquidity and mitigate the risk of a broader tightening in financial conditions that might disrupt the monetary transmission mechanism. The strength of this channel therefore depends on the degree of market dysfunction and the amount of gilts held by dealers."

Buiter et al. (2023) offer a policy discussion of emergency market-function programs, including both lending of last resort and buying of last resort. A market-function purchase program would naturally be triggered only if lending of last resort by the central bank is insufficient, as was the case in March 2020. Within the first few days of Treasury market dysfunction in mid March, the Fed had sat-

Figure 10
Weekly Purchase of U.S. Treasuries



Note: Total weekly purchases of Treasuries by the Fed from the week of March 16, 2020. Data: Federal Reserve. Source: Duffie (2020).

urated dealers with virtually unlimited repo financing of their Treasuries, quickly returning repo rates to normal levels *(Copeland et al., 2021)*. However, in the "cash" market for trading Treasury securities, extreme illiquidity persisted for several more weeks. In response, the Fed purchased an enormous quantity of Treasuries, nearly $1 trillion in the first three weeks of the crisis, as depicted in Figure 10, in addition to large quantities of mortgage-backed securities.

For the largest dealers, those affiliated with U.S. bank holding companies, these purchases failed to liberate as much balance-sheet space as one might have hoped because the Fed paid dealers for its purchases with new reserve balances, which have the same capital requirement under the Supplementary Leverage Ratio Rule (SLR) as any other asset, including the Treasuries that the Fed purchased. On April 1, 2020, the Fed temporarily exempted both Treasuries and reserves from the SLR for bank holding companies, although it was not until the middle of May that the Fed, the Office of the Comptroller of the Currency, and the Federal Deposit Insurance Corporation adopted a similar SLR exemption for commercial bank subsid-

iaries. Treasuries held by bank-affiliated dealers remained subject to risk-based capital requirements, given their obvious re-pricing risk.

He, Nagel, and Song (2020) and *Breckenfelder, Grimm, and Hoerova (2022)* analyze the implications of bank leverage constraints on market liquidity during the COVID-19 crisis. *He, Nagel, and Song (2020)* estimate significant "inconvenience yields" for Treasuries associated with the SLR and "find that during the two weeks of turmoil, Treasury yields rose substantially above maturity-matched OIS rates, reflecting the inconvenience yield." The SLR exemptions expired on April 1, 2021.

The Fed's March 2020 program of market-function purchases eventually became a quantitative-easing (QE) program. Market participants may not have had a clear perception at each point of time of how much of current purchases would have sufficed for monetary policy objectives alone. This suggests the transparency value to monetary policy transmission of a clearly demarcated market-function purchase program *(Duffie and Keane, 2023)*. Purchases that are designated to cure a market dysfunction would be expected have the same monetary-policy impact as concurrent QE purchases, dollar for dollar, but the opposite conclusion applies only to the extent that markets are actually dysfunctional.

Moreover, market-function purchases may be needed just when monetary policy objectives imply tightening, thus sales of government securities! For example, on September 22, 2022, the Monetary Policy Committee of the Bank of England voted to begin selling gilts for the purpose of quantitative tightening. Within a day of this announcement, a UK fiscal policy shock triggered fire sales of gilts by liability-driven investors that destabilized the gilt market. On September 28, the Financial Policy Committee of the Bank of England instituted a program of gilt purchases that restored market stability. On October 22, Bank of England Governor Andrew Bailey stated that "There may appear to be a tension here between tightening monetary policy as we must, including so-called Quantitative Tightening, and buying government debt to ease a critical threat to financial stability. This explains why we have been clear that our

interventions are strictly temporary and have been designed to do the minimum necessary."[32]

Hauser (2021) proposed that central banks need "new tools" such as market-function purchase programs to deal with dysfunction in government securities markets. *Duffie and Keane (2023)* provide a cross-jurisdictional discussion of market-function purchase programs, covering their objectives, effectiveness, and design. They emphasize that the transparency of these programs and the intent to use them in a market-function emergency supports financial stability, the transparency of monetary policy, and the safe-haven quality of government securities. At the point of issuance of government securities, investors will treat the existence of market-function programs that can be activated in a future liquidity crisis as a feature of the securities for which they are willing to pay a premium. Governments would then benefit from stronger primary-market demand, lowering the cost to taxpayers of financing government deficits. The extra price premium associated with improved future safe-haven services would also lead to a more efficient allocation of the securities across investors, given the heterogeneity of investor preference for safe-haven services.

Knowledge of the existence of a liquidity backstop from a buyer of last resort could, however, lead some investors to take additional leverage. This moral hazard can be addressed with improvements in regulation and market structure, discussed in the next section, that promote increased market capacity and stability.

Duffie and Keane (2023) note that, at least in some jurisdictions and in some situations, a fiscal authority can conduct market-function purchases in the form of buybacks. As for the United States, where buybacks are likely to be reinitiated, the Treasury Borrowing Advisory Committee stated that "Treasury buybacks are intended to support healthy market functioning but not mitigate episodes of acute stress in markets."[33]

Depending on the setting, fiscal-authority market-function purchase programs might reduce potential tensions over monetary policy communication and in extreme cases could mitigate fiscal dom-

inance concerns. However, there are limits on the speed with which the fiscal authority can conduct purchases, relative to the central bank, which has the ability to immediately fund its purchases by creating reserve balances.

VI. Market Structure and Capacity

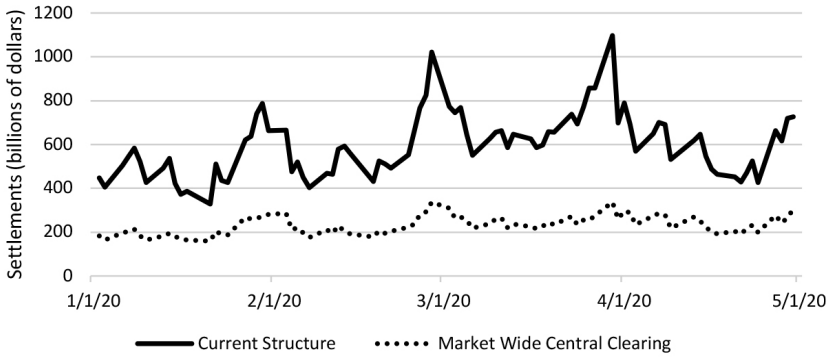
Over time, reforms to the structure of the U.S. Treasury market have been considered primarily for their potential to improve market efficiency and stability.[34] Some key potential improvements in market structure may also increase the intermediation capacity of the market, which is my main focus here. These include, especially, broad central clearing and all-to-all trade, which are the main focus of this section. Central clearing increases the amount of trade that can be effectively intermediated on existing dealer balance sheets. All-to-all trade adds intermediation capacity to the market through better matching efficiency for some types of trade and by allowing some trade that does not necessarily require dealer intermediation.

Improving post-trade price transparency with the real-time publication of Treasuries transactions[35] would also improve market intermediation capacity through a more efficient matching of specific types of trades to specific dealer balance sheets *(Duffie, Dworczak, and Zhu, 2017)*. The Fed's new Treasury financing facilities, the Standing Repo Facility (SRF), the Bank Term Funding Program (BTFP), and the Foreign and International Monetary Authorities (FIMA) Repo Facility,[36] could also reduce the likelihood of stressing the intermediation capacity of the U.S. Treasury market by making it easier for some investors that need cash, and do not necessarily need to sell their securities, to instead obtain financing for their Treasuries from the *Fed. Group of Thirty (2021)* and *Hubbard et al. (2021)* recommend broadening access to the SRF.

VI.A Central Clearing

Broad central clearing in the U.S. Treasury market, recently proposed by the Securities and Exchange Commission,[37] could increase the intermediation capacity of the market through several different channels that I outline here. The main purpose of central clearing,

Figure 11



Note: Total daily settlements of U.S. Treasury securities transactions under the current market structure and in a counterfactual market structure with market-wide central clearing. Source: Fleming and Keane (2021).

however, is to lower counterparty risk and, from that, improve financial stability.[38]

When a trade is centrally cleared, the original buyer and seller are no longer exposed to each other for the settlement of their trade — they instead face the central counterparty (CCP). In case of a default, the surviving clearing members of the CCP are mutually responsible for covering most of ultimate losses.[39] U.S. Treasuries transactions between primary dealers are centrally cleared by the Fixed Income Clearing Corporation (FICC).[40]

On average, a participant in the U.S. Treasuries market is protected by FICC on about 22% of market transactions.[41] By comparison, central clearing covers virtually 100% of exchange traded derivatives and equities, and the majority of swap-market transactions. In the bilateral non-centrally-cleared Treasury repo market, which is larger than the centrally cleared component of the market, *Hempel, Kahn, Mann, and Paddrik (2022)* found that a majority of repos have no "haircut" to cover default losses. The lack of central clearing in this market therefore increases both counterparty credit risk and leverage.

Figure 11, from *Fleming and Keane (2021),* shows a comparison between the daily settlement commitments of Treasuries dealers in the opening months of 2020 and the much smaller settlement commitments that would have applied in a counterfactual market with broad central clearing. As the figure shows, for the same set of trades,

central clearing of the entire market would have reduced peak daily settlements in March 2020 from about $1 trillion to about $300 billion, a vast reduction of dealer balance-sheet commitments. *Baranova et al. (2023)* conduct an analogous study for the UK gilt market, with directionally similar but not as dramatic balance-sheet efficiency gains from central clearing. *Chen et al. (2022)* show the significant netting benefits of clearing in Canada's government securities market.

In addition to benefiting financial stability, the netting of purchases against sales that is achieved by central clearing also improves the efficiency with which dealers use their balance sheets.[42] Broader central clearing of Treasuries could also, depending on its design, promote the introduction of all-to-all trade of Treasuries by making it simpler for trade platform operators and investors to arrange for safe and efficient trade settlement, without necessarily requiring the intermediation of a dealer. All-to-all trade would further increase the capacity and resilience of U.S. Treasury markets, as I discuss in the next subsection.

Central clearing also improves market safety and economizes on dealer balance-sheet commitments by reducing settlement delivery failures, which rose significantly during the most stressful days in March 2020. *Fleming and Keane (2021)* show that broad central clearing would dramatically reduce delivery failures, which reached $85 billion per week in March 2020, finding that "nearly three-fourths (74%) of fails in specific issues are effectively "daisy chain" fails, which could be paired off and hence eliminated with increased central clearing. Moreover, the percentage of fails that pair off tends to be higher when fails are higher and in issues where they are higher. It follows that expanded central clearing not only reduces the balance sheet resources needed for intermediation overall through reduced settlement fails, but that the benefits are greatest when they are most needed and for the securities for which they are most needed."

Central clearing comes with some costs. *The Brattle Group (2022)* collected a range of views of market participants regarding the costs and benefits of central clearing in U.S. Treasury markets. Among the concerns expressed in this survey is the risk of concentrating settlement at a central counterparty. A CCP like FICC is systemically

important and, effectively, too big to fail. Because of these concerns, large U.S. CCPs are designated by the Financial Stability Oversight Council as systemically important, which implies a heightened level of supervision by U.S. regulators. Without careful regulation, supervision,[43] and failure resolution planning, CCPs risk financial instability *(Powell, 2017)*. Market participants also expressed concern over their participation costs for central clearing, which include fees, operational costs, and the cost of funding margin requirements. These costs reduce the incentives of individual firms to participate in central clearing. In effect, each participant is incurring costs to insure other market participants against its own default. Central clearing costs are likely to be more tangible and internalized by market participants than are the broader public benefits of increased financial stability and intermediation capacity. The promotion of public goods is more easily addressed by the official sector.[44]

VI.B All-to-All Trade

The advent of all-to-all trade in the U.S. Treasury market could significantly increase the intermediation capacity of the market, among other benefits such as improved competition and market efficiency.

All-to-all trade means that a broad set of market participants, dealers and non-dealers alike, are able to trade at quotes supplied by each other. This can be achieved on a continuous limit order book, or via all-to-all requests for quotes on an electronic trade platform, or with occasional batch auctions, or by size-discovery trading on dark pools, among other trade protocols. Analysis of the benefits of all-to-all trade in government securities markets has usually focused on the associated improvements in competition and allocative efficiency *(Allen and Wittwer, 2023; Kutai et al., 2022)*. Like *Chaboud et al. (2022),* my main focus here is the impact of all-to-all trade on market intermediation capacity and resilience.

In 2022, the *Securities and Exchange Commission (2022)* discussed reforms that may encourage all-to-all trade in the U.S. Treasuries market, including the removal of exemptions for Treasuries securities to fair-access rules.[45] As I mentioned earlier, central clearing also lowers barriers to all-to-all trade by making it simpler for trade platform

operators and investors to arrange for safe and efficient trade settlement without necessarily trading directly with a dealer.

Currently, there is a "done-with" norm in the U.S. Treasury market, meaning that an investor who arranges with a dealer for the central clearing of a trade must also conduct the trade with that same dealer. This done-with practice, among other disadvantages such as reducing competition, also lowers the ability or incentives to conduct all-to-all trade. Anonymous central clearing and a greater flexibility for done-away trades would promote the introduction and adoption of all-to-all trade and thus a likelihood of increased market capacity.

In a future U.S. Treasury market that includes all-to-all trade, investors would continue to conduct some trades directly with dealers but could also expose some of their trading interests simultaneously to many non-dealers and dealers at all-to-all trade venues. Although some all-to-all trade has emerged in the corporate bond market, bilateral trade with dealers retains the dominant share of market intermediation. The option to source liquidity either way would increase market efficiency and the total intermediation capacity of the market *(Allen and Wittwer, 2023)*. I conjecture that market illiquidity on all-to-all trade venues in March 2020 did not significantly exceed levels that are predicted by contemporaneous price volatility. Illiquidity could be measured by bid-ask spread, price impact, and negative log depth. Like a pure dealership market, an all-to-all market has capacity limits related to the willingness of investors to commit capital to the provision of liquidity. However, coupling a dealership market with all-to-all trade venues increases the sources of potential capital commitments to the provision of immediacy by including dealers and many non-dealers. Beyond the wider sourcing of capital, the capacity of all-to-all venues benefits from matching efficiency, relative to pure dealership markets, which have lower pre-trade price transparency and limited bilateral trade relationships. Matching efficiency can be especially impaired if some dealers are nearing their capacity

for intermediation. *Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023)* provide evidence of high excess illiquidity for the U.S. Treasury market in March 2020 (Section III), and also at the failure of Lehman Brothers in 2008. They show that this excess illiquidity is predicted by the unusually heavy loading of dealer balance sheets at these times.

VII. Final Remarks

Volatility is likely to explain the majority of variation in illiquidity in many financial markets, except when a market becomes dysfunctional. The extent of illiquidity in excess of that predicted by volatility could be viewed as an index of market dysfunction, despite some limitations of this measure. In the U.S. Treasury market, this dysfunction index is reasonably well explained by heavy loading of dealer balance sheets, which places the resilience of the Treasury market at risk just when safe-haven investors are most dependent on intermediation.

A resilient U.S. Treasury market supports financial stability, dollar dominance, effective monetary policy, capital market efficiency, and the provision of safe-haven services to global investors.

The total amount of Treasuries outstanding will continue to grow rapidly relative to the intermediation capacity of the market because of large and persistent U.S. fiscal deficits and the limited flexibility of dealer balance sheets, unless there are significant improvements in market structure. Broad central clearing and all-to-all trade have the potential to add importantly to market capacity and resilience. Additional improvements in intermediation capacity can likely be achieved with real-time post-trade transaction reporting and improvements in the form of capital regulation, especially the Supplementary Leverage Ratio. Backstopping the liquidity of this market with transparent official-sector purchase programs will further buttress market resilience.

Appendix: The Dealer Model and its Solution

The dealer problem described in Section IV is more completely formulated as follows. We fix a probability space and an information filtration satisfying the usual conditions. Because A and B are differentiable, for each pair (a, b) in the space C of bounded and predictable ask and bid processes there is a non-explosive counting process M^a of dealer purchases with integrable intensity process $\{A(a_t) : t \geq 0\}$ *(Brémaud, 1981)* and a non-explosive dealer-sales counting process N^b with integrable stochastic intensity $\{B(b_t) : t \geq 0\}$. For each initial inventory x in $S = \{0, 1, \ldots, \bar{x}\}$ and each pair (a, b) of ask and bid processes, a unique dealer inventory process $X^{(a,b)}$ is defined by

$$X_t^{(a,b)} = x + \int_0^t 1_{\{X_s^{(a,b)} < \bar{x}\}} \, dM_s^a - \int_0^t 1_{\{X_s^{(a,b)} > 0\}} \, dN_s^b.$$

The dealer's optimal expected present value of future cash flows is well defined by

$$\begin{aligned} V(x) &= \sup_{(a,b) \in C} E\left[\sum_{j=1}^{\infty} e^{-rS_j} b(S_j) - \sum_{i=1}^{\infty} e^{-rT_i} a(T_i) + \int_0^{\infty} e^{-rt} d\left(X_t^{(a,b)}\right) \, dt\right] \\ &= \sup_{(a,b) \in C} E\left[\int_0^{\infty} e^{-rt} \left[b_t B(b_t) - a_t A(a_t) + d\left(X_t^{(a,b)}\right)\right] \, dt\right], \end{aligned}$$

where $T_i = \inf\{t : M_t^a = i\}$ is the time of the i-th dealer purchase and $S_j = \inf\{t : N_t^b = j\}$ the time of the j-the dealer sale. By the usual martingale verification method, any solution of the HJB equation shown in Section IV can be verified as the value function V and the associated Markov quotation policy $x \mapsto (a_x, b_x)$ can be verified as optimal.

The model is solved by value iteration, as follows. We begin with some initial "guess" $V_0(0), \ldots, V_0(\bar{x})$ of the solution of the HJB equation, and the bid and ask policies $b_1, \ldots, b_{\bar{x}}$ and $a_0, \ldots, a_{\bar{x}-1}$ that solve the associated optimization problems in the HJB equation, after replacing V with V_0. By algebraic rearrangement of the HJB equation, we can update our guess to $V_1(0), \ldots, V_1(\bar{x})$, where

$$
\begin{aligned}
V_1(0) &= \frac{d(0) + A(a_0)(V_0(1) - a_0)}{r + A(a_0)} \\
V_1(x) &= \frac{d(x) + B(b_x)(b_x + V_0(x-1)) + A(a_x)(V_0(x+1) - a_x)}{r + A(a_x) + B(b_x)}, \quad 0 < x < \bar{x}, \\
V_1(\bar{x}) &= \frac{d(\bar{x}) + B(b_{\bar{x}})(b_{\bar{x}} + V_0(\bar{x}-1))}{r + B(b_{\bar{x}})}.
\end{aligned}
$$

Following this update method, successive iterations V_0, V_1, V_2, . . . are generated until $\max_x |V_n(x) - V_{n-1}(x)|$ is within a given error tolerance. Any limit of V_0, V_1, V_2, . . . is the unique solution of the HJB equation.

Endnotes

[1]See *Garbade (2021)* and *Menand and Younger (2023).*

[2]From FR2004 data and market-implied yield volatilities, *Duffie, Fleming, Keane, Nelson, Shachar, and Van Tassel (2023)* provide statistics on the time series of gross and net total primary dealer positions and dealer purchases from customers in Treasuries, agency mortgage-backed securities, and corporate bonds. With and without risk-adjustment, total gross inventories and customer-to-dealer daily sales peaked at over ten times their corresponding 2017-2022 sample medians.

[3]See *Fleming, Sarkar, and Tassel (2020); Garbade and Keane (2020); Fleming, Liu, Podjasek, and Schurmeier (2022); Getz, Remache, Chen, Stowe, Mithal, Brifu, and Chu (2021).* On April 1, the Fed temporarily exempted Treasuries and reserves from the Supplementary Leverage Ratio.

[4]See Figure 3 of *Logan (2020),* Figure 9 of *Duffie (2020),* and *Fleming and Ruela (2020).*

[5]See *Barone, Chaboud, Copeland, Kavoussi, Keane, and Searls (2022)* and *Fleming and Keane (2021).*

[6]The intermediation of trading treasuries a high fixed-cost business with significant additional scale benefits due to the ability to net purchases against sales across customers *(Wang, 2017).*

[7]See *Board of Governors of the Federal Reserve System (2020).* Other accounts of Treasury market dysfunction in March-April 2020 and its implications include those of *Brainard (2021), Duffie (2020), Hubbard et al. (2021), Group of Thirty (2021), Government Accounting Office (2021), Board of Governors of the Federal Reserve System (2021), Vissing-Jorgensen (2021),* and *Committee on Capital Markets Regulation (2021). Fontaine et al. (2021)* covers the situation in Canada. *Hauser (2020)* discusses the situation in the UK gilt market and the actions of the Bank of England.

[8]*He and Krishnamurthy (2020)* discuss safe-haven services offered by U.S. Treasuries in March 2020.

[9]U.S. Treasuries are also particularly useful to many central banks to hold in their foreign exchange reserves because they can be sold at stable or elevated prices for U.S. dollars, which are often needed in a crisis because of dollar funding stresses *(Das, Gopinath, Kim, and Stein, 2022).*

[10]*Coppola, Krishnamurthy, and Xu (2023)* show that the demand for U.S. Treasuries is raised by a *positive* complementarity associated with the ease of finding counterparties.

[11]See *Tarullo (2023); Group of Thirty (2021); Adrian, Fleming, Shachar, and Vogt (2017); Breckenfelder and Ivashina (2021); He, Nagel, and Song (2022).* Du, Hébert, and Li (2022) provide theory and evidence of a change in the pricing of Treasuries caused by post-GFC capital constraints on dealers.

[12]Beyond higher dealer capital requirements, increased dealer credit spreads induced by other post-crisis reforms imply higher costs for debt and equity financing of dealer inventories, as explained by Andersen, Duffie, and Song (2019) and Berndt, Duffie, and Zhu (2022). Klingler and Sundaresan (2023) analyze dealer balance sheet costs for Treasuries in their Appendix B.4.

[13]The first principal component places significant positive weight on each of the 18 underlying illiquidity measures, and explains 61% of their variation, in the usual sense of principal component analysis.

[14]Fleming and Ruela (2020) and Fleming and Ruela (2020) find large losses in market depth and increases in price impacts in March 2020. They estimate price impact as the slope coefficient associated with a regression of one-minute price changes on net order flow (buyer-initiated trades less seller-initiated trades). According to JP Morgan analysis by Henry St. John, Joshua Younger, and Sejal Aggarwal, "Total depth at the top 20 levels on both sides of the market collapsed, with a fairly staggering peak-to-trough decline of 92%." (The Life Aquatic: Deeper Depth in the Treasury Market Infrastructure, JP Morgan Fixed Income Strategy, June 5, 2020.)

[15]The interdealer data are from BrokerTec. The dealer-to-customer transaction data are from TRACE.

[16]See Jankowitsch et al. (2011).

[17]The Hu, Pan, and Wang (2013) noise measure of Treasury market illiquidity is the square root of the mean squared error (RMSE) obtained when fitting the prices of Treasury securities to a smooth mathematical model of the yield curve. The yield-curve fitting model used in this case is the non-parametric model of Filipović et al. (2022), derived from CRSP end-of-day quotes. Using data from 1990 to 2017, Goldberg (2020b) shows that the supply of liquidity by dealers to the U.S. Treasury market goes down as RMSE rises, along with a decline in dealer gross positions.

[18]Bogouslaslavsky and Collin-Dufresne (2023) provide related evidence regarding the relationship between liquidity, volume, and volatility in equity markets.

[19]Based on 1,336 observations, the estimated standard error of this coefficient is 0.038.

[20]This is based on the vector autoregressive modeling approach developed in Goldberg (2020b).

[21]In 2010, based on holding company public filings and FRED (for GDP), this ratio was $26.05 trillion in dealer assets divided by $15.05 trillion of GDP, which is 1.73. By the end of 2022, this ratio had declined by 18.5% to $35.88 trillion divided by $25.46 trillion.

[22]Here, the dealer's objective is maximization of the present value of dealing profits. In Amihud and Mendelson (1980) the dealer's objective is maximization of the steady-state expected net rate of dealer revenue. Amihud and Mendelson (1980) illustrate a solution for the case of linear demand and supply schedules. This model is also in the spirit of those of Garman (1976) and Ho and Stoll (1981). Eisenbach and Phelan (2022) provide a model in which a safe asset market functions well if deep enough, but can break down, with prices falling precipitously, if intermediated by dealers subject to balance sheet constraints. Kalsi, Vause, and Wegner (2023) go beyond the buyer-of-last-resort benefit of creating more dealer balance-sheet space by modeling the ability of a buyer of last resort to reduce self-fulfilling firesale equilibria. Other models of the impact of limited dealer intermediation capabilities or incentives for market liquidity include those of Gromb and Vayanos (2010), Geromichalos, Herrenbrueck, and Lee (2023), Weill (2007), and He and Krishnamurthy (2020).

[23]Ho and Stoll (1983) analyze a related model of dealer competition.

[24]A complete mathematical specification of the dealer's problem is stated in the Appendix.

[25]For the boundary cases: $\max_a\{-V(0)(r + A(a)) + d(0) + A(a)(V(1) - a)\} = 0$ and $\max_b\{-V(n)(r + B(b)) + d(n) + B(b)(b + V(n - 1))\} = 0$.

[26]The condition is that dealer's optimal expected net rate of gain is equal to the "required return" $rV(x)$. At given quotes (a, b), the expected net rate of gain in value is the sum (i) of the dividend payout $d(x)$ net of holding cost, (ii) the mean rate of gain from selling, which is the product of the selling rate $B(b)$ and the gain in value $b + V(x - 1) - V(x)$ from a sale, and (iii) the mean rate of gain from buying, which is the product of the buying rate $A(a)$ and the gain $V(x + 1) - V(x) - a$ from a purchase. That a function V solving the HJB equation is in fact the optimal present value of future profits is verified by a standard martingale argument.

[27]For example, consider the parameters $r = 0.10$, $n = 50$, $c = e^{40}$, $k = e^{-20}$, $\alpha = \beta = 3$, and $d(x) = x$ for all x. At the efficient-market bid price of $b = 1/r = 10$, the dealer buys at the mean arrival rate of $B(10) = e^{-20}e^{3\times10} = e^{10}$ units per year. If the dealer reduces its bid price by 0.1% from 10 to 9.99, the mean purchase rate declines to $B(9.99) = e^{9.97}$. Similarly, at an ask price of $a = 10$, the mean arrival rate of sales is $A(10) = e^{40}e^{-3\times10} = e^{10}$. For the present purposes, the model is solved by "value iteration," meaning iterative solution of HJB equation.

[28]For large v and y, the formulas shown for a and b imply that $b - a$ is approximately $2V(x) - V(x+1) - V(x-1)$.

[29]Suppose the value of owning the bond for a randomly chosen potential seller is π. Then the expected time rate of seller surplus is $A(a_x)E(a_x - \pi \mid \pi < a_x)$.

[30]The modified HJB equation is

$$0 = \sup_{a,b}\{-V(x)(r + A(a) + B(b) + \lambda(x)) + d(x) + A(a)(V(x+1) - a) + \lambda(x)\,(m(x) + V(x-1)) + B(b)(V(x-1) + b)\},$$

with the obvious elimination of b at $x = \overline{x}$ and a at $x = 0$.

[31]See Vissing-Jorgensen (2021); Bernardini and De Nicola (2020), and Fleming et al. (2022).

[32]See Bailey (2022).

[33]See *Treasury Borrowing Advisory Committee (2023).* In his *May 2023 Quarterly refunding statement,* Assistant Treasury Secretary Josh Frost stated that "Based on feedback from a broad variety of market participants, including the Treasury Borrowing Advisory Committee and primary dealers, Treasury believes it would be beneficial to conduct regular buyback operations for cash management and liquidity support purposes. Treasury anticipates designing a buyback program that will be conducted in a regular and predictable manner, initially sized conservatively, and not intended to meaningfully change the overall maturity profile of marketable debt outstanding." *See Frost (2023).*

[34]See, for example, U.S. Department of the Treasury and Federal Reserve (1969), U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, and U.S. Commodity Futures Trading Commission (2015), U.S. Department of the Treasury (2017), and Adrian, Fleming, Goldberg, Lewis, Natalucci, and Wu (2013). The most recent broad U.S. official-sector discussions of reforms, Interagency Working Group for Treasury Market Surveillance (2021) and Interagency Working Group for Treasury Market Surveillance (2022), were triggered by the market dysfunction in March 2020.

[35]See *Brain et al. (2018).*

[36]The BTFP provides financing for banks. FIMA was also established as a special repo facility that allows foreign monetary authorities with a custodial account at the Federal Reserve Bank of New York to obtain repo financing for the securities held in their custodial accounts.

[37]See "SEC Proposes Rules to Improve Risk Management in Clearance and Settlement and to Facilitate Additional Central Clearing for the U.S. Treasury Market," Securities and Exchange Commission, press release, September 14, 2022.

[38]See Duffie (2020), Hubbard, Kohn, Goodman, Judge, Kashyap, Koijen, Masters, O'Connor, and Stein (2021), Group of Thirty (2021), Liang and Parkinson (2020), and relevant reports of The Treasury Markets Practices Group (TMPG) (Treasury Markets Practices Group, 2018, 2019; Treasury Market Practices Group, 2021a,b). The TMPG states at its web site that "The TPMG is composed of senior business managers and legal and compliance professionals from a variety of institutions–including securities dealers, banks, buy side firms, market utilities, and others and is sponsored by the Federal Reserve Bank of New York."

[39]Typically, a CCP operator contributes a comparatively small amount of capital.

[40]In the current market structure, transactions by principal trading firms (PTFs) in the interdealer market are not cleared by the CCP, but rather are cleared on the balance sheets of interdealer brokers. Customer-to-dealer Treasuries securities trades are not centrally cleared. Some Treasury repos are cleared by "sponsors." FICC clearing members are also responsible for covering the liquidity needs of the CCP, through the Capped Contingent Liquidity Facility.

[41]This is from a simple calculation (Duffie, 2020), based on data from Treasury Markets Practices Group (2018).

[42]In current accounting practice for the determination of U.S. regulatory capital under the SLR requirement, commitments to settle a cash-market Treasuries transaction do not count toward assets, unless the settlement fails. This is not consistent with the regulatory capital accounting treatment for the closing leg of a Treasury repo, which is economically identical, but does count toward assets. Because of this accounting inconsistency, the shareholders of large dealer banks have a regulatory-capital incentive in favor of broader central clearing in the repo market that does not apply to the market for cash Treasuries trading.

[43]Hubbard et al. (2021) and Group of Thirty (2021) offer policy recommendations for the case of FICC.

[44]Treasury Markets Practices Group (2019) wrote that "the TMPG believes that to the extent that public policy interests are served by moving to more widespread utilization of central clearing, that is something best addressed by the official sector."

[45]The SEC proposed a new definition of "exchange" that would have the effect of covering the principal interdealer and multidealer-to-client platforms for Treasury securities and therefore require them to comply with Regulations ATS and SCI. Group of Thirty (2021) and Group of Thirty (2022) explain the implications.

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Commentary: Structural Changes in Financial Markets and the Conduct of Monetary Policy

Jeremy C. Stein

I'd like to thank the organizers of the conference for including me; it's a pleasure to be here and to comment on this terrific and very thought-provoking paper by Darrell Duffie. I should say at the outset that Darrell and I collaborated, along with Tim Geithner and Pat Parkinson, on a G30 report on the Treasury market in 2021, and on a follow-up last year, and our policy views are quite closely aligned. I will highlight a couple of areas of nuance, and emphasis, but I generally agree with much of what Darrell has to say from a policy perspective.

The first part of the paper is a beautiful piece of positive economics, which demonstrates both theoretically and empirically how dealer balance sheet constraints play a central role in shaping market liquidity in extremis. As Darrell showed, in "normal times," when dealers are not too close to their capacity constraint, market liquidity is well explained by the volatility of Treasury returns. This is as you would expect, if dealers are risk averse, or if higher volatility is accompanied by a higher risk of adverse selection.

However, in times like March 2020, this relationship breaks down, and liquidity is much worse than you would expect even given the quite elevated levels of volatility. Here, what seems to matter is that dealers are close to their capacity constraint — loosely speaking,

for an individual dealer this is when the quantity of Treasuries that they have taken on to their balance sheet is close to its historical maximum. If you want to explain the March 2020 type outliers in liquidity that are not well-explained by volatility, Darrell's measure of capacity utilization, once it gets in the neighborhood of 40% to 80%, starts to matter in a highly non-linear way. And he and his co-authors have constructed an informative proxy for capacity utilization, in the sense that it does a good job of soaking up a lot of the remaining variation in liquidity that is not accounted for by volatility.

Moreover, Darrell then builds a simple model of market-making that shows that these empirical patterns are more or less exactly what you should expect in a world where dealers face hard capacity limits. Again, this is a really elegant bit of positive economics: a simple but institutionally well-motivated model that fits some otherwise quite puzzling non-linearities in the data extremely well.

Once Darrell has established that his model is a useful way of understanding the world, he uses it to conduct a policy thought experiment: suppose the central bank has an asset purchase rule that has it buying Treasuries from dealers once their holdings hit a certain percentage of their capacity limit — e.g. the Fed starts taking Treasuries off their hands when their inventories are at say 80% of their maximum capacity. He shows that this intervention dramatically improves market liquidity in the tails. Which is as you would expect if a dealer capacity constraint was the underlying problem.

So that is the first part of the paper. Which again, really advances our understanding of the drivers of market liquidity both in normal times and extremis, and illustrates how central-bank asset purchases can in principle be deployed to improve market function. But before we go from there to a set of policy recommendations, we need to ask a series of questions. To do so, let us stipulate that: (i) we have an interest in preserving market liquidity; and (ii) central-bank asset purchase can help, particularly when capacity constraints are binding or near-binding. Does it follow that such purchases are the best or only way to go? Or are there other approaches that might want to be the first line of defense? And if we are going to in some cases use asset purchases for market function purposes, how do we communicate about them, both ex ante and ex post?

If Darrell's diagnosis is correct and dealer capacity constraints are indeed at the root of the problem, a natural question to ask is: why take these as exogenously given? Can we relieve these constraints in some way? And while Darrell's empirical measure is agnostic as to the root of the constraints — they could come in part from dealers' internal risk management considerations, for example — one suspects that the risk-insensitive leverage ratio is at least part of what is going on. In which case making the leverage ratio less binding would be a step in the right direction. We hammered on this point in the G30 report, and emphasized that, importantly, defanging the leverage ratio absolutely does not have to come at the cost of weakening overall capital in the banking system. It is straightforward to make a compensating adjustment to risk-based capital standards to ensure that overall capital does not decline, or indeed actually goes up, in light of a relaxation of the leverage ratio.

So in light of the clear benefits of dialing back the leverage ratio, it was disappointing to me to see that in Vice Chair Barr's July 10 speech on the so-called holistic capital review, where he laid out a set of enhancements to the risk-based capital standards, when it came to the leverage ratio he said: "With respect to the enhanced supplementary leverage ratio (eSLR), I am not recommending changes to the calibration at this time. With the revisions in risk-based capital requirements I mentioned above, the eSLR generally would not act as the binding constraint at the holding company level, where Treasury market intermediation occurs."

Now clearly, this assertion is directionally correct: if you raise the risk-based requirement enough, even if you do not touch the leverage ratio, it mechanically becomes less binding. And one can surely crunch some numbers to try to get a quantitative handle on the importance of the effect that Vice Chair Barr alludes to. However, I recall with regret a lesson that I learned during my time at the Board, when we first passed the eSLR. At the time, I was nervous about exactly this issue — that the leverage ratio would become a de facto binding constraint and would distort behavior in undesirable ways. But I allowed myself to be reassured by a Board staff analysis that concluded that this would not be the case. With the benefit of

hindsight, we can see that this analysis was too optimistic. So I am inclined to be somewhat more skeptical this time around, and would prefer that the distortions caused by the leverage ratio be dealt with more frontally and more robustly.

A second point, and this was something else that our G30 report emphasized, is the value of having a broad access standing repo facility, where by broad access we meant a willingness to provide repo financing to essentially anyone with Treasuries to pledge to the central bank. In July 2021, the FOMC established two standing repo facilities: a domestic one (SRF) and one for Foreign and International Monetary Authorities (FIMA). However the SRF did not provide as broad access as the G30 recommended, but instead limited access to primary dealers and banks.

Why the emphasis on broad access? In March 2020, we know that much of the selling came from non-bank and non-dealer entities like mutual funds and hedge funds, who had sudden cash needs. And the hope is that if these players know ahead of time that they have certain access to repo financing, they will not feel as much of a rush to sell, thereby cutting off some of the spiral before it starts, and — importantly, in light of Darrell's analysis — lessening the demands on dealer capacity. Whereas if you have a narrow facility where the Fed only lends to banks and dealers, you need to rely on them on-lending to the mutual funds and hedge funds. And especially in a stress situation, you cannot count on that on-lending happening, because their willingness to do the on-lending is held back by both regulatory constraints and their own internal tolerance for taking on counterparty risk at a time of stress. So with a narrower-access facility, the risk is that the Fed's liquidity provision effectively gets "stuck" in the bank/dealer sector, and never makes its way to those who need it most.

What about moral hazard — might not a broader facility encourage e.g. hedge funds to lever their positions more aggressively? There are a number of points to be made here, but let me just note one: it is important to think of moral hazard in relative terms. If you do not offer broad access to the SRF, the worry is that, as in March of 2020, the Fed will instead be cornered into having to buy Treasuries on an ad hoc basis, rather than just lending against them. And that clearly

creates more of a moral hazard regarding how market participants price duration risk.

Which brings me to a final tool which Darrell emphasized, outright Fed purchases for market-function objectives. So let me start with two points of agreement: (i) clearly, as Darrell shows, such purchases can be a powerful tool when dealer capacity is strained; and (ii) one absolutely does not want to take such a tool off the table. But in my view, it should ideally be used as something of a last resort; I would rather see us do everything we can with respect to easing artificial capacity constraints, and broadening access to repo before turning to purchases. These are both considerably lighter-footprint interventions, and also have the benefit of not creating any confusion between a market-function policy intervention as opposed to one that is being used for monetary-policy purposes.

Nevertheless, central bank purchases are likely to remain an important piece of the arsenal for dealing with market function in extreme cases. That said, one issue is how one talks about them, if at all, ahead of time. In the last line of Darrell's paper, he writes: "Backstopping the liquidity of this market with transparent official-sector purchase programs will further buttress market resilience." This sentence is worth unpacking. Does transparent mean that the Fed should communicate ex ante the circumstances under which it will intervene in the market? Or more modestly, that when it does intervene, it ex post says loudly and clearly, "these are market function purchases, not monetary policy purchases, and so don't expect us to hold on to the bonds for too long, and don't draw any inferences whatsoever about the stance of monetary policy"?

The latter type of ex post communication absolutely makes sense and is important to do well, as the Bank of England did during their LDI market intervention last year. The former strikes me as much trickier, and I am inclined to be more skittish about any ex ante talk about purchases — i.e. of laying out a purchase reaction function, if you will. This is different from my instinct with a repo facility, where it is all about creating broad market confidence that there is a standing facility that promises to provide liquidity.

Why the difference? In Darrell's model, two conditions hold: (i) you can draw a clean separation between a market that is experiencing dysfunctional liquidity versus one that is simply being hit with large fundamental shocks that ought to be moving prices a lot; and (ii) you have a very good real-time proxy for when the dysfunction sets in — dealer capacity is at say 80% of its maximum. In this kind of idealized world, an ex ante rule, such as intervening when dealer capacity hits some threshold, probably makes sense. But I worry that this is not the world we live in.

One observation is that inevitably, there is going to be a high degree of correlation between liquidity being strained and large moves in fundamentals, and in practice articulating a policy that separates the two in a way that is clearly understood by market participants is going to be difficult. So one worry is that either you rule in too much, in sense that you are heard as prepared to jump in any time the Treasury market has an unusually sharp move in yields, which then distorts pricing of duration; or alternatively you rule in too little, and don't actually give yourself license to intervene when it would make sense.

On the latter, one needs to be careful about over-extrapolating from what is essentially one episode, i.e., March 2020. It may be that next time the Treasury market goes haywire, it does so even if dealer balance sheets are not so overloaded. Indeed, this is not an unreasonable characterization of what happened in the U.K. at the time of the LDI episode: there were enormous strains in the Gilt market, and central-bank intervention was arguably necessary, but the core problem was not with dealer balance sheets, and a dealer-capacity measure based on Darrell's work would likely not have raised the requisite red flags.

To summarize: market-function purchases need to be part of the toolkit, ideally as a last resort after progress has been made on some of the other fronts I have mentioned. My instinct is that if they are used, they will have to be rolled out on an ad hoc basis, because we cannot write down a reliable state-contingent rule ex ante for when they will be most needed. And if central bankers try to talk more broadly and abstractly about the benefits of market-function purchases ex ante without specifying a concrete rule, they run the risk of

being heard to be more interventionist than they intend to be, and of creating too much expectation on the part of market participants that they will step in anytime there is a large move in rates. Transparency will nevertheless be important ex post — if it does become necessary to do market-function purchases again at some point in the future, it is critically important to clearly separate them from monetary policy, and to define an exit strategy that fits with the premise that the central bank is only serving as a temporary market maker.

General Discussion: Structural Changes in Financial Markets and the Conduct of Monetary Policy

Chair: Betsy Stevenson

Maurice Obstfeld: This is an absolutely great paper by Darrell Duffie and a very important line of work. I also loved Jeremy Stein's discussion on the policy implementation issues. Underlying this whole discussion and where you started out, Darrell, is that the dollar is in effect the world's currency, and the U.S. Treasury obligation is therefore the world's benchmark safe asset. And those two factors in principle endow Treasuries with a liquidity premium, a topic other people in this room, such as Arvind Krishnamurthy, have worked on quite a bit. So when we're supporting Treasury market functionality, we're supporting the core of the international monetary system.

It's striking to me that over the years since the global financial crisis, there's been a lively discussion of the high global demand for safe assets in the 2000s and of possible shortages of safe assets. Pierre-Olivier and co-authors did a lot of work on what they labeled the "new Triffin problem": the idea that the governments that issue safe assets may be unable to increase supply in line with demand without risking the very safety of their obligations. An additional problem that Darrell's paper brings to the fore is that to support a bigger supply of safe Treasury assets, you may also need to expand market infrastructure, and notably intermediary balance-sheet capacity, in ways that overcome unintended consequences of some of the financial regulations

that were agreed in the Basel III reform. The FEMA facility is one step in that direction, to address Treasury holdings of the official sector and ensure that in a crisis, foreign exchange reserves can indeed fulfill their precautionary role. Jeremy's points are very relevant here. Clearly much more market reform is going to be needed to support the dollar in its global role as the premier global international unit of account, store of value, and medium of exchange. Darrell and a number of others, including the group chaired by Don Kohn, have been making proposals in this direction.

Having said that, it's still not clear what might be the alternatives to the dollar. So we may face a choice between a dollar-based system that works smoothly, or one that periodically is dysfunctional. And the latter would be very destabilizing for the world financial and trading system.

Joachim Nagel: Thank you Darrell for your interesting paper. I know that central banks are the lender of last resorts. Should we become the buyer of last resort? I'm not so sure about this. I know a little bit about the, let me say, the anchor function of the bond market. And I know when central banks would try to give market participants the indication that they know that this functionality index of a certain market, the market participants will test you. They will find your pain point.

And I believe that this at all a difficult approach for central banks. I'm much more in favor that we need more constructive ambiguity, not to give too much clarity to the market participants. And my argument behind this is that in the case where you have this interference between what you do regarding your market function purchases and what you have to do on the monetary policy side, I think I do not see how to communicate where is your sin line of defense, what are you doing on the market function side and what you have to do on the monetary policy side. So I would like to hear from you, how can we solve this? But as I said, I do not believe that we should get into that buyer of last resort function. Thank you.

Betsey Stevenson: And I should remind people when I call on you to raise your hand so that the microphone can find you. Tiff Macklem.

Tiff Macklem: Darrell, I'm very grateful for this work. You've given us a way to formalize and measure some things we're seeing in the market and some very thoughtful recommendations. Two questions. The first really picks up on Jeremy Stein's advice about thinking more about broad access repo facilities. I am particularly interested in this because in Canada we have introduced a contingent term repo facility exactly for large NBFIs, large pension funds, large asset managers. We are very worried about moral hazard and that's why it's a contingent facility, not a standing facility. But any advice you have in the scope, the size, the design of these things would be very helpful.

My second question is, I wonder if your analysis has any implications for the issuance structure of government debt. I mean, what I have in mind is if you want to facilitate the all-to-all market, should treasuries be concentrating more in the benchmarks? Should they be doing more buybacks of off the runs? Would that make a difference in these extreme situations or only just help with regular liquidity? Thank you.

Betsey Stevenson: So I'm going to take two more questions and give you a chance to respond.

Ben Broadbent: I want to join others in complimenting Darrell on the paper. Fantastic piece of work. I just wanted to say a couple of things about last year when we went through something similar and we did end up being a purchaser of last resort. It's definitely not what we first wanted to do and I had lots of concerns about it. Probably top of the list for me was precisely the misperception that this was a monetary easing, not least because we all spent ten years telling people that every time the balance sheet goes up, that's what it is. It's monetary easing. And I think we have long conveyed the way QE works and what it does in a slightly too simplistic way as it happens. As it turned out, things worked about as well as we could have hoped and we were able to distinguish between the two sorts of interventions. By various means, it was very targeted in terms of where we bought in the government bond market. It was only at the long end where the problems were.

We made a promise in the sense to the MPC and when I was both part of the executive having to buy the bonds, but then sitting on the MPC that it would not conflict with their targeted level of QT holdings a year later. So we made a commitment to sell them relatively quickly, whereas QE decisions are more open-ended. And as it happens, all those bonds were sold within about three months.

But there's no doubt it's pretty uncomfortable to think to end up doing it. The only other thing I'd say is that Jeremy said all these problems are made worse and the need to buy is made worse because central banks only have relationship with commercial banks. I just point out this is a much more general problem because over the last ten years, risk has migrated to non-banks. We had no option. At the moment we do not have the means of central banks of lending to non-bank institutions. And I think whatever the regulatory solutions to this particular problem, central banks need to think about how to develop that capacity with non-banks. I think access to the balance sheets of central banks that are not purchases, otherwise we will end up having to buy more often than we'd like.

Betsey Stevenson: Great. Jared Bernstein.

Jared Bernstein: Thanks for a great presentation and comments. Darrell, I thought your argument was fundamentally airtight. So keep that in mind, given my comments. In the world that I live in, it is very hard to get people to look around the corner and take actions for something that they don't see as particularly broken. The idea being that it's a one in a thousand thing, it happens, the Fed does some magic with the plumbing and a few weeks later we're okay, so kind of go away, with your fancy fixes. And in your discussion you took us through all the ways in which the solutions you proposed would be pretty awesome. I'd like to ask you to hold forth a little bit, and I think Jeremy was helpful in this regard, in ways that those solutions could go wrong because that would be helpful in making this case.

And Jeremy, while I very much appreciated that part of your commentary, I did want to say that again, in the world in which we dwell in, in political economy, moral hazard is not fuzzy at all and it's very pronounced, it's increasingly problematic. And the idea of providing

broader access to repo will get a blowback among people who say, there you go again, bailing out the banks and not doing anything for the little guys and gals. So I'd be interested in both of your holding forth on ways in which we can get policymakers to recognize that a one in a thousand thing that the Fed comes in and saves the day is actually not optimal.

Betsey Stevenson: Okay. I know there's a lot more hands, but I'm going to turn to Darrell to respond. And then Jeremy, maybe you want to as well.

Darrell Duffie: Thanks very much. Terrific questions. There's a theme in the comments from Maury Obstfeld, Joachim Nagel, and Tiff Macklem about the role of the central bank as a lender of last resort, not as a buyer of last resort, in situations like this. And as you all commented, it's very natural for the Fed to step in with liquidity by providing financing for Treasury securities. The Fed specifically introduced the foreign institutional monetary authority, called FIMA, for that purpose so that central banks around the world with accounts at the New York Fed can get liquidity for their Treasuries when they might otherwise have sold them, adding to the pressure on dealer balance sheets.

Likewise, the standing repo facility, as Jeremy emphasized, stands ready to provide liquidity, which would allow investors to get financing if they only needed cash and they didn't need to get out of a risk position or to raise cash for other reasons. Most recently, after Silicon Valley Bank failed, the Bank Term Lending Program was introduced as a way for banks to avoid being forced to sell their Treasury securities in order to get liquidity. They could finance them with the Fed. So, these are all natural and important first lines of defense that the central bank can provide when markets are not functioning properly. However, as we saw in March of 2020, although prior to some of these facilities, that would not have been enough. The Fed came out guns blazing, and within three days cured all the financing problems in the U.S. Treasury market. Repo rates went completely back to normal. There were no signs that financial intermediaries, primary dealers and others, were having difficulty getting financing for their Treasury securities. However, problems in the cash trading

market for treasury securities continued for weeks afterwards despite all of the measures that the Fed took, including very large purchases, exemption from the supplementary leverage ratio rule, and many other measures undertaken by the Fed.

So, neither the first line of defense, lending of last resort, nor the second line defense, buying of last resort, is going to be sufficient to cure these problems. And there are no silver bullets. It's a question of reducing the frequency with which markets become dysfunctional. And that's why all of the measures that I suggested, I believe, are very important and why they are being considered today in the U.S. official sector. These go to things like longer term improvements in price transparency, central clearing, and eventually, hopefully on its own, all-to-all trade.

Let me go to one point that I would add to what Maury said in terms of the great things the Fed is doing to provide global investors with access to liquidity for U.S. Treasuries, which is not treasury-specific. It's the swap lines that the Fed provides. Those are crucial to maintaining this dollar-treasury-securities complex of liquidity that supports the safe haven status of the U.S. dollar. There's no other security market, as Maury alluded, that could possibly substitute for U.S. Treasury securities. So, it's not like, if nothing was done, U.S. Treasury securities would be supplanted anytime within our lifetimes by another security. It's a question of the quality of safe-haven services and the cost to U.S. taxpayers. I want to go to Jared Bernstein's remarks and then maybe Jeremy will add to that. What might go wrong if we simply didn't do anything other than hope that in the one in a thousand day the Fed will do whatever it can?

If we did more than that, what could go wrong? Well, it's been suggested with some logic that if the market becomes more transparent and more liquid because you improve central clearing, you improve price transparency and you add all-to-all trade, that the profitability of being a dealer will go down. And if dealer profitability goes down, perhaps dealers will commit less capital to the U.S. Treasury market. There are two possible negative outcomes there, one of which I give a little bit more credence to the other. One possible outcome is that, lacking sufficient profitability in the secondary market, they won't

commit as much capital to the primary issuance market, and it will be more costly or more risky for the U.S. Debt Management Office to get its auctions sold out.

The primary dealers take down roughly 10%, plus or minus. Could that fraction go down a bit? Maybe. The second thing that might go wrong, which I disagree with and which I hear quite often from the dealer community, is "If our profit margins are not sufficiently good, if the market becomes too competitive, then we won't be supplying as much liquidity to the secondary market and liquidity will get worse." If you reduce the logic of that to its bare bones, it basically says "Liquidity in the U.S. treasury market will become so good that it will be very bad." And that one I don't buy. Jeremy, over to you.

Jeremy Stein: Yeah, just to Jared, the political economy considerations that you brought up, I think these are very, very important. And when I'm thinking about the market function asset purchases and wanting to do that with as low a probability as possible, really foremost in my mind is not just the economic footprint, but it's the political economy footprint. Again, you can't take it off the table, who knows what's going to happen, but that to the extent that you can make that a lower probability event by doing some of these other things, even including the broader access repo thing which has some political economy taint but I think considerably less, that's the basic judgment there.

Betsey Stevenson: Neel Kashkari?

Neel Kashkari: Two quick comments. Darrell, first, whenever people point to widening bid/ask spreads as evidence of market dysfunction, I'm skeptical. Go back to March 2020, what was happening? New pandemic. No one knew how deadly it was. No one knew how contagious it was. How could bid/ask spreads not widen in that environment? So, I'm skeptical that any of these reforms, unless we address the uncertainty at the root of this, I think you're going to see this behavior. And it's not to me evidence that something's broken in the market, it's just the reality of what was happening in the world in March of 2020. And then in defense of the leverage ratio, March of 2023 to me demonstrates how flawed and imperfect risk-weighted

assets or risk-based capital regimes can be. So, that's why you need both leverage ratio and risk-based capital.

Karen Dynan: I enjoyed both the paper and the discussion. Darrell opened the paper actually with just one sentence pretty much saying, "Well, the stress was because of the increased regulation to some extent, but really we don't want to go back to regulatory reform." I want to give him a chance to revisit that maybe following up a little bit about what Jeremy said. In fact, the truth is we have a lot more treasury debt. We have less capacity for banks to absorb that. They really are the only places that ultimately can absorb it except for central banks. And I think you're making the case that we really want central banks to pick up a big piece of it, but that too carries risk, as people have alluded to, central bank independence, a sense of overstep.

I guess the scenario I was thinking about is when we come close to breaching the debt ceiling, what happens in the episode where there's a run on treasuries and they're not perceived as safe assets and that's why there is a run? Do you really want the central bank to be the institution that's absorbing that or would you really rather put that back into the private sector? So, I guess I want to revisit the issue of, as Jeremy said, these regulations were very important, but is there a form of these regulations that would allow capacity to rebuild in the banking system to hold more of these securities, particularly during times of crisis, so that central banks don't have to react as much?

Eswar Prasar: So, Darrell, I'd paraphrase your argument as basically being, it's better that the central bank announces in advance that it's going to step in when needed so that it won't have to step in. So, if there were all these facilities in place, you would not have had March 2020 happening. And then the other side of the argument is the possibility of moral hazard and so on. And I wondered if that argument is somewhat being discounted in the sense that it's not just moral hazard, but also that you may precipitate precisely the problems you're trying to avoid by favoring a part of the financial system that has access to these instruments, creating incentives to load up on treasury collateral, giving advantages to size and so on.

And the bigger issue here is really that it's a good idea to make the safest asset in the world safer, which seems to be what we are talking about here. But at one level, we are concentrating our desire for safety just on one financial asset if you think about domestic investors and about foreign investors. So, the fact that these sorts of moves would essentially, rather than broadening the class of financial safe assets that people seem to want in droves, pins everything on one financial asset seems to create a vulnerability of its own.

Amir Sufi: So, a lot of the questions I feel like are getting to an issue that I'd just love to hear the two of you or anybody else, especially the people who are actually practicing central banking. You've got these two securities. You have cash and you have treasuries. They're both U.S. government liabilities. They're both going to be honored no matter what, no matter what Fitch says. And so at the end of the day I feel like people are mentioning moral hazard and maybe we're thinking about moral hazard, I just want to understand. We have a market price of treasuries in normal times, which we think reflects something about expectations, discount rates, et cetera, and we've got this cash.

And I just am having a hard time pinning down what moral hazard friction you would ever have in which you would want a private sector player to be uncertain about getting the cash price of a fair fundamental value treasury. And if we agree that that is something we would always want, that two U.S. liabilities should be able to be exchanged at a price that we think reflects fundamentals, then maybe we should just do whatever we can to make sure that happens. So, I guess this may be not a question for the two of you because I don't think you're sympathetic, but just as a question, am I missing something? What is the precise moral hazard that we would want to impose that transaction risk on people who are holding U.S. treasuries?

Betsey Stevenson: One more question.

Agustin Carstens: Yes, great paper as usual with Darrell. You concentrate your analysis on what happened in March 2020, and that is a time where there was exacerbated uncertainty in the world economy. Traditionally then is when everybody would want to hold

treasuries. That is a paradoxical aspect. So, I think it's very relevant why this didn't happen. And for me, I want to build a little bit on what Ben Broadbent mentioned. Non-bank financial intermediation has become extremely important and we don't have transparency about that sector. We don't have a good way of reading what is going on there. The dealer's architecture was built when non-bank financial intermediation was extremely small. Banks were doing pretty much all the intermediation. So, I think that it really would compliment your list of actions to endorse and support more disclosure of non-bank financial intermediation and for the architecture that is needed to allow for non-bank financial intermediation to take place in the context of a maximum possibility of financial stability. Because I agree with you, there will always be accidents, and therefore I think all your other solutions are very important.

Betsey Stevenson: Great. So, Darrell, why don't you respond?

Darrell Duffie: Okay, I'll try to be brief. Neel Kashkari, Eswar Prasar, and Amir Sufi, you all are operating on the moral hazard issues associated with standing ready to support the U.S. Treasury market. Does that not encourage potentially excessive risk-taking? Macroprudential policy is obviously very important here. My viewpoint is the first thing to do is to make sure that the U.S. Treasury market is capable of providing a resilient, deep liquid market, given the rest of the market, that is, given the players that are actually holding Treasuries and may actually want to liquidate them in a crisis.

If I were at the Debt Management Office of the U.S. Treasury Department, I would not be trying to discourage mutual funds, hedge funds and foreign central banks from loading up on U.S. Treasury securities. I would be very pleased if they loaded up on those securities and I would be leaning hard on the development of market structure that's able to handle liquidations in a crisis. I think that's the approach that the official sector should take, at least in the United States. From a parochial viewpoint, you want people to have a high demand for the U.S. Treasury security as a safe haven. The supplementary leverage ratio came up a couple of times.

This is not, and I am 100% with Jeremy on this. It's discussed in the G30 report that Tim Geithner chaired, that Jeremy mentioned, that the supplementary leverage ratio is creating a distortion. When the Fed went in and purchased a trillion dollars of treasuries in three weeks, given what I said in my earlier presentation, you might've reacted with, "Phew, that is going to take down some of the loading on dealer balance sheets. They'll be able to provide more intermediation." But how did the Fed pay for those Treasury securities? It created new reserve balances and loaded up those banks with a trillion dollars, one for one, with reserve balances, which attracted exactly the same capital requirement as the Treasuries that the purchases had taken off the balance sheets. So, there was no relief from Fed purchases with respect to the supplementary leverage ratio.

It's not that one needs to rely only on risk-based capital requirements. I made a proposal at the Banca d'Italia several years ago, saying you could impose the SLR on a system-wide basis, dialing up risk-based capital requirements in the manner that Jeremy suggested, until you've got the same amount of capital in the system that you would've had under the SLR, but not imposing the distortionary SLR on a bank-by-bank basis. Overall, I'm of the view that the SLR, despite the political economy headwinds, should go.

Betsey Stevenson: Jeremy, I'm giving you one minute.

Jeremy Stein: Okay. So two quick things. Amir Sufi, on the moral hazard, I essentially agree with you 100% if we're talking about repo lending against the treasuries. And to the extent that there's a benefit because people buy them more aggressively, guess what? The rates go down and the taxpayer benefits. So I think that's right. I think it's very hard to find a moral hazard there.

I think it's different with purchases, right? Because then you're interfering with the pricing of duration risk, which is a thing that the private market should be doing. To Neel Kashkari on the failures of risk-based regulation, yeah, you know what? Regulation is a nasty business and it's very hard to write good regulation. People are always evading the rules. I don't know that another more distortive rule is the answer to that. I think what we learned, again,

or should have relearned from SVB, is about why regulation needs to be complimented with supervision to fill in the inevitable gaps that any rule is going to have. So any rule is going to be flawed and subject to arbitrage, and the hope is, if the supervisors are doing a good job, they're spotting those things a little bit more in real time and reacting to them.

Betsey Stevenson: Excellent. That's a great note to end on.

Structural Constraints on Growth: The Outlook for Long-Term Economic Growth

Charles I. Jones

Abstract

What are the prospects for economic growth in the United States and other advanced countries over the next several decades? U.S. growth for the past 150 years has been surprisingly stable at 2% per year. Growth theory reveals that in the long run, growth in living standards is determined by growth in the worldwide number of people searching for ideas. At the same time, a growth accounting exercise for the United States since the 1950s suggests that many other factors have temporarily contributed to growth, including rising educational attainment and a rising investment rate in ideas. But these forces are inherently temporary, implying that growth rates could slow in the future. This prediction is reinforced by declining population growth rates throughout the world. In contrast, other forces could potentially sustain or even increase growth rates. The emergence of countries such as China and India provides large numbers of people who could search for ideas. Improvements in the allocation of talent — for example, the rise of women inventors — and increased automation through artificial intelligence are other potential tailwinds.

I. Introduction

What are the prospects for economic growth in the United States and in other advanced countries over the next several decades? Let me begin with one of my favorite charts in economics: the time path of U.S. GDP per person over the past 150 years, shown in Figure 1. The surprising thing about this chart is how well a straight line with a slope of 2% per year fits the logarithm of U.S. living standards. Clearly there are decades with faster than 2% growth as well as decades with slower than 2% growth. But the extent to which the data adhere to a straight line is remarkable.

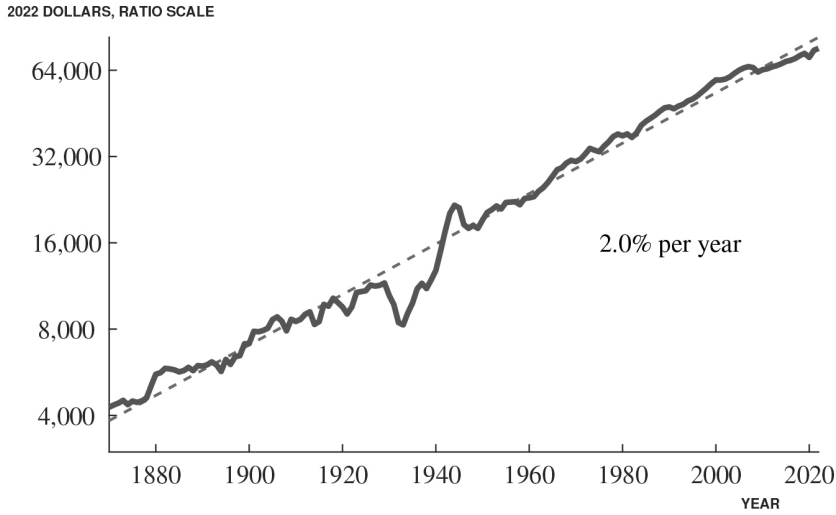
At some level, then, a simple forecast — which has worked out very well historically — is to project the 2% growth into the future. While the statistical regularity makes this tempting, I'll argue below that the theory of economic growth provides reasons to be cautious about assuming this continuation. There are reasons why growth might be slower as well as reasons why growth might be faster. I'll discuss each of these below in the context of "tailwinds" and "headwinds," after first summarizing the lessons from growth theory.

II. Growth Theory in a Nutshell

Why do living standards tend to rise over time? That is, how do we understand the sustained exponential growth in GDP per person in frontier countries like the United States for more than a century? The key to answering this question was provided by Paul Romer in his 1990 paper (Romer, 1990) and served as the basis for his Nobel Prize in Economics in 2018. The key is that ideas are different from nearly all other goods in economics in that they are *nonrival,* or what I prefer to call *infinitely usable.*

Consider most goods in economics, such as a computer or a barrel of oil or an hour of a surgeon's time. Each of these goods is rival, meaning that it can only be used by one person at a time. If I'm using my computer or an hour of a surgeon's time, those goods are not available for you to use simultaneously. Most goods in economics share this feature, which gives rise to the scarcity that is at the heart of economics.

Figure 1
Real GDP per Person in the United States



Source: Barro and Ursua (2010) until 1928 and after using the NIPA data from the FRED database (GDPCA and B230RC0A052NBEA).

Ideas, in contrast, are nonrival or infinitely usable. Think about calculus or the latest Covid-19 vaccine or a state-of-the-art machine language algorithm. Each of these are ideas and, once the idea is invented, can potentially be used by any number of people simultaneously: one person's use does not inherently reduce the amount of the idea available for use by others. The Covid-19 vaccines provide an excellent recent example. Once the vaccine has been invented, its design can benefit billions of people without ever having to be reinvented.

The implication is that living standards are tied to the total number of ideas that have ever been invented, not to "ideas per person." The contrast with rival goods like capital is important here. One computer makes one worker more productive. If we want to make a million workers more productive in the same way, we need a million computers. In contrast, one new idea — such as the harnessing of electricity — can make any number of workers more productive.

This gives rise to the following theory of growth:

Income per person ← Ideas ← People

That is, income per person depends on the total number of ideas ever discovered. Where do these ideas come from? They are invented by researchers, entrepreneurs, and scientists — that is by people. This leads to the somewhat surprising conclusion that living standards depend on the number of people searching for ideas. And therefore the growth rate of living standards in the long run depends on the growth rate of the number of people searching for ideas:

Growth in income per person ← Growth in people searching for ideas

In the long run, the growth in the number of researchers and entrepreneurs is limited by the population growth rate because the share of people doing research must level off. Growth in living standards in countries at the world frontier is ultimately tied to the population growth rate of the countries that produce ideas. A more detailed but still accessible overview of this theory is provided by Jones (2019, 2022).

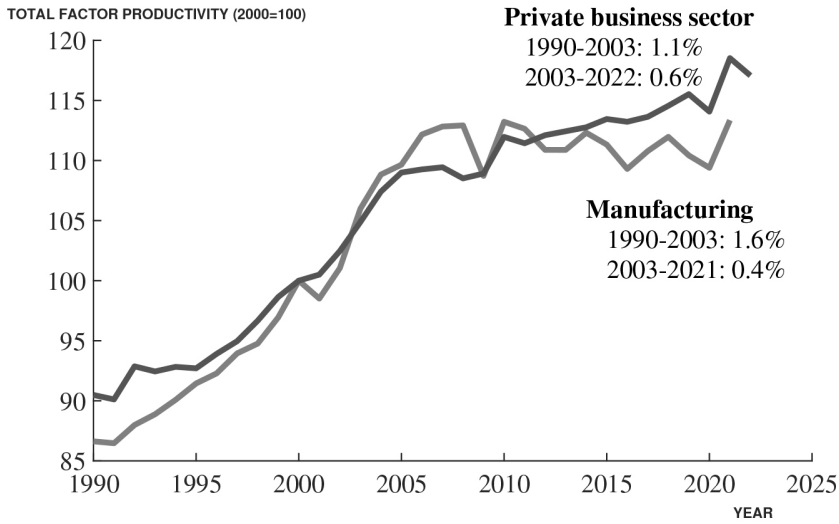
III. Headwinds

We turn now to five headwinds that might lead to slower growth in frontier countries such as the United States in the coming decades.

1. Growth is already slowing. The first headwind is, of course, that we are already seeing slow growth. Figure 2 shows the level of total factor productivity in the United States since 1990. Two lines are shown, and both suggest slowing growth. For the private business sector as a whole, growth in the years before 2003 averaged 1.1% per year but just over half as much as 0.6% per year since 2003.

One hypothesis often put forward is that many of the so-called "free" goods associated with Google, Facebook, and other tech companies have become increasingly important and are likely not adequately captured in our output measures. A response to this concern is to consider manufacturing, which is traditionally viewed as the sector of the economy that is best measured. The remarkable fact is that the slowdown in TFP growth is much more severe in manufacturing

Figure 2
U.S. Total Factor Productivity



Source: BLS Multifactor Productivity from the FRED database (MFGPROD and MFPPBS).

than in the rest of the economy: from 1.6% before 2003 to just 0.4% after. Moreover, there has essentially been zero growth in manufacturing TFP since 2005.

2. Ideas are getting harder to find. The second headwind is a direct implication of the growth theory that we laid out in Section II. In particular, according to this theory, there is an important sense in which ideas are getting harder to find. Now of course we do not have great measures of ideas themselves, and some ideas are huge while others are small. But the sense in which this statement is true is that achieving constant rates of exponential growth requires devoting larger and larger numbers of people to the hunt for ideas.

My favorite example of this phenomenon is Moore's Law, the empirical regularity that the density of computer chips — the number of transistors packed into each CPU — doubled every two years between the 1970s and the 2010s. What makes this such a great example is that Moore's Law is at the heart of the most dynamic sector of modern economies. Through the widespread adoption of computers, smartphones, the internet, and other complementary

inventions, Moore's Law is likely responsible for a large fraction of economic growth in recent decades. As is well known, a process that doubles every T years corresponds to constant exponential growth at 70/T percent per year. So another way of stating Moore's Law is that the density of computer chips rose at a stable rate of 35% per year for at least half a century.

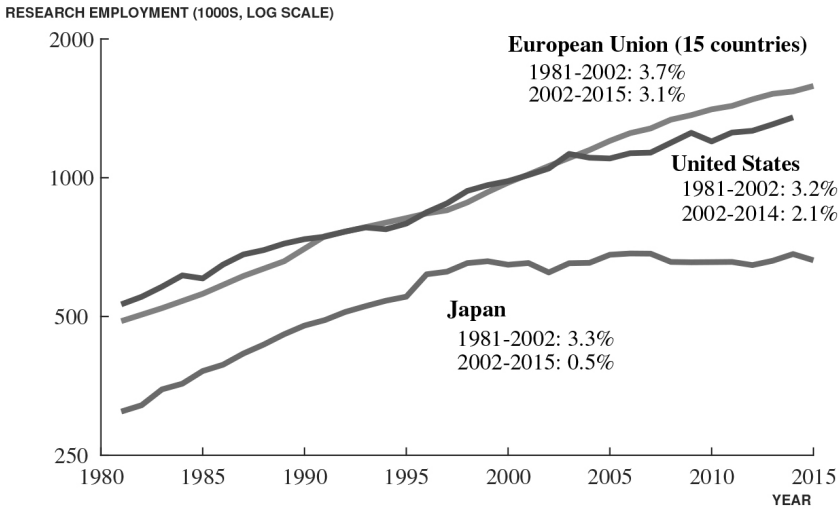
How was this growth achieved? As documented carefully in Bloom, Jones, Van Reenen and Webb (2020), the global research effort devoted to pushing Moore's Law forward by companies like Intel, AMD, Nvidia, Samsung, TSMC, and ASML — but also historically by IBM, Motorola, AT&T, and Texas Instruments — rose dramatically over this period, doubling roughly every decade. By the 2010s, it took 18 times more researchers than in the 1970s to generate the doubling of semiconductor chip density. It is the ever-increasing number of people searching for ideas that sustains constant exponential growth.

An immediate implication of this theory is that if the growth rate of those searchers were to decline, exponential growth rates in living standards or in the power of computer chips would also slow. What does the data look like?

Figure 3 shows overall research employment in select countries and regions around the world. Interestingly, in each of these cases, the growth rate of research employment slowed after 2002 relative to the two decades before. In other words, one possible explanation for the slowdown in productivity growth in the U.S. and in other countries is that the growth rate of people searching for ideas also appears to have slowed.

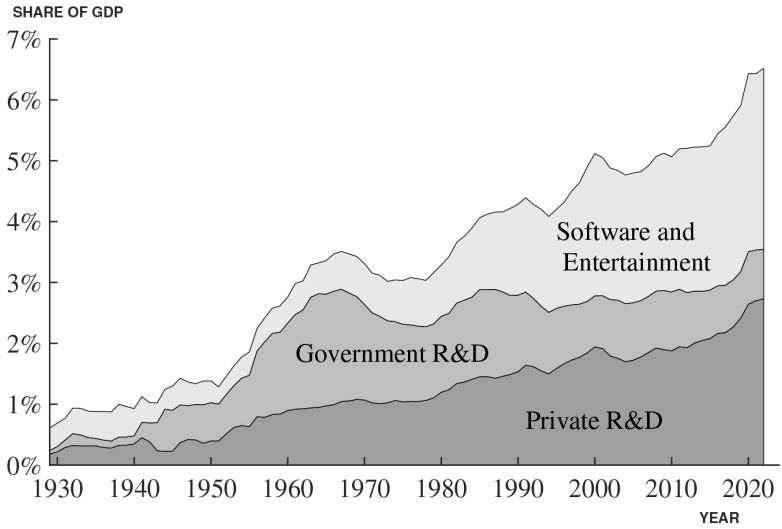
3. Investment rates in infinitely usable ideas have been rising historically. Figure 4 provides another measure of research effort by showing the U.S. investment share of GDP in intellectual property products, which includes privately-funded R&D, publicly-funded R&D, as well as computer software and digital entertainment products like songs and movies. This investment rate in ideas has risen from around 1% of GDP in the 1930s to more than 6% of GDP in recent years. On the one hand, it is great that we (and other

Figure 3
Research Employment in Select Countries



Source: Main Science and Technology Indicators, OECD (2017).

Figure 4
U.S. Investment in Infinitely Usable Ideas



Source: U.S. intellectual property products investment and components, National Income and Product Accounts via FRED.

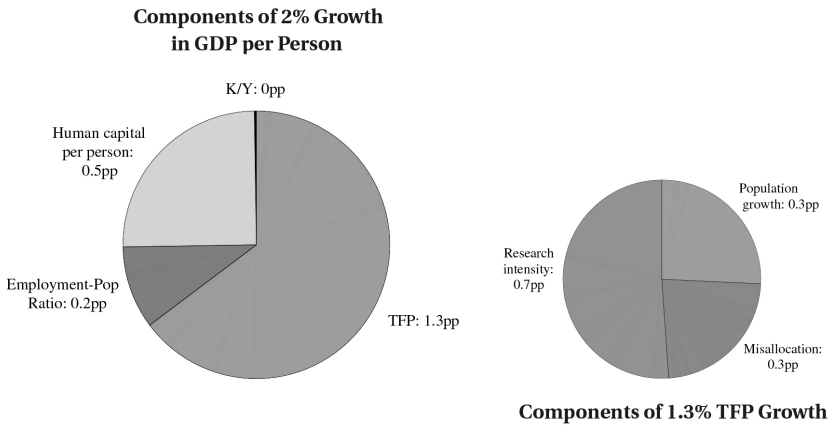
countries) are investing ever larger shares of GDP in these infinitely usable ideas. On the other hand, though, this inherently suggests a future slowdown in growth: our stable growth rate of 2% per year has been achieved while investing an increasing share of GDP in intellectual property products. At some point, this share has to stop rising, and when it does, the implication is that this past source of growth will be unavailable. The growth accounting exercise in the next point quantifies this slowdown.

4. Educational attainment is stagnating. During the 20th century, educational attainment in the United States increased substantially, by just under one year per decade when averaged over the entire labor force (Goldin and Katz, 2008). However, the educational attainment of recent cohorts has risen much more slowly and nearly stagnated, as discussed in Autor, Goldin and Katz (2020).

Figure 5 quantifies this effect using a growth accounting exercise conducted by Jones (2022). With a Mincerian return to education of roughly 6%, each year of educational attainment for the adult labor force should raise labor productivity by around 6%. Because this change occurred each decade historically, we divide by 10 to get the annual growth contribution which works out to be about 0.5 percentage points per year, or fully one quarter of the 2% U.S. growth rate. (This is the "human capital per person" slice of the pie chart.) If educational attainment continues to stagnate, the implication is that this half-a-percentage point contribution to economic growth would disappear. The broader growth accounting in Figure 5 is also helpful for judging the contribution of the rising investment share of intellectual property products. In particular, in this accounting, rising "research intensity" accounts for 0.7 percentage points of the 2% growth. When research intensity levels out at some point in the future, this component of growth would vanish as well. There is more uncertainty in the magnitude of the contribution than is suggested in this chart, but the numbers still give a helpful sense of what could happen.

5. Population growth is slowing and may turn negative. According to the theory discussed in Section II, 100% of growth in living standards must be due to population growth in the long run.

Figure 5
Historical Growth Accounting



Note: The figure shows a stylized growth accounting exercise for the United States since the 1950s. Source: Jones (2022).

Interestingly, that need not be true historically because the "long run" may not yet have been reached. An important finding of the growth accounting exercise shown in Figure 5 is that since the 1950s, only about 15 percent (0.3 percentage points) of growth is due to population growth. Other forces have contributed 85 percent of the total. These include the rise in educational attainment and the rise in research intensity just discussed, but also the rising employment-population ratio and a decline in misallocation (which will be discussed further below). At some level, this is encouraging because it suggests that other economic forces can raise growth rates for more than half a century. However, the implication of growth theory is that these other forces are inherently transitory. The implication is that the long-run component of growth may be something like 0.3%, much slower than the 2% growth we've experienced historically.

In fact, the numbers are even more pessimistic than this because population growth rates themselves are slowing throughout the world. This was driven home to me by the Bricker and Ibbitson (2019) book, *Empty Planet.* These authors observed that fertility rates all around the world have been declining. In fact, for the high-income countries as a whole, the total fertility rate — the number of children women have over their lifetime on average — is now

1.7. Simply to keep populations constant, total fertility rates need to be just over two. In other words, in rich countries as a whole, observed fertility rates are already consistent with a declining population rather than with a growing population. It is distinctly possible that global population will level off and then start to decline over the next century. The implication for growth theory is that living standards could stagnate rather than continue to grow exponentially: if the number of people searching for ideas declines over time rather than rising, economic growth eventually comes to an end (Jones, 2020).

IV. Tailwinds

The preceding discussion of headwinds highlights numerous reasons why growth rates in frontier countries such as the United States might slow in coming decades. However, there are at least three important tailwinds that will push against a slowdown and could possibly even increase growth rates, at least for a while.

1. The rise of China and India. The production of new ideas is a global phenomenon: ideas created anywhere have a strong tendency to benefit people all around the world. The "infinite usability" does not stop at national borders. In this context, the economic development of China and India is noteworthy. Each country has a population as large as the United States, Western Europe, and Japan combined. In 1970, these economies were so poor and so far from the world technological frontier that their populations could not meaningfully contribute to producing new ideas that would raise living standards in the U.S. and Europe. However, decades of rapid economic growth mean that this is no longer true, especially in China already but also in India in the future. For example, in 2013–2016, Tsinghua University produced more of the 10 percent most highly cited papers in STEM than any other university in the world (The Economist, 2018). So even if population growth rates are slowing around the world, global research effort could continue to rise in the next several decades as researchers and entrepreneurs in China and India join the search for ideas.

2. Improving the allocation of talent. Sandra Day O'Connor — the first women Supreme Court Justice in the United States — graduated from Stanford Law School in 1952 with the third best academic record in her class. The only job she could get in the private sector was as a legal secretary (Biskupic, 2006). According to Hsieh, Hurst, Jones and Klenow (2019), a similar fact was true more broadly for high-skilled occupations: in 1960, 94 percent of doctors, lawyers, and managers in the United States were white men. By 2010, this share had fallen to 60 percent. Part of what was going on during that fifty-year period was the Sandra Day O'Connor story writ large. The allocation of people was increasingly based on talent and comparative advantage rather than being distorted by various barriers and social norms. Hsieh, Hurst, Jones and Klenow (2019) show that 40% of growth in income per person and 20% of growth in income per worker over these 50 years was due to the improved allocation of talent.

According to Brouillette (2023), 4% of inventors based on patent statistics were women in 1976, rising to 12% by 2020. Bell, Chetty, Jaravel, Petkova and Van Reenen (2019) show that the extent to which people are exposed to inventive careers in childhood has a substantial influence on who becomes an inventor. Exposure in childhood is limited for girls, people of certain races, and people in low-income neighborhoods. So the opportunities to expand the talent for research are not only limited to China and India and other developing countries. How many future Steve Jobs and Jennifer Doudnas are waiting to realize their potential?

3. Artificial intelligence. The final tailwind is perhaps the most uncertain but also has the greatest upside potential. The recent emergence of ChatGPT and other large language models indicates dramatic advances in artificial intelligence. Machines are increasingly able to substitute for humans in various tasks. We've argued that a lack of talented people to search for new ideas is an impediment to future growth. What if machines can replace people in this task as well? Aghion, Jones and Jones (2019) show that in models like those discussed in the first part of this paper, it is at least possible

for growth rates to rise if A.I. can partially or fully replace people in generating ideas.

However, that paper also emphasizes various bottlenecks that can limit the extent of these effects. For example, automation has been going on since the Industrial Revolution. The steam engine, electricity, internal combustion engines, tractors, and semi-conductors are all examples of amazing new technologies that helped automate various parts of the economy. And yet as shown back in Figure 1, none of these technologies accelerated growth during the past 150 years. The development of a new general purpose technology every few decades may be precisely what kept the 2% trend going for so long. Perhaps A.I. is just the latest amazing technology that will postpone a slowdown for several more decades and permit 2% growth to continue a bit longer.

So while it is conceptually possible for A.I. to raise growth rates, it is far from certain. Theory says it is possible while history gives reasons for caution.

V. Concluding Thoughts

Because ideas are infinitely usable, living standards in any country depend on the total stock of ideas that have ever been invented throughout the world. Ideas are discovered by people, so living standards are tied to the global number of people searching for ideas. In growth rates, this means that the growth rate of living standards in the long run depends on population growth.

Historically, other factors have been important. In the United States since the 1950s, perhaps 85 percent of growth has been due to other factors such as rising investment rates in ideas, rising educational attainment, the increase in the employment-population ratio, and the improvement in the allocation of talent. But each of these forces is inherently temporary: the fraction of GDP devoted to investment in ideas will someday level off and educational attainment is already beginning to stagnate. Moreover, population growth rates themselves are slowing around the world and even potentially turning negative. A long list of headwinds confront future economic

growth, suggesting that growth in the next several decades could be slower than in the past half century.

On the other hand, there are tailwinds that could offset these forces. The rise of China and India and the improved allocation of talent throughout the world mean that there are many more people with the potential to become the next Steve Jobs or Jennifer Doudna. Artificial intelligence appears to be a new general purpose technology, perhaps on par or even exceeding electricity and the semiconductor. The widespread application of A.I. could stimulate economic growth in the coming decades, though there are substantial uncertainties around this possibility.

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Structural Constraints on Growth: The Workforce Behind the Workforce

Nela Richardson

Thank you to the Jackson Hole Symposium organizers for providing this topic, "Structural Constraints on Growth", to orient thoughts on the dynamics of the current labor market. My remarks are heavily informed by ADP's extensive data on the workforce.

ADP provides payroll services for more than 25 million U.S. workers, or about 1 in 6 workers in the United States, and 40 million workers worldwide. We operate in 140 countries. Last year, we processed 75 million U.S. tax records and moved $2.7 trillion in client funds around the world. To sum that all up, we have a lot of data.

And because my remarks come between those of two esteemed academic economists, I'd like to appeal to the non-economists in the room with data storytelling examples to showcase the shifting dynamics present in the current labor market and how those shifts effect long-term economic growth.

My main example of the structural constraints on growth comes from the care economy, a sector of the labor market that is rarely highlighted in monetary policy discussions but is essential to worker productivity and long-term economic growth.

Before turning to the care economy, I'd like to provide a broad view of the labor market for some context. Workforce data from the last three years – the pandemic period – show that the labor market is both incredibly strong and incredibly fragmented.

At the macroeconomic level, economists generally discuss the labor market like it's one thing, but it's not. Rather, collections of microcosms collide to form the labor market. This fragmentation has been exacerbated by the pandemic.

There are five areas of fragmentation that I'd like to highlight, then connect to the worker experiences seen in the care economy.

I. Fragmentation and the Labor Market

I.A Demographic Fragmentation

The first area of fragmentation is demographics. It's generally recognized that major economies such as the United States and Europe are aging. But that's only part of the story.

Last year, the ADP Research Institute looked into school-bus drivers. We were inspired by headlines, in Chicago especially, about shortages of school bus and their impact on education. Kids were late to school because there weren't enough bus drivers. Classes were forced to start late, and students returned home well into the evening because there were too few drivers.

We went into the data to see what happened to all the bus drivers after schools reopened after the pandemic. Our hypothesis, based on what we knew about the demographics of bus drivers, was that this is an occupation with a high concentration of older workers. We surmised that this cohort of workers would be reluctant to drive a bus of mobile germs (otherwise known as children) during a pandemic. So, they left the profession.

Well, we were right about the demographics of the drivers. About 51 percent of the post-pandemic school-bus driver population were 55 or older. But we were totally wrong on who was leaving the profession. It wasn't the older drivers who left, it was the younger ones. Thirty percent of drivers aged 25 to 35 left the profession in the two years after the pandemic. Why?

The rise of the digital economy – driven by heavy consumer demand for buying goods online and having those goods delivered – changed the incentive structure for workers who held a commercial driving license. With so many people ordering groceries for delivery, for example, young drivers were incentivized to switch from education to transportation and warehousing jobs.

Wages for school-bus drivers stayed relatively low, while wages for delivery drivers soared. This wage shift led the demographic impact to play out differently than expected.

I.B Competitiveness Fragmentation

The second source of labor market fragmentation is competition for workers. A great example of is found in the leisure and hospitality industry, where many jobs have few skill requirements. It's also an industry where, before the pandemic, wages didn't keep up with inflation. Workers who switched jobs actually made less money, not more.

Before the pandemic, real wages for workers on average in this industry barely treaded water – pay grew neck-and-neck with inflation. That has changed radically post-pandemic. In fact, leisure and hospitality was the lead driver of super-charged wage growth over the entire post-recovery period.

Using anonymized worker-level data from ADP payroll systems shows median pay growth for the leisure and hospitality sector peaked at nearly 17 percent year-over year growth in March 2022. Pay growth has slowed a great deal since then. As of July 2023, median pay for the sector grew by 7.2 percent from the previous year.

Even with this slowdown, pay growth is much higher than it was before the pandemic and arguably inconsistent with a 2 percent inflation target.

So, the question is, have low-skilled workers become more competitive in the labor market? Is that a change? Is that a fragmentation that we're seeing? In my view, wages are what bridge the labor market and inflation. You want to make sure that that bridge is pointing to lower inflation, not higher inflation.

Whether there's been a structural shift in the wage dynamics for low-skill workers over the long term remains an open question. The job market might return to a modest trajectory of low-skill wage growth characteristic of the pre-pandemic time period. Alternatively, the labor market might have seen a permanent shift in the competitiveness of low-skill workers due to persistent labor shortages, one that results in a higher trajectory of pay growth.

It's also important to do a sanity check here. The rapid wage growth over the last year amounted to just a $5,000 average increase for leisure and hospitality jobs, from peak wage growth to now. Five thousand dollars. That's not much in a household budget strained by inflation, and that's why it's important to look at levels, not just growth rates.

I.C Churn Fragmentation

The third area of fragmentation is churn. Workforce churn has three dimensions that are relevant to structural constraints on the labor market:

1. Ease of entry
2. Turnover
3. Rejoin rates

The first churn indicator is the ease by which workers can move between and within jobs. Industries with high skill, education, or licensing requirements limit worker mobility both at the geographic and sector levels.

One way to quantify an industry's barriers to entry is to measure the percentage of new hires in a given month. We define new hires as workers who joined their employer in the previous three months. This percentage varies dramatically by industry.

For example, the information industry is a relatively high-skill sector comprising workers in software, publishing, and communication. Less than 2 percent of workers in this industry were hired in the last three months, according to the ADP Research Institute.

In contrast, the professional business services sector includes a wide range of skill levels. Workers span the spectrum, from highly skilled professionals such as accountants and lawyers to office managers and support staff. In contrast to the information industry, 22 percent of workers in the professional business services sector in the last three months were new hires.

This pattern of skill barriers and new-hire percentages is seen across industries, including leisure and hospitality, where 16 percent of workers are new hires, manufacturing (10 percent), and construction (less than 4 percent).

The second indicator of workforce churn is turnover, which skyrocketed in the aftermath of the pandemic. Turnover has normalized since those early days, but there are industries where seasonal turnover trends are deeper now than they were before the pandemic.

Given its seasonal nature and low barriers to entry, leisure and hospitality is a sector with high turnover. Surprisingly, another seasonally driven sector is education. A large proportion of teachers leave their employers at the end of the school year. We don't think of this as a high-turnover industry, but in fact there's a seasonal component to the turnover.

The third component of workforce churn is what we call the rejoin rate. When we look at quits and the overall data, we think of people who leave with a permanent goodbye to their employer. Oftentimes, however, the relationship between employer and employee is more like a revolving door. People come back. We saw a big pickup in rejoin rates during the pandemic.

The biggest jump in the number of workers rejoining former employers came in June 2020, when companies hired 4.8 million workers. The rejoin rate exploded. Many people went back to their former employers, rehired after being furloughed. We also see a high rejoining rate in the teaching profession.

People leave, there's a separation, they come back. But to foreshadow insights from our care economy analysis, this trend is changing.

I.D Geographic Fragmentation

The fourth place of fragmentation in the market is geography. From the worker's perspective, geography is defined not just by a job's location, but also its cost of living.

The pandemic transformed geographic fragmentation after a shortage of affordable housing in major job centers collided with the adoption of technology to aid remote collaboration. As a result of these two trends, jobs are becoming more geographically concentrated based on pay level.

Analysis by my team at the ADP Research Institute found that high-value, C-suite executives are becoming concentrated in San Francisco, New York, and Washington, D.C., while less valued, lower-skilled occupations such as customer service support jobs, are being relocated to more affordable cities.

This geographic job diffusion is relevant not only to the labor market; it has important social and political implications as well.

I.E Worker Sentiment

Worker sentiment plays a significant role in employee behavior. The sentiment behind the Great Resignation is a canonical example of how people's thoughts and feelings effect their work choices.

Since the peak of the Great Resignation, there have been attempts to put new taglines on worker sentiment. The Great Resignation was followed by the Big Stay, where workers opted to stay put as job openings started to decline and layoffs at big companies started making headlines.

Another sentiment-inspired tagline was Quiet Quitting, doing the minimum required for a job, and there was even Bare-Minimum Mondays, in which workers were encouraged to take Monday as a self-care day and ease into the week.

But behind taglines is the fact that worker sentiment can and should be measured as an important signal of labor market participation.

At the ADP Research Institute, we've spent more than a decade measuring worker sentiment globally. We think worker sentiment is a state, not a trait, one that changes over time.

We recently developed a tool to measure worker sentiment based on 490,000 survey responses in 49 countries. We call it the Employee Motivation and Commitment Index. This index measures how employees feel about their place at work and whether they're thriving and growing. Because the index changes over time depending on individual and collective circumstances, it can provide context on the state of specific industries, the labor force, and the economy.

An index value of more than 100 is consistent with growing commitment and motivation. A value of less than 100 signals diminishing levels of these states. In August 2023, the EMC Index fell from 108 to 100, its lowest point since June 2022. The index peaked in December 2022 at 121 after a year of robust pay growth, strong hiring, and the rise of remote work.

II. The Example of the Care Economy

I chose the care economy because it's personal. I've interacted professionally with the labor market as a mother. Without the care economy, frankly, I wouldn't be here. To be even more direct, even the collective brain power in this room at Jackson Hole has to be nurtured, maintained, and educated.

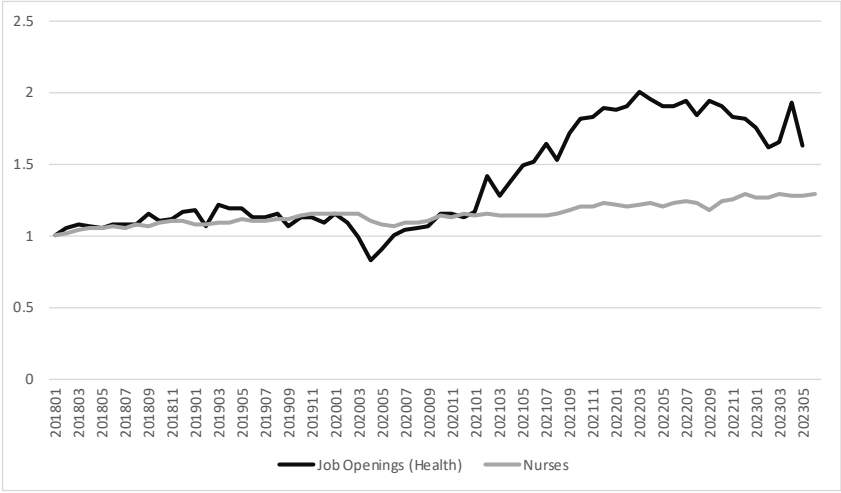
Without the care economy, great ideas, innovative technologies, and new markets can't be developed. The care economy is important to the workforce productivity growth that drives a thriving economy.

I focused on nurses and teachers because they're easily recognizable as hallmark occupations of the care economy, occupations in which the majority of professionals are women and people of color.

II.A Supply Gaps in the Care Economy

Figures 1 and 2 show that the post-pandemic demand for nurses and teachers is far outstripping supply.

Figure 1
Job Openings (Health) vs. the Nursing Employment Index



Source: Bureau of Labor Statistics, the ADP Research Institute

According to the Bureau of Labor Statistics, job openings in health are up 62 percent. But ADP data for a sample of employers present in our database from 2018 through 2023 shows nursing employment up just 30 percent.

The demand-supply gap in teaching is much more dire. Job openings in education are up 95 percent since 2018, but employment in teaching has gone up only 5 percent.

II.B New Hires

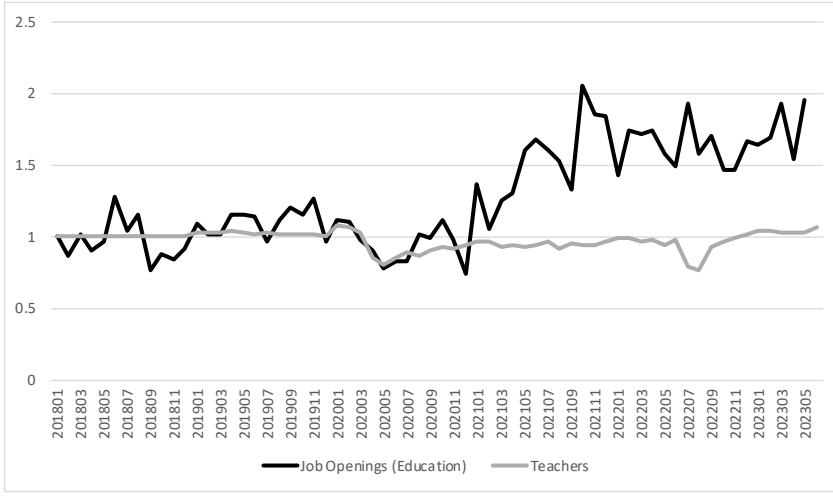
Figure 3 shows that nursing is growing faster than the overall employee market.

There was a pandemic dip in March and April 2020, but it was much shallower than the dip in the overall market. The post-pandemic growth rate has been stronger.

Figure 4 shows that teaching employment is lagging the overall market.

The pandemic dip for teaching employment was deep and teacher employment continues to track lower relative to the broader labor market.

Figure 2
Job Openings (Education) vs. Teacher Employment Index



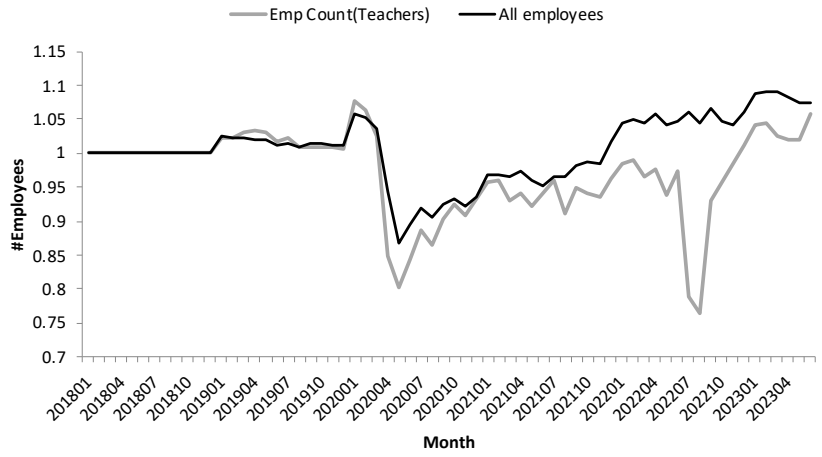
Source: Bureau of Labor Statistics, ADP Research Institute

Figure 3
Nursing Employment Index, YOY change

Source: The ADP Research Institute

We also saw something interesting that we've never seen before, and I had to spend the remaining of my time on this slide. I think it's worth illustrating.

Figure 4
Teaching Employment Index, YOY Change



Source: The ADP Research Institute

There was also a big dip in employment for teachers last year. Now, that's not entirely surprising. There's generally a seasonal dip in employment from June to July, at the end of the school year. But this regular dip in employment typically coincides with a drop in tenure and age, which suggests older workers leaving the profession consistent with retirements.

In June 2022, however, not only was there a much bigger decline in employment, but the average age and tenure of teachers increased. This is consistent with younger professionals leaving the labor market just like we saw in the school bus driver analysis.

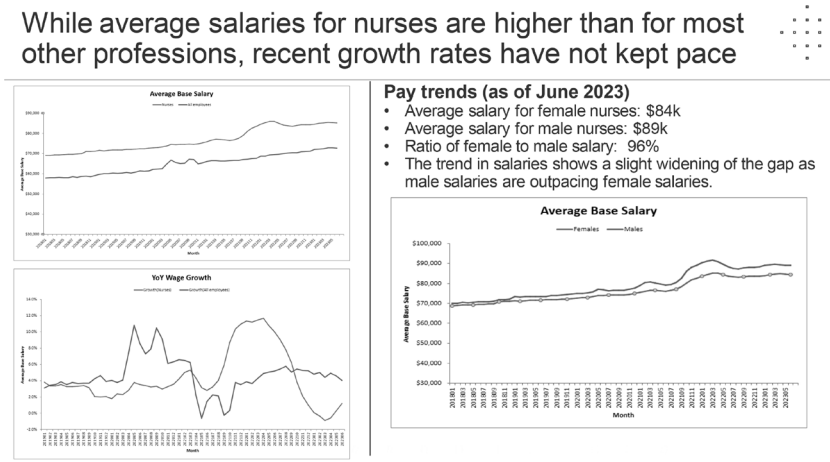
II. C Pay Trends

Shifts in pay trends after the pandemic can explain changes in employment.

For example, nurses are paid well in comparison to all workers, as shown in Figure 5. Additionally, the gender gap is narrow, unlike with most occupations where women make 80 percent of base salary compared to men.

However, recent pay growth for nurses has lagged.

Figure 5
Wage Dynamics for Nurses



Source: The ADP Research Institute

For teachers, the story is different, as we see in Figure 6. The ratio of female salaries to male salaries is 73 percent, highlighting the gender pay gap in this sector.

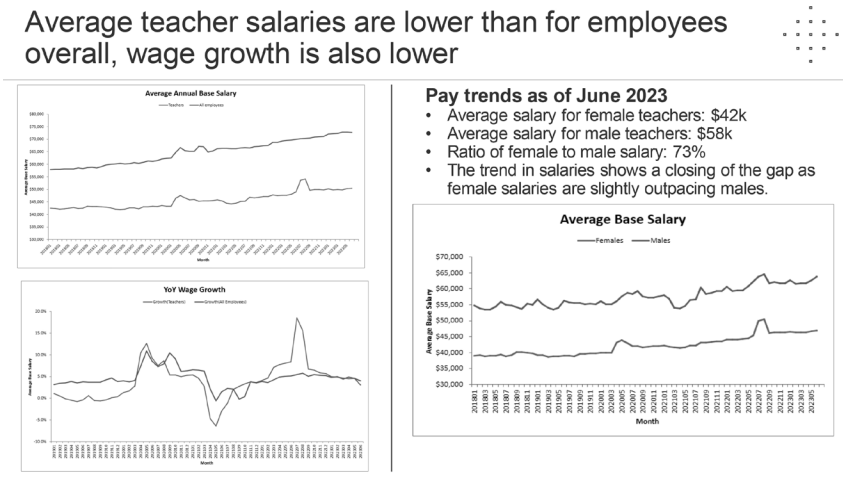
Average teacher's salaries are lower than for all employees overall. Wage growth is also lower, except for that June 2022 employment dip that I pointed out earlier.

The data also shows a huge response by schools. Wage growth accelerated quickly after the drop in employment, suggesting that employers had a strong desire to get these workers back.

Schools were largely successful in recovering from the employment dip at the end of the 2023 school year. This year's June-July drop was not as extreme as last year's, as a result of the big push in wage growth.

The results on demographics were more mixed. The average age of teachers fell, but average tenure rose. This could signal a possible boom-bust wage cycle in education in which younger people leave, then schools raise wages to lure them back, only to let pay growth slide again the following year.

Figure 6
Wage Dynamics for Teachers



Source: The ADP Research Institute

II.D What's Next for the Care Economy

The upshot of this analysis is that the care economy is undergoing crosscurrents of structural change that could limit the ability of working families to participate fully in the labor market.

As care demands grow, a shortage of reliable child and elder care, health care, and other social support could restrict progress in overall employment, worker productivity, and economic growth.

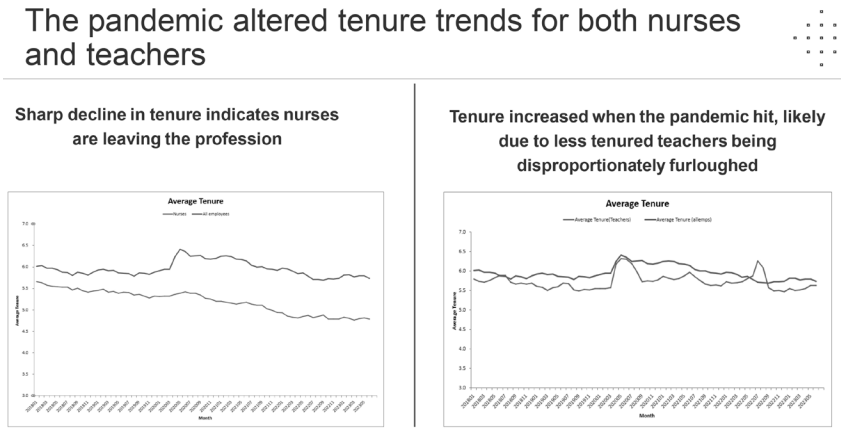
Figure 7 highlights these concerns. Data suggests that experienced nurses are leaving the profession. Over the last five years, average tenure has fallen from 5.7 years to 4.8 years.

Tenure hasn't fully recovered either, as younger teachers were more likely to be furloughed or laid off.

Moreover, demographics are driving changes in employment. As seen in Figure 8, while the number of entry-level nurses continues to climb, fewer young people are going into teaching.

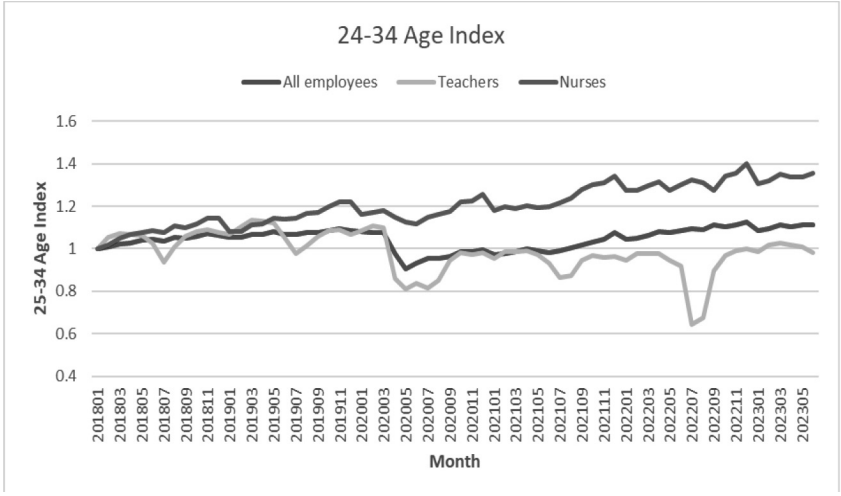
The bad news in both occupations is that the growth rate of entry-level workers is not keeping up with demand.

Figure 7
Average Tenure Trends



Source: The ADP Research Institute

Figure 8
Entry-Level Workers in the Care Economy



Source: The ADP Research Institute

III. Conclusion

The care economy has always been a critical, yet rarely discussed, feature of a productive workforce. The labor market fragmentation we see more broadly has an even more pronounced impact on the care economy and its ability to support a thriving and productive workforce. Fractures in this industry could ultimately pose a constraint on economic growth over the longer term.

Structural Constraints on Growth: Structural Shifts in the Global Economy

Chad Syverson

I really appreciate the invitation to come visit with you today about supply constraints and their interaction with monetary policy. It is always fun to be here, and it is a special treat to be a panelist again. I have four main points to make, so I am going to get right to them.

1. Productivity Is the Long Run Constraint

My first point builds on something that is said a lot, but it is important enough that I will say it again: As the horizon elongates, supply changes from *a* constraint to *the* constraint. Productivity growth is the only way to sustain growth in income per capita over the long run.

We heard earlier about the conventional wisdom that monetary policy has, at best, modest effects on the supply side and no long-run effect on productivity itself. However, as the work of my colleague Yueran Ma and her coauthor Kaspar Zimmermann showed — effectively, in my opinion — this may not be true. When the case is laid out, it makes sense. Investments in innovation are, after all, investments. If we think monetary policy influences investment, it is not surprising that it could affect innovation as well. Now, investments in innovation might have more uncertain outcomes that are realized with longer lags. That makes innovation a harder outcome to

conduct monetary policy by, but it does not diminish the monetary-policy-to-innovative-investment channel's empirical influence on outcomes. Productivity's importance means we should closely study the workings of this channel.

There is a broader point about monetary policy and productivity. I do not have to tell anyone in this room that monetary policy, like most decisions large and small with economic implications, is usually an exercise in constrained optimization. You make adjustments in an effort to get closer to the best possible outcome, given inherent limits. Fundamentals change in a way that necessitates tightening or loosening, and you turn the dial a bit this way or that in an attempt to move things closer to the optimum, trading off various considerations.

Productivity growth changes that equation, literally. It is not about trying to do better within a constraint. It *changes* the constraint, by loosening it. This turns a world of inherent trade-offs into one where those trade-offs do not bite. It changes this *or* that into this *and* that.

There is some math that says the benefits from loosening constraints tend to be considerably larger than the benefits of getting closer the optimum within a constraint. That is what productivity growth does across all sorts of settings. To my more mathematically oriented friends in the audience, what I am saying is that productivity is the giant Lagrange multiplier on our economic lives. For those of you whom I might have just lost, I am just saying that productivity growth makes everything easier. And reducing inflation is no exception.

Of course, recognizing the importance of productivity does not mean it is easy to manipulate. As I just noted, monetary policy's influence on productivity is uncertain and can act slowly. But its broad influence, especially in the long run, makes understanding productivity growth of immense importance.

All that said, even if one chooses to focus exclusively on monetary policy's demand effects, practitioners cannot ignore productivity or the supply side more generally. The economic outcomes we observe and care about — inflation, output growth, wage growth, and em-

ployment growth — depend on the confluence of supply and demand. Even if you are only thinking of monetary policy as a tool to manipulate demand, the effects of that demand manipulation depend on what supply is doing. That is true in the long run because of productivity. But it is also true in the short run, and that leads me to my second point. It regards data patterns that, while I have not seen anyone yet discuss them, vividly demonstrate how monetary policy's effects depend on the confluence of supply and demand.

2. Supply and Monetary Policy in the Short Run

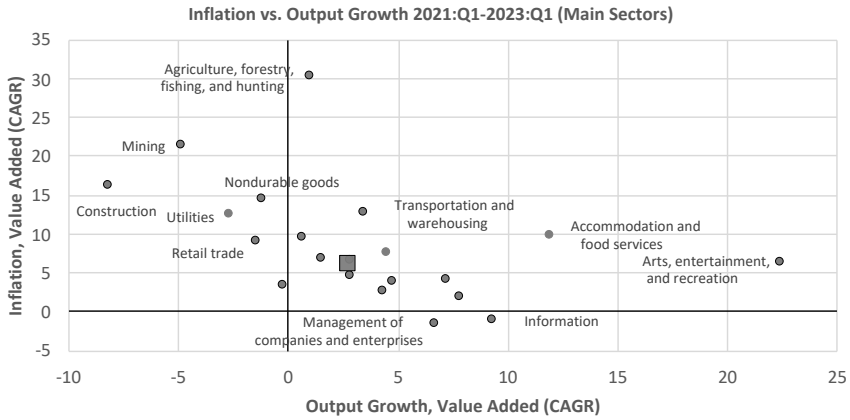
You can see what I am talking about in Figure 1. It shows, for the major sectors of the private U.S. economy, the relationship between inflation in the sector and the sector's output growth. The growth rates are over the recent inflationary period, which I define as spanning 2021:Q1 through 2023:Q1. I have labeled a few of the sectors at the edges of the data cloud for reference and in case you are curious about the outliers. The larger square data point shows for comparison inflation and output growth for the entire private economy over the same period.

There is a clearly negative relationship between inflation and growth across sectors. Sectors that saw the highest inflation saw the lowest output growth, and those that had the least inflation had the largest output growth.

This pattern is not an artifact of aggregation. Figure 2 shows the analogous relationship for more detailed industry definitions (which, combined, are still exhaustive of the private economy, as with the sector-level breakdown in Figure 1). The clearly negative relationship between inflation and output growth remains.

This pattern is what we would expect to find if demand were (essentially) fixed across industries, and what varied across industries was supply. Sectors experiencing the most negative supply shifts would see the highest inflation and slowest output growth. Those experiencing outward supply shifts, on the other hand, would see faster output growth and lower inflation. (This is a similar logic to that behind why one uses a supply-shifting instrument to trace out the demand curve.)

Figure 1
Product Market Inflation vs. Growth across Industries



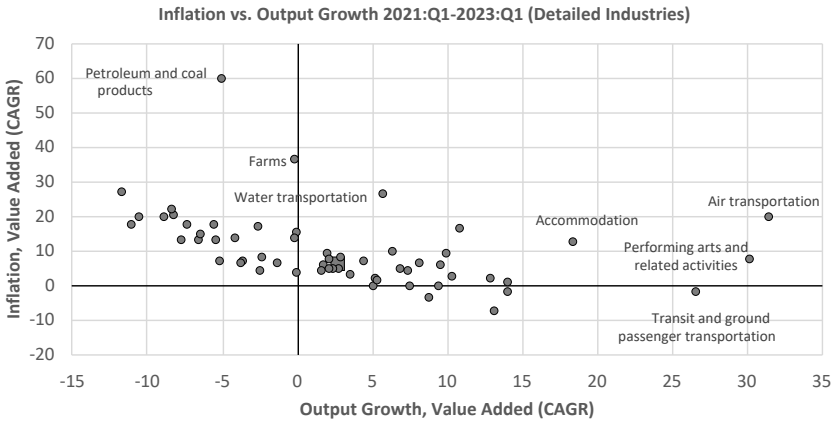
I can think of no mechanical or conceptual factors that would make this negative relationship inevitable. If, instead, demand variations in the face of fixed supply were the primary determinant of output and price growth across sectors, the figure would show a positive relationship. The most inflationary industries would be those experiencing the most output growth, because they faced outward demand shifts. Industries with inward demand shifts would experience low inflation and low output growth. In still another possible scenario, if demand and supply shifts were about equally important across industries, we would see a shotgun-blast pattern rather than a clear negative or positive slope. These scenarios were certainly possible — nothing I know of about how the economy works or how monetary policy affects it would preclude them from happening. They simply did not.

The data indicate supply shifts, rather than demand, appear to explain the considerable majority of variation in inflation in the cross section.

Two questions naturally emerge from the patterns in Figures 1 and 2.

First, if supply shifts explain most of the inflation variation across industries, does this mean supply was the primary determinant of overall inflation? I think it is reasonable to argue that if supply matters so much in the cross section, it might also have mattered a lot

Figure 2
Product Market Inflation vs. Growth across Industries, Detail



for aggregate inflation. That said, an honest empiricist knows Figures 1 and 2 do not offer any evidence about that supposition; they have only a single data point regrading overall inflation.

Second, if supply shifts explain differences in inflationary pressure across sectors, what are the sources of such shifts? In thinking about this question, it is worth noting first that the sector-specific quantity and price indexes used here are for value added. Value added has the benefit of avoiding double counting. We know that holds for output, but it also holds for prices. Value added price indices should not double count the effect of a few inflationary commodities running down the supply chain and raising costs and prices for many industries. The inflation patterns in Figures 1 and 2 are therefore not simply separate manifestations of a single underlying price shock to a key input. Instead, value added prices should reflect only the price effects of an industry's value added components: labor, capital, and value added total factor productivity.

Labor is a major component of value added. Could it be that the industry-specific supply shifts in the product market actually reflect industry-specific *labor* supply shifts? I can explore this hypothesis in a similar fashion to the sector-level inflation and output growth comparison I just discussed. In this case, however, rather than comparing an industry's inflation to its output growth, I look at the relationship

between an industry's wage growth and its employment growth over the same period using BLS data.

Figure 3 shows the result for broad sectors, and Figure 4 shows the analogous figure for the more detailed industries. The clear downward-sloping relationship across industries seen in product markets is not present in the labor market. Industries that experienced the highest wage growth did not see systematically lower employment growth. Nor did they see systematically higher employment growth. The wage-employment growth relationship across industries exhibits a shotgun-blast type pattern. Supply and demand variations appear to matter roughly equally in determining industry-level labor market outcomes. The correlation between industries' wage growth and employment growth is statistically zero.

To understand more about why the patterns in industries' product markets do not match up with what is going on in their labor markets, consider the following. The correlation between industry output growth and employment growth is around 0.7, at either level of aggregation shown in the figures. Industries that produced more, hired more. The quantities are in alignment. The break between the product and labor markets arises in the patterns of product-market inflation and wage growth. Industry inflation and wage growth are statistically uncorrelated. Wage increases in an industry do not predict price increases in that industry.

By the way, the patterns seen in Figures 1-4 hold if I weight sectors or industries by their GDP share.

Does this mean labor supply does not matter at all? No, in some industries it does appear to be about labor supply movements. At the same time, however, in other industries labor demand drives outcomes. This combination leads to the disconnect between inflation and wage growth across industries.

If labor supply shifts are not the sole source of the output supply shifts that drive variations in industry-level inflation, this leaves two other possibilities.

One is capital supply shifts. I could not think of a way to test easily given the available data — finding credible industry-specific capital

Figure 3
Wage vs. Employment Growth across Industries

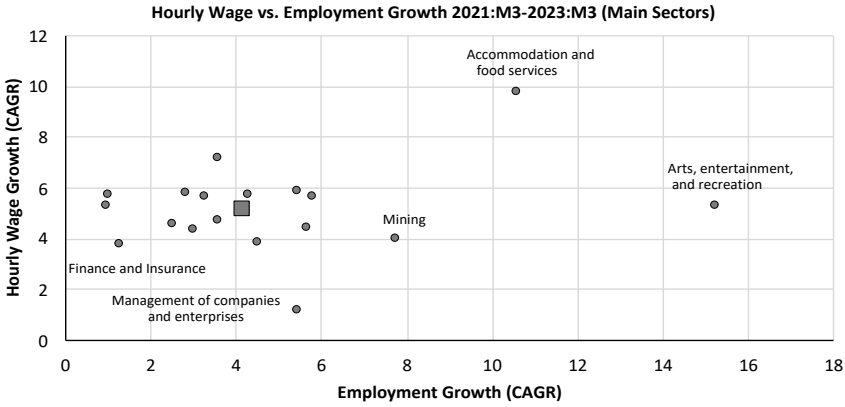
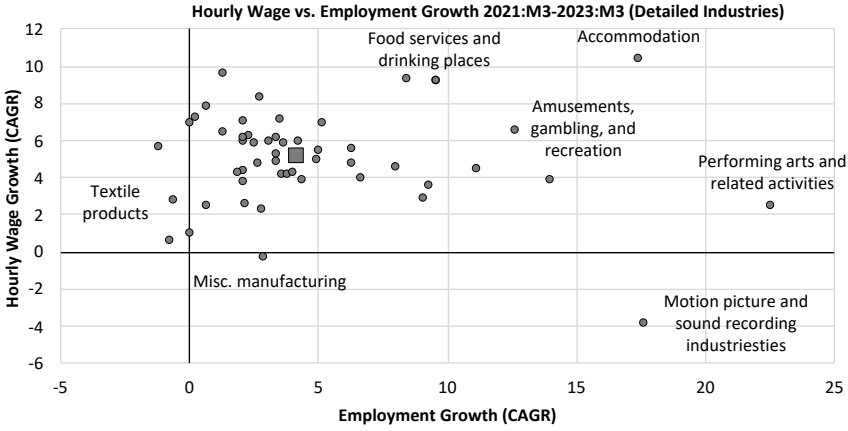


Figure 4
Wage vs. Employment Growth across Industries, Detail



prices is tricky, and in any case industry-level capital stocks come out with large lags. That said, I am not aware of work or even anecdote-based arguments that might suggest these are important.

The other, and I think more likely, potential source of supply shifts involves total factor productivity. I suspect the specific mechanisms through which industry productivity shifts likely vary across sectors, making a simple unified explanation for industry supply shifts elusive. Nevertheless, the patterns I just discussed point to the

importance, even in the near term, of understanding sector-specific supply factors when considering monetary policy's effects. In that vein, for my third point, I highlight a particularly salient case of sector-specific productivity shifts.

3. Construction Productivity

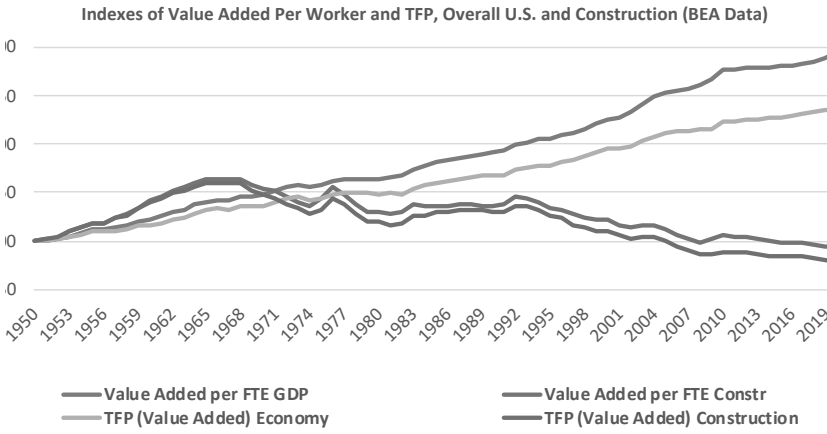
Negative productivity shocks are inward supply shifts. As just discussed, given stable demand conditions, they cause lower quantity growth and higher prices. In recent work, Austan Goolsbee and I draw attention to the construction sector, which has been experiencing poor productivity performance over a long period.

Figure 5 compares the evolution of labor and total factor productivity in the U.S. construction sector and the total economy over 1950-2020. After construction productivity grew faster than economy-wide productivity for almost two decades, it abruptly slowed and changed directions in the late 1960s. Average productivity growth in the sector has been negative since then. Yes, negative productivity growth. And yes, for over 50 years.

Our study is able to eliminate some possible explanations for this strange and awful performance. The sector has not under invested in capital. Its inputs have not become more expensive relative to other sectors' inputs. It is not just measurement problems due to bad deflators or other issues. For example, the number of square feet of housing built per year by a worker in single-family housing construction is the same now as it was in the mid-1970s. Adjusting for measures of housing quality, as we and Garcia and Molloy (2022) have done, does not turn this fact around. It moves measured performance from terrible to merely awful.

But to be honest, we could not in the end point to a single, critical factor as responsible. It may well be a problem created by combination of many factors. If you allow me to step away from the paper and data for a moment, my conversations with people in and around the sector make me suspect part of the problem is that firms in the sector have little incentive to become more efficient. Rather than viewing operational discombobulations and change orders as costly, they appear to view them as great profit opportunities. Furthermore,

Figure 5
Productivity in the U.S. Construction Sector



an increasing number of folks have recognized that political economy surrounding the industry may not be healthy. We seem to have achieved a sort of learned helplessness when it comes to building things. Hopefully future work will teach us more about the roles of these factors.

Whatever the causes, we must contend with a major sector of the economy that has been struggling for half a century. Construction's poor productivity performance is particularly concerning in that it produces a large share of the economy's physical capital stock, the bedrock upon which future growth is built. That is costing us all.

4. A Case for Productivity Optimism

Having sounded that pessimistic note about productivity in an important sector, my fourth and final point is a case, grounded in the data, for productivity optimism over the medium run. We could use it. The world is 15-20 years into a productivity growth slowdown that has cost us trillions of foregone output.

One of the most concerning productivity-adjacent trends before the pandemic was a decades-long decline in measures of dynamism: labor market turnover, new company formation, and the like. Dynamism is important because of three facts research has established across hundreds of industries, periods, and countries. One, there are

large productivity differences across producers, even within narrowly defined markets. Two, the churning process supported by dynamism shifts activity across those producers with their varied productivity levels. Three, the direction of this churn on average rewards productivity. More productive businesses are more likely to grow and survive, less productive ones are more likely to shrink and exit. This shift in activity from less productive to more productive businesses creates productivity growth, even in the absence of productivity growth within any given producer.

The downward trend in dynamism meant this productivity-boosting churning process had been slowing. Pandemic-related business- and job-preservation polices, while having many benefits, compounded this concern given their potential to further impede dynamism and the productivity growth it produces.

As we emerge from the pandemic, however, there are encouraging signs. The shorter-run concern does not seem to have bitten. Pandemic policies did not cause the gears of dynamism to gum up. There are no indications that we are near a zombie firm apocalypse. Better yet and tied more to the long-run, the decades-long decline in churn appears to have stopped or even turned around. Multiple metrics of churn have increased from their pre-pandemic values. This is certainly true in the U.S., and where data is available, one sees similar changes in other OECD countries.

Figure 6 shows pre- and post-pandemic values for some U.S dynamism metrics. Gross labor flows — hires plus separations as a share of employment — are about 10 percent higher than their 2015-19 average. If we look within separations, the ratio of quits to layoffs is at historic highs. I know folks look at quit and layoff rates as indicators for many phenomena, but I view their ratio as an indicator about future productivity growth. Quits mean workers are voluntarily leaving their old jobs to move to ones that, via revealed preference, they like better. While revealed preference is about utility, utility is correlated with wages, and wages are correlated with productivity. Labor market churn powered by quit rates that are just coming off historical highs means to me that workers are moving at unprecedented rates into jobs where they are more productive.

Figure 6
A Resurgence of Dynamism?

Metric	2015–19	2022–23
Average hires + separations rate, U.S.	7.4	8.0
Quits per layoff, U.S.	1.8	2.7
Business formations per month, U.S. (thousands)	270	430
"High propensity" business formations per month, U.S. (thousands)	100	140

This notion is supported by some work coauthors and I have done looking at Chilean data linking workers to companies. We find that workers do in fact on average move to firms that are more productive. That "on average" proviso hides a lot of variation; in fact, only 53% of worker moves are to higher-productivity employees. But this is enough to grow economy-wide productivity by a large amount. Even a modest increase from 53% to 55% or 56% would have huge effects on productivity growth.

Of all the signs of increasing churn, however, perhaps most exciting is the fact that business formation rates have risen. In the U.S., at least, they have risen a lot. They have averaged about 430,000 a month since 2022, up from 270,000 over 2015-19. These are not just people starting eponymous consulting companies in their spare bedrooms. The pattern holds even if we focus on only "high-propensity" business starts: those having attributes known to be predictive of future growth. Monthly values of these are up 40% relative to pre-Covid averages.

Somewhat beyond, but perhaps also related to, these hopeful signs about renewed dynamism is another potential marker of future productivity growth, the productivity J-curve. This is a measurement phenomenon Erik Brynjolfsson, Daniel Rock, and I exposited in recent work.

The story of the productivity J-curve starts with the notion that harnessing the full benefits of a new general-purpose technology requires a large amount of investments in complementary capital. Often, this capital is intangible. Think of AI as a candidate general purpose technology. To exploit AI, companies have rewrite software, retrain employees, create new procedures, and even reconfigure their

organizational structures, just to name a few things. All these intangible-building activities take resources.

While in concept these expenditures reflect new capital creation, an output, both company and national accounts treat them as expenses rather than investments. This missing output causes measured productivity to understate true productivity. In short, the data make it look like producers are spending a lot of resources doing AI-related things but are getting little for it.

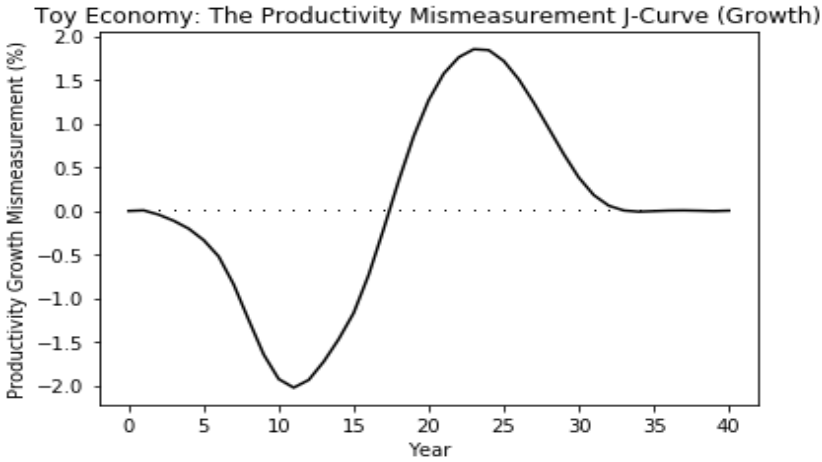
That is the initial part of the J-curve story. Later, when that newly built intangible capital is in place and yielding output, the productivity mismeasurement goes the other way: we observe the output but we under count the inputs used to make it. As a result, measured productivity overstates true productivity.

Therefore the productivity J-curve is a story of productivity mismeasurement across time. Productivity is understated during the emergence of a general-purpose technology, and it is overstated later. Figure 7 shows a stylized view of J-curve mismeasurement in a model economy.

While the figure is stylized, we chose the parameters of the model to be somewhat realistic. To that point, note time horizon on the horizontal axis. The mismeasurements — both initial productivity understatements and later productivity overstatements — last a decade or more. We dug into this further and did some calculations for the J-curves tied to more mature general purpose technologies, like computer hardware and software. There too, we found mismeasurement periods that lasted decades. Therefore a technology can be present, well known to users and consumers, diffusing quickly and becoming ubiquitous, yet productivity metrics can still be understating true output.

If AI fits the bill as the next general purpose technology, and I think the developments of the past year or two have only indicated this is more likely than ever, measured productivity growth might start to understate true productivity growth. In fact, some back of the envelope calculations indicate we may just now be getting to the point where AI-related intangible investments are large enough to miss a

Figure 7
The Productivity J-Curve, Stylized



few tenths of a percentage point of aggregate productivity growth. Time will tell, of course, but I believe this is something worth keeping an eye on for now.

That upbeat note closes out my fourth and final point. Thank you very much for your attention.

General Discussion: Structural Constraints on Growth

Chair: Betsy Stevenson

Betsey Stevenson: Great. So we have about 20 minutes for discussion. Let's stay focused on these three terrific presentations and open it up for general discussion.

Peter Henry: Thank you to the presenters for a great set of discussions. I wanted to offer just a perspective on something really important that Chad Syverson said and just give us slightly different picture of where a big growth opportunity is. Chad, you talked about the correction of misallocation of talent being responsible for 40% of GD per worker growth in the United States. And I think it's really important to realize that correcting another form of what I would call misallocation is actually the key to unlocking another potential tailwind to growth that we didn't actually mention, which is Africa. So 1.2 billion people in the case of sub-Saharan Africa, population growth that is in excess of 2% per year. What's the misallocation?

Well, to understand it, I think you have to go back to your point about non-rivalry, right? So let's take two ideas, the wheel and electricity, both those as ideas are non-rival, but without roads and without grids, there's no way for a very large fraction of the population in sub-Saharan Africa to actually use the idea of the wheel or electricity to come up with new innovations, let alone just drive output through sort of the traditional Cobb-Douglas production kinds of methods.

And in the absence of this ability to put ideas to productive use, growth is slower than otherwise could be. And so really the misallocation there, what is the misallocation? It's misallocation of infrastructure capital around the world, right? Or public capital right? Now, this isn't true everywhere. There are places in sub-Saharan Africa because of economic policies where infrastructure capital cannot be put to good use. And so the key question is where is this true and where isn't it true? And so here I'll just offer a little advertisement. So Camille Gardner, PhD student at Brown University, and I have a paper that's coming out in the Journal of Economic Literature in December that actually offers what we call a dual hurdle framework, which looks at when in the world or where in the world is it the case and how do we diagnose where the rate of return on essentially additional infrastructure and investment in infrastructure can actually unleash the kind of growth and positive externalities that you're talking about.

Pierre-Olivier Gourinchas: I want to follow up on what Peter Henry just said and also bring a question to Chad. Among the tailwinds you mentioned, Chad, were China and India and unlocking growth in these two parts of the world. And Peter just talked about Africa. But at the same time, when we look at the numbers of the fund, we're concerned that the medium-term growth numbers, say five years out, seem to be declining and have been doing so for a while. They were above 4%, around 1999, 2000. And we're looking now at numbers that are closer to 3% for the global economy. And some of that slowdown is particularly large in emerging market economies and low-income countries compared to advanced ones.

And of course, when you think about generating new ideas, I think you mentioned the fact that it's a world frontier. We want all the resources to be integrated, we want everyone to be pulling in the same direction and we're concerned that we're seeing forces going in the other direction. We're seeing forces that are pushing towards fragmentation, whether we're looking at trade, whether we're looking at capital flows, whether we're looking at technological decoupling, and all of these things would go really in the direction of slowing

down things further, even with the grim outlook that you already put in front of us.

And so I wonder if you have some views on that particular dimension, whether that would create another misallocation going forward where you'd have different blocks and different growth trajectories, but certainly not optimal from a global point of view.

Alan Blinder: Thank you for those three great presentations. I have one very simple, I think, question for each of the Chads, if you'll pardon the plural. For Chad Jones, the notion that you can reliably, or you could have historically reliably, just have forecast 2% per capita growth seems to run in the face of what almost all of us economists say when people ask us about medium run productivity growth, which is that we've never been any good at predicting it. I'm just wondering how we reconcile those two things.

And for Chad Syverson, I'm wondering, as I look at the J curve for innovation, it reminds me of things like the computer paradox and things like that. Couldn't a lot of what's going on here be learning how to use this new stuff, which in the very near-term sort of gets in the way and messes things up. But then you learn how to use it, and it's better technology than you ever had.

Karen Dynan: Thanks for those great presentations. On the promise of AI for raising productivity growth, I think it's important to distinguish it between its promise for increasing productivity by what you were talking about, Chad, which was generating more ideas and its promise for increasing productivity by basically substituting for what people do. I was just in a conversation with people yesterday about how we need fewer research assistants now because ChatGPT is coding for us.

And I guess what worries me about some of these very bullish estimates we're seeing coming out about AI increasing productivity growth is that I don't see how we would get, say, 4% productivity growth every year without substantial displacement. And so then you're in a world where you get great outcomes in terms of output per worker, but not necessarily that much more GDP per person if

you don't end up with some wave of new jobs that gets all those displaced people back into the labor force.

And furthermore, you might end up with social dysfunction that leads to political economy outcomes that actually hurt productivity in other ways. So this is all a long way of saying that I feel like the conversation around AI and productivity growth needs to also be thinking about the implications for what happens to the amount of labor.

Yoon-Je Cho: I found the three presentations extremely fascinating. I have one question to Charles Jones. I found your paper very interesting. In your handout, the page nine, the misallocation factors. In the second point, you have white men's proportion in U.S. business, but to me it's not just in the business or the allocation problems, but it may be due to the composition of U.S. population changes. Over the last five decades, in the proportion in the U.S. population, I think the non-Hispanics white man has decreased fast. So it's not just misallocation or better allocation problems, but may be due to the immigration policies plus the different fertility rates of different groups of people in the U.S. population. So I wonder whether this could be a forecast for the future growth due to allocation problems of talents or the forecast reflecting the changes, rapid changes in the composition of population for the future growth. What is your view on this?

Betsey Stevenson: So given the time and that there are three panelists to respond, what I'm going to do is just keep taking a few more questions and then let them wrap up.

Jan Eberly: There have been a few industries that have been remarkably resistant to productivity improvements, and Chad Syverson pointed out one of them as construction. It takes me back to John Haltiwanger's charts this morning, showing the business entry data or the new business applications and tying that to business dynamism and then hopefully the third step to productivity growth. One of the highest sectors in terms of business applications is construction. Yet you don't seem very optimistic there, but maybe you changed your mind. And the other one is food and accommodation, which again is a sector that's been very resistant to productivity growth. Do you

have more optimism about service sector productivity going forward, which would be a welcome development, but we haven't typically seen in the past?

Barry Eichengreen: I wanted to push back against Chad Jones's vague sense of pessimism about the future. The stool rests on three legs, all of which I kind of object to, the first one being ideas are proportional to population. If you go back in history when ideas were not so mobile internationally, they don't all come from the more populous countries. Number two that we have been witnessing a secular decline in research productivity that is likely to persist. Research productivity depends on research organization and it's repeatedly changed with the rise of the industrial research lab, the rise of the national laboratory and the rise of whatever comes next so extrapolating that trend is risky. And the third leg of the stool is that there is this iron law that per capita GDP grows by 2% a year. And I would observe that that figure would look very different if you did it for the world economy.

Yuriy Gorodnichenko: I have a question for the panel. On balance, what is your best guess about the growth rate of potential output, Y* over the next five, ten years?

John Haltiwanger: So I'll try to be quick. I want to push Chad a little bit on thoughts about the productivity slowdown that he pointed out and whether his explanation, whether there's something else going on and it influences some of the statistics you provided.

Lots of us have been trying to figure out this productivity slow down and one of the things we've been pushing on is the decline in business dynamism as Chad talked about, but kind of the flip side of that. And part of that is the shift particularly in the high-tech sectors towards large mature firms in the post 2000 period. In the 1990s in the surge time, that was a time when it was dominated by younger, smaller businesses and that's changed. And what do we know about these large mature businesses in terms of R&D? It doesn't look like they spend a lot on R&D, but it's not so clear the payoff is so high. It would be interesting to redo your statistics where you actually literally controlled for the changing size distribution to see whether

indeed the apparent slowdown in research productivity is this shift towards large mature high-tech businesses that aren't so good at producing major innovations.

David Romer: Two brief questions. The first is for Chad Jones. I didn't understand why reduced misallocation was a tailwind rather than a headwind. It's been a factor pushing growth above normal misallocation at some point can't become negative. It can at most be zero. At some point that has to stop. Is there evidence that there actually scope for increasing the rate at which we're reducing this allocation.

Second most obviously for Chad Jones as well, but I'd love to hear everyone's views on this, are you underselling the potential of AI to be a fundamental changer? And I think of it in the idea production function. If researchers get replaced, that argument becomes researchers plus research machines, then the growth rate of researchers is no longer the constraint. That seems like a very fundamental change, which is to not to deny the complications first of getting there and second that Karen Dynan raised of the other disruptions caused along the way.

Betsey Stevenson: I want to now give each of the panelists time to respond.

Chad Jones: Okay, thanks very much. Let me start with David Romer's two points. I think those are both great points. Absolutely, the misallocation point is in both categories that I struggled with where to put it in the interest of time, but a decent amount of growth has been due to improvements in the allocation of talent. That's what we found in that paper. And at best we can allocate things perfectly and so that's not going to be a force that's there forever. So growth would slow down.

On the other hand, when you're thinking about the next ten, 15 or 20 years, there are lots more people. We have a student at Stanford, Jean-Felix Brouillette who documents that in 1976, 3% of patents were filed by women and in 2017 it was up to 12%. But there's still a lot of runway there. And so both of those things I think are true.

On the potential for AI to be a game changer, I go both ways on this. It is theoretically possible and it's exactly what you said, but the model that we looked at, we looked at a bunch of different models with Ben and Philippe and one of them had suppose you constantly automate X percent of the remaining things you haven't automated. In that model, where you have to do everything. So it's a Baumol cost disease kind of model. You have to do every, to get a research idea, you have to do 37 things right and you keep automating some of them, well, that generates constant growth rather than exponential growth. On the other hand, if machines can literally do everything, you could get a singularity, you can mathematically get it. So I think the spectrum of uncertainty is really, really great there and certainly Karen Dynan's point about what are the consequences for the labor market. Daron and Simon Johnson's new book emphasizes a lot of that. I think there are a lot of things there.

I'll just mention one other thing that didn't come up but that I've thought about it in other paper, which is if AI is profound enough to raise growth rates to 4% or 10% per year, it's also profound enough to be more dangerous than nuclear weapons. And that's something we should worry about too. I think that the range of uncertainty there is probably tremendous.

Other questions. Peter Henry, yes, the misallocation of talent in Africa I think is another thing one could identify. I think the paths to unlocking that misallocation are less clear and I think your paper on that is great because it gives us maybe one thing to look at.

Another thing that hasn't come up that I would emphasize as well is it may be hard to get your favorite country to change their policies. Political economy stuff is really hard. It's much easier to let people from your favorite country come to the U.S. and work with our great institutions. And I think sort of immigration of talented people seems like one thing that didn't come up yet, but that why are we sending all these talented people away once they graduate from top universities and want to work in great companies here.

Alan Blinder predicting productivity growth – yes, I think it's levels versus growth rates in good decades versus bad decades. You saw the

graph, the graph is kind of there and it's remarkable how successful it is, but if you look decade by decade, it moves around and it's hard to predict. But those things have historically averaged out I think is the answer to that question.

Nela Richardson: I'll just pick up with this theme of productivity and what it means from the labor market with a data lens. I mean if you accept the tenant that growth is based on more workers becoming more productive, then there's some problems.

The first problem from a data perspective is that very few companies actually skill up their workers. In fact, when we looked at workers over the last four years, about 50 million workers, over 90,000 firms, only 4% of them got training. I mean that's pretty low. And there's a huge runway of skill development. The labor shortages we're seeing right now are going to turn into skill shortages.

The second part of this is that the problem with economics is there's another side to the market. And if you look at certain professions, let's take sales. Sales could be a highly productive profession, made even more productive by AI and these kinds of tools to help you perfect your pitch, respond to your consumer base, have great marketing campaigns based on the people who buy your product except your consumer base has gotten smarter. They've learned how to search, they've learned how to price compare. So going into a room as a salesperson means you have to be that much smarter than you did 20 years ago because your consumer has gotten that much smarter.

This is back to your point where you have to run faster to get the same amount of growth and will tech help us run faster? I sometimes think of ChatGPT like a peloton, you can put as many as you want in a home office. It doesn't mean people are going to use it. And so that whole idea of adoption of technology to make the worker better is an open question.

And then this is kind of outside of my remarks, but more in terms of experience because this idea that large companies are slowing down the productivity gain because you're just too bureaucratic. There's been big headlines about this in tech, but that presumes that large companies aren't smart enough to change their business model and

how they do R&D. And I think one place of transformation you'll see is that venture capital will flow from large companies to smaller innovative companies. Look, you offload that risk of development of research to a much smaller enterprise. You wait until that enterprise has proved the business case and then you consider a merger or an acquisition or a talent merger or some sort of partnership. So I think that we haven't seen that as much, but I think it's coming and that might help with some of the productivity slowdowns that we've seen for larger companies.

Betsey Stevenson: Great. Chad, you have the remaining time.

Chad Syverson: Okay. Jan Eberly, you asked that specific question about business formation rates and sectors that haven't been super performers in the productivity space. For aforementioned reasons, I'm not that optimistic about the construction entry. Even if they have new business models, you still have the political economy that surrounds the sector. I don't know how they're going to fix that. That's our job, I think. The restaurant sector, actually I am optimistic about, and I'm going to give away Austan Goolsbee's and my next project. Productivity — real sales per employee or per employee hour — in food services went nowhere for 30 years. 1990 to 2021. After that they went up 15% and they've stayed there. We're trying to figure out why. New business models seems to be part of it and it could be tied to entry.

For the stuff tied both to Karen Dynan's and Alan Blinder's questions about AI, general purpose technologies, is this about learning, these long lags? Yes. I love the Paul David story of general purpose technologies really come in two waves, one is you get the replacement of the old technology. That's a productivity boost. But the bigger one often is that you can now do things completely differently that you couldn't do with the old technology. And it takes a while to learn about that. I view the sort of intangible investment that creates the J curve as a specific story about how that learning occurs. So I think that's going on.

And finally, Yuriy Gorodnichenko, you asked for a number. I'm going to embarrass myself and give a number. I'm going to give a

range. It's going to be really imprecise. I would be disappointed if AI doesn't raise annual labor productivity growth by at least half a percent. I would be thrilled if it's more than one and a half percent. I think it's probably going to be somewhere in the middle. But hey, it could be as high as, I don't know, not nuclear Armageddon high, but I would like it to be high. All right, thanks.

Betsey Stevenson: Great, thank you. Thanks to everyone for the very rich and interesting discussion.

Luncheon Address: Policymaking in an Age of Shifts and Breaks

Christine Lagarde

Over the past three years, people around the world have experienced an unprecedented series of shocks, albeit to varying degrees.

We have faced the pandemic, resulting in a partial shutdown of the global economy. We are confronting a war in Europe and a new geopolitical landscape, leading to profound changes in energy markets and trade patterns. And climate change is accelerating, compelling us to do all we can to decarbonise the economy.

One visible impact of these shifts has been the return of high inflation globally, which has caused anguish for many people. Central banks have responded by tightening monetary policy and, while progress is being made, the fight against inflation is not yet won.

But these shifts could also have profound longer-term implications. There are plausible scenarios where we could see a fundamental change in the nature of global economic interactions. In other words, we maybe entering an age of shifts in economic relationships and breaks in established regularities. For policymakers with a stability mandate, this poses a significant challenge.

We rely on past regularities to understand the distribution of shocks we are likely to face, how they will transmit through the economy,

and how policies can best respond to them. But if we are in a new age,past regularities may no longer be a good guide for how the economy works.

So, how can we continue to ensure stability?

The challenge we face was well-captured by the philosopher Søren Kierkegaard, who said that "life can only be understood backwards; but it must be lived forwards".

Since our policies operate with lags, we cannot wait for the parameters of this new environment to become entirely clear before we act. We have to form a view of the future and act in a forward-looking way. But we will only ever truly understand the effects of our decisions after the fact. So we will have to establish new frameworks geared towards robust policymaking under uncertainty.

Today, I will lay out the three main shifts characterising the current environment and how they could change the type of shocks we face and their transmission through the economy. I will then touch on the three key elements of robust policymaking in this setting: *clarity, flexibility* and *humility.*

Shifts in the Global Economy

Since the pandemic, the European and global economies have undergone three shifts which are changing global markets — and which are playing out over different time horizons.

First, we are seeing profound changes in the labour market and the nature of work.

Labour markets are historically tight across advanced economies — and not only due to strong labour demand after the pandemic. In some economies, workers who left the labour force have not fully returned, be it due to sickness or changing preferences.[1] In others, like the euro area, employment is at record highs, but people are working fewer hours on average.[2]

The pandemic has also accelerated digitalisation,[3] which is likely to affect both the supply of workers and the composition of jobs. Remote working has increased,[4] potentially making labour supply more

elastic. And this is now dovetailing with the generative AI revolution, which — like all technological revolutions — is likely to both destroy some jobs and create new ones.

According to one estimate, more than a quarter of jobs in advanced economies rely on skills that could easily be automated.[5] But ECB research also finds that employment shares in occupations more exposed to AI have risen in most European countries over the past decade, refuting the idea that the AI revolution will necessarily lead to a decline in employment.[6]

Second, we are undergoing an energy transition, which in tandem with accelerating climate change is triggering profound transformations in global energy markets.

Although Europe has experienced the largest shock, the global energy mix is also in flux as suppliers that previously balanced the market retreat from it. For some years now, the U.S. shale oil sector has been moving towards a slower growth strategy and investing less in production capacity. And OPEC+ members have been consistently missing their production targets.

At the same time, the push towards renewables is gaining momentum everywhere, driven by fresh concerns about energy security as well as the imperative of climate action.[7] The EU is now aiming for more than 40% of energy generation to come from renewables by 2030, while the United States is on track for the majority of its electricity to be solar and wind-generated by 2050.[8]

Third, we are facing a deepening geopolitical divide and a global economy that is fragmenting into competing blocs. This is being accompanied by rising levels of protectionism as countries reconfigure their supply chains to align with new strategic goals.

Over the past decade, the number of trade restrictions in place has increased tenfold,[9] while industrial policies aimed at reshoring and friend-shoring strategic industries are now multiplying. And while this has not yet led to de-globalisation, evidence of changing trade patterns is mounting.[10] The fragility of global supply chains highlighted by the pandemic has also accelerated this process.[11]

These shifts — especially those related to the post-pandemic environment and energy — have contributed to the steep rise in inflation over the last two years. They have restricted aggregate supply while also directing demand towards sectors with capacity constraints.[12] And these mismatches arose, at least initially, against the backdrop of highly expansionary macroeconomic policies to offset the effects of the pandemic, requiring a rapid policy adjustment by central banks.

Whether all these various shifts will prove to be permanent is not clear at this stage. But it is already evident that, in many cases, their effects have been more persistent than we initially expected. And this raises two important questions about the nature of key economic relationships.

Two Questions About Key Economic Relationships

The first question is whether the shocks driving economic fluctuations will change.

In the pre-pandemic world, we typically thought of the economy as advancing along a steadily expanding path of potential output, with fluctuations mainly being driven by swings in private demand. But this may no longer be an appropriate model.

For a start, we are likely to experience more shocks emanating from the supply side itself.[13]

We are already witnessing the effects of accelerating climate change, and this will likely translate into more frequent supply shocks in the future. More than 70% of companies in the euro area have been estimated to be dependent on at least one ecosystem service.[14] The shift in the global energy mix is also likely to increase the size and frequency of energy supply shocks, with oil and gas becoming less elastic[15] while renewables still face intermittency and storage challenges.

Reshoring and friend-shoring also imply new supply constraints, especially if trade fragmentation accelerates before the domestic supply base has been rebuilt. ECB research finds that, in a scenario where world trade fragments along geopolitical lines, real imports could decline by up to 30% globally and could not be fully compensated by greater trade within blocs.[16]

At the same time, our higher exposure to these shocks can trigger policy responses which also move the economy. Most importantly, we are likely to see a phase of front loaded investment that is largely insensitive to the business cycle — both because the investment needs we face are pressing, and because the public sector will be central in bringing them about.

For example, the energy transition will require massive investment in a relatively short time horizon — around €600 billion on average per year in the EU until 2030.[17] Global investment in digital transformation is expected to more than double by 2026.[18] And the new international landscape will require a significant increase in defence spending, too: in the EU, around €60 billion will be required annually to meet the NATO military expenditure target of 2% of GDP.[19] Even if carbon-intensive capital is written off more rapidly,[20] all this should lead to higher net investment.

Such a phase of higher structural investment needs will make the economic outlook harder to read. In the euro area, for instance, investment rose in the first quarter of this year amid stagnant output, in part because of pre-planned investment spending under the Next Generation EU programme.

The second question concerns how these shocks transmit through the economy.

The new environment sets the stage for larger relative price shocks than we saw before the pandemic. If we face both higher investment needs and greater supply constraints, we are likely to see stronger price pressures in markets like commodities — especially for the metals and minerals that are crucial for green technologies.[21] And relative prices will also need to adjust to ensure that resources are reallocated towards growing sectors and away from shrinking ones.[22]

Large-scale reallocations can also lead to rising prices in growing sectors that cannot be fully offset by falling prices in shrinking ones, owing to downwardly sticky nominal wages.[23] So the task of central banks will be to keep inflation expectations firmly anchored at our target while these relative price changes play out.

And this challenge could become more complex in the future because of two changes in price- and wage-setting behaviour that we have been seeing since the pandemic.

First, faced with major demand-supply imbalances, firms have adjusted their pricing strategies. In the recent decades of low inflation, firms that faced relative price increases often feared to raise prices and lose market share.[24] But this changed during the pandemic as firms faced large, common shocks, which acted as an implicit coordination mechanism vis-à-vis their competitors.

Under such conditions, we saw that firms are not only more likely to adjust prices, but also to do so substantially.[25] That is an important reason why, in some sectors, the frequency of price changes has almost doubled in the euro area in the last two years compared with the period before 2022.[26]

The second change has been the tight labour market, which has put workers in a stronger position to recoup real wage losses. Previously, even when shocks did feed through to prices, the risk of second-round effects was contained as we were mostly operating with persistent labour market slack.[27] But as we are seeing today, when workers have greater bargaining power, a surge in inflation can trigger "catch up" wage growth which can lead to a more persistent inflation process.[28]

We certainly cannot exclude that both these developments are temporary. In fact, we are already seeing some evidence in the euro area that firms are changing prices less frequently, although in an environment with falling energy and input prices.[29] And it is possible that the tightness in the labour market will unwind as the economy slows, supply-demand mismatches created by the pandemic fade and, over time, digitalisation leads to higher labour supply, including by reducing entry barriers.[30]

But we also need to be open to the possibility that some of these changes could be longer-lasting. If global supply does become less elastic, including in the labour market,[31] and global competition is reduced, we should expect prices to take on a greater role in adjustment. And if we also face shocks that are larger and more common —

like energy[32] and geopolitical shocks — we could see firms passing on cost increases more consistently.

In that setting, we will have to be extremely attentive that greater volatility in relative prices does not creep into medium-term inflation through wages repeatedly "chasing" prices. That could make inflation more persistent if expected wage increases are then incorporated into the pricing decisions of firms, giving rise to what I have called "tit-for-tat" inflation.[33]

Robust Policymaking in an Age of Shifts and Breaks

So, in this age of shifts and breaks, where we do not yet know whether we are returning to the old world or entering a new one, how can we ensure policymaking remains robust?

To my mind there are three key elements: *clarity, flexibility* and *humility*.

First, we need to provide *clarity* on our objective, and on unwavering commitment to deliver on it.

Clarity will be important to establish the proper role of monetary policy in the ongoing transitions. We must be clear that price stability is a fundamental pillar of an investment-friendly environment. Faced with a changing world, monetary policy should not itself become a source of uncertainty.

This will be crucial to keep inflation expectations firmly anchored even when there are temporary deviations from our target, as may be the case in a more shock-prone economy. And it will also be key to maintaining public confidence that, even in a new environment, we will not lose sight of our target. We must and we will keep inflation at 2% over the medium term.

But in order to achieve our goals, we need *flexibility* in our analysis.

We cannot make policy based on simple rules or intermediate targets in an uncertain economy.[34] And this means that we cannot exclusively rely on models that are estimated with old data, attempting to fine-tune policy around point forecasts. At the same time, we must also avoid the other pitfall of focusing too much on current data and

"driving in the rear-view mirror", since this is likely to make monetary policy a reactive force rather than a stabilising one.

We will instead have to construct policy frameworks that capture the complexity we face and provide a hedge against it — something central banks are already starting to do. In the ECB's case, we have made our future decisions contingent on three criteria: the inflation outlook, the dynamics of underlying inflation and the strength of monetary policy transmission.

These three criteria help mitigate the uncertainty surrounding the medium-term outlook by blending together our staff's inflation projections, the trend that we can extract from underlying inflation, and the effectiveness of our policy measures in countering that trend. Looking ahead, I expect this type of "multi-legged" approach will be needed to calibrate policy effectively. But we will also need to enhance this process by regularly updating our models and forecasting technologies,[35] and with deeper analysis of the variables that act as the best leading indicators.[36]

The third element that is crucial in this new environment is *humility*. While we need to continue striving to sharpen our picture of the medium term, we should also be clear about the limits of what we currently know and what our policy can achieve. If we are to maintain our credibility with the public, we will need to talk about the future in a way that better captures the uncertainty we face.

The ECB has already been moving in this direction in our forecasting process, but there is still a way to go. We have published sensitivity analyses of key variables like energy prices and wages, and we used scenario analysis during the pandemic and after the start of the war in Ukraine. We are also aiming to be more transparent in accounting for our forecast errors.

Research suggests that households trust central bank forecasts less if their recent performance has been poor,[37] but we can mitigate this problem if we talk about forecasts in a more contingent way and provide better explanations for errors. For this reason, ECB staff have started publishing the main factors behind our inflation forecast errors and we intend to continue doing so.[38]

Conclusion

Let me conclude.

There is no pre-existing playbook for the situation we are facing today — and so our task is to draw up a new one.

Policymaking in an age of shifts and breaks requires an open mind and a willingness to adjust our analytical frameworks in real-time to new developments. At the same time, in this era of uncertainty, it is even more important that central banks provide a nominal anchor for the economy and ensure price stability in line with their respective mandates.

In the current environment, this means — for the ECB — setting interest rates at sufficiently restrictive levels for as long as necessary to achieve a timely return of inflation to our 2% medium-term target.

And moving forward, we must remain clear in our objectives, flexible in our analysis and humble in how we communicate. As John Maynard Keynes once said, "the difficulty lies, not in the new ideas, but in escaping from the old ones".

Endnotes

[1]This effect is more visible in the United States than in the euro area. See Botelho, V. and Weißler, M. (2022), "COVID-19 and retirement decisions of older workers in the euro area", *Economic Bulletin*, Issue 6, ECB; Faria e Castro, M. and Jordan-Wood, S. (2023), "Excess Retirements Continue despite Ebbing COVID-19 Pandemic", *On The Economy Blog*, Federal Reserve Bank of St. Louis, 22 June.

[2]Arce, O., Consolo, A., Dias da Silva, A. and Mohr, M. (2023), "More jobs but fewer working hours", *The ECB Blog*, 7 June.

[3]Jaumotte, F. et al. (2023), "Digitalization During the COVID-19 Crisis: Implications for Productivity and Labor Markets in Advanced Economies", Staff Discussion Notes, No 2023/003, IMF, 13 March. The implications of digitalisation for the labour market and other aspects of the economy are also discussed in Dedola, L. et al. (2023), "Digitalisation and the economy", *Working Paper Series,* No 2809, ECB, April.

[4]See Dias da Silva, A. et al. (2023), "How people want to work — preferences for remote work after the pandemic", *Economic Bulletin,* Issue 1, ECB.

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[6]Albanesi, S. et al. (2023), "New technologies and jobs in Europe", *Working Paper Series,* No 2831, ECB, July.

[7]See also Breckenfelder, J. et al. (2023), "The climate and the economy", Working Paper Series, No. 2793, ECB, March.

[8]U.S. Energy Information Administration (2023), "Annual Energy Outlook 2023", 16 March.

[9]Comparison between 2012 and 2022. Specifically, trade restrictions across goods, investment, and services. The data cited relate to exports only. See Georgieva, K. (2023), "Confronting Fragmentation Where It Matters Most: Trade, Debt, and Climate Action", *IMF Blog*, 16 January.

[10]Alfaro, L. and Chor, D. (2023), "Global Supply Chains: The Looming 'Great Reallocation'", paper presented at the 2023 Jackson Hole Economic Policy Symposium hosted by the Federal Reserve Bank of Kansas City, August.

[11]Lebastard, L., Matani, M. and Serafini, R., "GVC exporter performance during the COVID-19 pandemic: the role of supply bottlenecks", *Working Paper Series*, No 2766, ECB, January 2023.

[12]See Ferrante, F. Graves, S. and Iacoviello, M. (2023), "The inflationary effects of sectoral relocation", *Journal of Monetary Economics*, forthcoming.

[13]This new situation has similarities with the "real business cycle" paradigm which, between the late 1970s and 1980s, posited that economies were constantly buffeted, not by demand disturbances (as in the competing Keynesian and monetarist traditions) but by real productivity shocks hitting economic potential and setting off business cycle fluctuations. See Kydland, F. and Prescott, E. (1982), "Time to Build and Aggregate Fluctuations", *Econometrica*, Vol. 50, No 6, November, pp. 1345-1370.

[14]Examples of ecosystem services include the products that we obtain from ecosystems such as food, drinking water, timber and minerals; protection against natural hazards; or carbon uptake and storage by vegetation. See Elderson, F. (2023), "The economy and banks need nature to survive", *The ECB Blog*, 8 June.

[15]Balke, N., Jin, X. and Yücel, M. (2020), "The Shale Revolution and the Dynamics of the Oil Market", *Working Papers*, No 2021, Federal Reserve Bank of Dallas, June.

[16]Attinasi, M.-G., Boeckelmann, L. and Meunier, B. (2023), "The economic costs of supply chain decoupling", *Working Paper Series*, No 2839, ECB, August.

[17]European Commission (2023), "2023 Strategic Foresight Report", July.

[18]International Data Corporation (2022), "IDC Spending Guide Sees Worldwide Digital Transformation Investments Reaching $3.4 Trillion in 2026", 26 October.

[19]NATO data. This figure excludes the four non-NATO EU countries (Ireland, Cyprus, Austria and Malta).

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General Discussion: Luncheon Address

Heather Boushey: I really enjoyed those remarks. One of the things I just wanted to ask you to spend a couple more sentences on is how you're thinking about some of the modeling challenges, or you and your team. Many of the challenges that you laid out, particularly on the supply side, are things that in particular as we're thinking about the clean energy transition, rely on information that as you point out, we don't have and we don't know exactly. While we know from an engineering standpoint what it looks like to transition from a fossil fuel economy to a clean energy economy, thinking about all of the different frictions and challenges along the way, we don't yet have good models there and I'm wondering how you at the European Central Bank (ECB) are thinking about it. This is something we're thinking about a lot I know over here. Curious to hear if you have any other thoughts on some of the bigger questions for the modeling community in your call to action there.

Christine Lagarde: I knew you'd be asking a question like that and I'm not the best person to address it, because I don't come from that community, and I'll be very happy to hand the floor over to [ECB Chief Economist] Philip Lane who can comment.

But I will say two things. One is we have set up within the Governing Council, which includes 20 governors of the 20 member states of

the Euro area, a special subgroup that was tasked with reviewing our models. Because we had to constantly modify our projections and it became quite clear that, first of all, we always ended at 2% because models consistently converge towards our target.

Second, there was something that we had to address and investigate ourselves. So in that group, [National Bank of Belgium Governor] Pierre [Wunsch] was there, obviously Philip was leading the group. Where are you, my colleague from Spain? There you are. [Bank of Spain Governor] Pablo [Hernandez de Cos] was part of that group as well. So you had really top-notch economists who addressed the matter very humbly. They were fed by staff, but they had the ability to criticize, second guess and think it through. So that's number one.

Number two, on the climate change dimension, you are absolutely right. I think we are trying as hard as we can to integrate that dimension. It is not easy. The experts in that field are scarce and few and highly paid, if I may say. We are trying hard.

Julia Coronado: So it's such an interesting time for you to be speaking to us this year because there's such a contrast between some of the data flow in the United States and in Europe. We've had some good news on inflation, better than expected and growth that's sort of outperforming expectations and you've arguably had the opposite of that, right?

Christine Lagarde: I would be happy to challenge that, but go on.

Julia Coronado: Well, I welcome that challenge. And then my question is to the extent there is a difference, how much of that do you attribute to your proximity to the war in Ukraine? And when you're dealing with a situation like a war, as a central banker from this medium-term perspective, how do you fold that in to your horizon or the reaction function and how different is that?

Christine Lagarde: Yes. I will challenge a little bit your first assumption, which is that things are going well in the U.S. economy and things are going very poorly in the European economy.

It was at cross purposes. I would like to pay tribute to my colleague, Chair Powell, for the hard and great work that he's doing.

And I know that he pays tribute to me as well because it is not an easy thing to do at the moment. The political pressures that we can be under are tremendous.

But in terms of inflation, first, if I look at my HICP numbers, which is my headline, to give you a point of reference, in October HICP was at 10.6%. We are down to 5.3%[1]. So granted we started a little bit later, we effectively started by announcing the cutting down of the asset programs and the end of accommodative monetary policy in December of 2021.

But we only started hiking rates in July 2022. There was a time difference with what was happening at the Fed. I wouldn't be very surprised if that same time difference is continuing to differentiate us, but we have divided it by two. Core inflation is at 5.5%. It was much higher. We are going to continue to have quite a lot of base effects which will affect headline, not so much core, but core also incorporates indirectly some of the energy and food prices. I'm pretty confident that come the end of 2023, we will be showing numbers that will look significantly different from what we have at the moment.

There is nothing to be ashamed of with having halved HICP numbers. What matters of course is what we see in 2023, 2024 and 2025. And there of course we stand by the projections that we published back in June.

On growth, first of all, I would like to pay tribute to the U.S. ability to portray good numbers in such a positive and optimistic fashion. No, it's true. It's true. We get good numbers, we focus on PMI, sort of mediocre ones. You get good numbers and you vroom.

The machine is on the good numbers and it matters a lot, for expectations, for public perception. Everybody a year ago would have assumed that Germany would go into a serious recession and that the growth model was dead. I'm happy to give the floor to my colleague, Joachim Nagel, who is head of the Bundesbank, but this hasn't happened. There've been technical recessions two quarters and now it is, number one, not broken. They're fixing it and they're demonstrating a resilience that I would not have expected. The way they've managed to build those LNG facilities in less than six months — we

were talking about bridges at our table, LNG facilities offshore — six months, thank you. That's really a terrific job. We expected all that to be a lot worse. It has turned out to be much more robust, much more resilient and a tribute to the entrepreneurs, the private sector, this very strong fiscal stimulus that was also put to play for the economy and a bit of monetary policy along the way.

Julia Coronado: Similar story of resilience and progress.

Christine Lagarde: Absolutely. And the proximity of the war, two things which are clearly differentiating factors. One is the very strong dependence that we had on Russian gas. That is something that you have not experienced in this country. The resources are plentiful in many ways, investment in those areas to be seen. But we were, for some of the member states in the euro area, more than 30% dependent on Russian gas supply for the energy mix that we had.

And to cut that from 30% to virtually zero now across the board — a couple of exceptions — but it's just a tremendous effort in a matter of 18 months, essentially. Even less so.

That's first point of differentiation. We don't have oil either. So Norway, the United States, and a few other suppliers stepped in and prices went up and we paid the price for that renewed independence vis-a-vis Russia.

The second point is the proximity of Ukraine and the fact that Ukraine joining the European Union[2], Ukraine receiving massive support from this country, bless America, and a long-term support from Europe. We have, I think a $50 billion commitment over the next three years, which gives visibility to Ukraine and which is probably the triggering factor for not only buying weapons and ammunition that we are all trying to rebuild as fast as we can, but also which will start the reconstruction hopefully in not too long a future.

But it's there. It's at the doorstep and the number of Ukrainian refugees which have come to Poland, to Germany, to Ireland, to many countries that you would not have anticipated would take on all these refugees has been tremendous. It is part and parcel of who we are now.

Jacob Frenkel: We have had a decade or more of inflation above target and both you and this morning, the chairman spoke about very clearly that the objective is to come back to the target. The work is still ahead of us and all the rest.

I think this is extremely reassuring because we have heard during the past few years, several attempts to say, "Let's move the goalpost away so we will declare victory and that's it." Namely, let's change the inflation target. We are in a new world now and all the rest. So I think this was extremely difficult, made it difficult to countries that were struggling with inflation, trying to achieve their inflation targets, to hear voices that may be the inflation target is not as important as it once was.

I think I was very reassured by your remarks and I wanted just to underscore it, that this is indeed a very clear message. Let's not follow Senator Aiken from 1966, declare victory and retreat from Vietnam.

Christine Lagarde: No, and I can assure you, Jacob, that from our perspective, we are playing a game. There are rules. You don't change the rules of the game halfway through. I'm not saying we're halfway through, probably a bit more than that. But changing the rules of the game at this point in time would be deceptive, would be totally inconsistent with trying to anchor expectations as we have and providing price stability as we should.

Some academics like to play with those numbers, with all due respect to all of them. I remember the days when Olivier Blanchard, I think it was the year before I joined [the IMF], in 2010, came up with that 4% target.

Peter Henry: You mentioned Olivier Blanchard, who when I was in graduate school, taught us about cold turkey disinflation versus gradualist disinflation. I'm wondering what is your perspective on how rapidly. It's very clear 2% is the target. Chair Powell made it very clear as well, but we've heard less discussion about the speed with which you'll be satisfied at reaching that target. Can you say a bit about how are you're feeling about the speed? You've cut it in half in a year. What's the view there?

Christine Lagarde: Well, our key line of communication is it has to be timely and it has to be sustainable. How do you define timely? It's obviously complicated and complicated by a lot of the factors that I have just mentioned. We operate with a projection horizon of around three years.

That's what we use. It doesn't mean to say that this is necessarily the medium-term perfect definition, but that reference point is obviously important. Sustainable, it's not because we have one measurement that will tell 2%. Either headline, which is the one that we have agreed is our target, or core, which is something that we look at very carefully, underlying inflation rather than core, but it has to be sustainable. So it's a combination of the two.

Clare Lombardelli: I wanted to ask about something completely different, which is if you go back ten years to the time you referenced, to 2013. That was again a very difficult time for the European economy, I'd really love to know what, what when you reflect on that time, was the most important or the strongest lesson that you learned through that episode and that you carry with you now.

Christine Lagarde: Well, disclaimer as a lawyer background, I would start with that. I was not in charge of Europe in any capacity at that time. I was head of the IMF. Yes, we had quite a few European programs, contrary to all expectations, one of which was Greece in particular.

But I looked at the speech I gave ten years ago, and the theme was unconventional monetary policies. That's what we were talking about in those days. Talking from my perspective of then at the time head of the IMF, having been finance minister for France and a member of the European institutions prior to that, I'd say that the fact that our economic and monetary union was not completed and is still not completed, is something that I carry with me and that I try to encourage as much as I can.

That's a big, big elephant in the room. I could tell you lots of other things, but the key thing that could actually significantly change the picture is that.

Endnotes

[1]Later revised to 5.2%.

[2]Note: Ukraine was granted European Union candidate status in June 2022.

Global Production Networks: The Looming "Great Reallocation"

Laura Alfaro and Davin Chor

Abstract

Global supply chains have come under unprecedented stress as a result of U.S.-China trade tensions, the Covid-19 pandemic, and geopolitical shocks. We document shifts in the pattern of U.S. participation in global value chains over the last four decades, in terms of partner countries, products, and modes, with a focus on the last five years (2017-2022). The available data point to a looming "great reallocation" in supply chain activity: Direct U.S. sourcing from China has decreased, with low-wage locations (principally: Vietnam) and nearshoring/friendshoring alternatives (notably: Mexico) gaining in import share. The production line positioning of the U.S.' imports has also become more upstream, which is indicative of some reshoring of production stages. We sound several cautionary notes over the policies that have set this reallocation in motion: It is unclear if these measures will reduce U.S. dependence on supply chains linked to China, and there are moreover already signs that prices of imports from Vietnam and Mexico are on the rise.

1. Introduction

Global supply chains have been in the spotlight over the past several decades among international business and policy circles. In the late 1990s and early 2000s, much attention was drawn to how

cross-border production and supply chain arrangements — often referred to as global value chains (GVCs) — could improve the efficiency of even the most complex manufacturing processes. Spurred by advances in communication technologies and a liberalizing trade policy environment, firms started to reap the benefits of specialization more extensively by performing production stages or procuring inputs across a host of locations, each particularly adept at delivering on their slice of the value chain. This in turn opened up opportunities for growth for those emerging economies who successfully gained roles in GVC-related production (World Bank 2020).

Lately, however, this optimistic view of GVCs has soured considerably. In its place, concerns are being voiced over the wisdom of sprawling supply chains that can expose firms and countries to the risk of disruptions. A confluence of recent events has shown that this risk now presents itself in myriad forms. Extreme weather events (associated with climate change) and natural disasters (such as the Tohoku earthquake) have sent shockwaves through global supply chains by disrupting the flow of critical inputs (Barrot and Sauvagnat 2016; Boehm et al. 2019). Public health shocks have emerged as a novel source of risk, epitomized by the shortages of medical equipment and other critical necessities at the height of the Covid-19 pandemic. There is a renewed awareness too of geopolitical risk. Russia's invasion of Ukraine exposed the vulnerability of European countries' natural gas supplies. Meanwhile, the brewing U.S.-China big-power rivalry has prompted a major policy rethink in the U.S. of its reliance on supply chains linked to China, particularly for goods deemed to be of strategic or national security importance.

This reconsideration of GVCs is fused at a deeper level with the broader backlash against globalization currently seen in many developed countries (Colantone et al. 2022; Goldberg and Reed 2023). The underlying causes of this backlash are complex and vary somewhat from country to country. But an influential line of research has found one common thread, linking this disaffection to the long-standing decline in manufacturing sector jobs in advanced economies that can be attributed (at least in part) to import competition

from China (Autor et al. 2013, 2016; Dauth et al. 2014; Colantone and Stanig 2018).[1] In countries such as the U.S., this has contributed to a strong under-current of reservation among segments of the general public about engaging with China as a trade and supply chain partner (Alfaro et al. 2023).

But sentiment aside, what do the data actually tell us about the state-of-play in global supply chains? In this paper, we take a broad-ranging look at the evolution of patterns of global supply chain activity, with a focus on the particularly eventful last five years (2017-2022). We do so by assembling information from a range of datasets that speak to sourcing within cross-border value chains. We document changes over time in terms of partner countries, products, and modes; more specifically, we keep an eye out for discernible signs of friendshoring, nearshoring, or reshoring in recent years.

Accordingly, the principal source of data we use will be product-level trade statistics (from UN Comtrade), which speak to direct import sourcing patterns over time. We combine this with measures of upstreamness, based on Fally (2011) and Antràs et al. (2012), to characterize the positioning of industries and countries within GVCs. We further supplement our analysis with information from various sources on multinational activity and FDI, on companies' earnings calls, as well as on the state of the U.S. manufacturing sector.

Our goal in working with these data sources is to provide an early assessment of recent shifts in global supply chains. More detailed assessments that use firm-level administrative data or updated World Input-Output Tables to construct more refined measures of GVC trade will surely be conducted as such resources become available. That said, we view it as important to highlight such trends as may already be evident from these more readily accessible sources of data. In what follows, we will largely focus on shifts from the perspective of the U.S., given the U.S.' role as a key nexus from which many GVCs are organized and in which much of the output from GVCs is ultimately absorbed; we will nevertheless draw some brief comparisons to changes seen in other major developed economies (namely, Europe and the UK).

We start by documenting trends in U.S. imports over the past four decades to ground our discussion of supply chain patterns in a longer-run perspective. In terms of locations, the bulk of the U.S.' direct import sourcing has historically been (and continues to be) from other high-income economies. A wave of shifts toward low-wage countries did get underway during the 1990s, with Japan and Canada losing import share in the U.S. to China and Mexico. It is important to note, though, that Japan and Canada have remained closely engaged with the U.S. economy, as FDI — especially from Japan — replaced trade as a mode for accessing the U.S. market.

In terms of product composition, the 1990s were also a period during which the U.S. established itself as an exporter of relatively upstream products (e.g., electronic integrated circuits, machinery and parts, and other material inputs for processing and assembly overseas), while being an importer of final goods (e.g., electronics, textiles). The late 2000s, in turn, saw a significant (albeit often overlooked) shift in the U.S.' trade profile, as its growing energy independence led to a decrease in imports of petroleum and related products.[2]

We then zoom in on developments in the past five years. While this recent period has been marked by intensifying anti-globalization sentiment, we confirm the broad assessment in other studies (e.g., Antràs 2021; Baldwin 2022; Aiyar et al. 2023; Goldberg and Reed 2023) that this has not led yet to an outright retrenchment in global trade as a share of world GDP. In fact, the aggregate value of key trade flows, such as U.S. goods imports, rebounded strongly after the Covid-19 pandemic to all-time highs in 2022.

However, the aggregate level of trade masks substantial shifts that are afoot in the source-country composition of U.S. imports. China's share of U.S. goods imports peaked at 21.6% in 2017 and has since fallen to 16.5% in 2022. Put otherwise, what we are seeing in the data are the early phases of a "great reallocation" in U.S. sourcing away from China. The locations that have (thus far) been the main beneficiaries of this shift comprise other low-wage manufacturing countries, with Vietnam most notably seeing a two-percentage point increase in its share of U.S. imports, as well as friendshoring or near-shoring alternatives, such as Mexico.[3]

We moreover find that this reallocation has been occurring at the product level: Across HS4 products, decreases between 2017-2022 in China's share of U.S. imports are systematically correlated with gains in the import shares held by Vietnam and Mexico (even after accounting for pre-trends in these countries' shares of the U.S. market). Both Vietnam and Mexico picked up import market share in various categories of electrical and electronic equipment. But there have been subtle differences too in the product mix of observed shifts, with Vietnam gaining ground in telephone sets, apparel and textiles, and Mexico increasing its U.S. import share in automobile parts, as well as glass, iron, and steel products.

This reallocation in the trade statistics lines up with evidence from other complementary data sources. Indeed, we find that references to friendshoring, nearshoring, or reshoring have been on the rise in companies' earnings calls since 2018 and that a good share of these discussions pertains to potential moves away from China toward Vietnam or Mexico. At the same time, China has dropped off in prominence as a preferred destination for greenfield FDI originating from the U.S. (as well as from other FDI source countries).

Last but not least, we present preliminary evidence that this reallocation away from China is being accompanied by some reshoring. We find that the upstreamness of U.S. imports rose slightly over the past five years, which suggests that more finishing stages of production in GVCs are now being performed within the U.S. The data up to 2022 also indicate that, for some subsectors, the long-run decline in U.S. manufacturing activity has bottomed out. While this is partly attributable to developments that occurred prior to 2017 (such as the Obama administration's policies to revive the U.S. automobile industry), there are signs too of an uptick in the last two years in establishment and employment counts in specific industries (e.g., semiconductors) that likely reflect recent efforts to promote domestic manufacturing capability in these areas.

What are the causes of this "great reallocation" away from China? And what are its likely consequences? The first question has a relatively straightforward answer: The ongoing shift in production and sourcing patterns is largely the result of intentional government policies, as

noted also by other observers.[4] Starting in 2018, the Trump administration reversed the U.S.' decades-long approach in favor of trade liberalization, by introducing a series of tariffs that eventually covered virtually all of the U.S.' imports from China.[5] While U.S.-based corporations may initially have been hesitant to incur the fixed and sunk costs of reconfiguring their global supply chains, the continued use of these tariffs under the Biden administration has since started to tip many companies out of a "wait-and-see" approach.[6] At the same time, U.S. government officials have been encouraging friendshoring and nearshoring in order to mitigate supply chain risk, particularly risk of a geopolitical nature.[7] The Biden administration's turn toward large-scale industrial policies, as announced in the Inflation Reduction Act (IRA) and the CHIPS and Science Act, has further laid bare its intent to bolster domestic manufacturing with the help of generous subsidies. These policy directions are unlikely to change in the foreseeable future even past the next presidential election in 2024, given what appears to be bipartisan support for policies that support U.S. manufacturing jobs.

With their broad scope and ambition, these policy measures are poised to profoundly reshape production and sourcing decisions in cross-border supply chains that emanate from the U.S. However, we seek to register two cautionary notes. First, the policies which have set this reallocation in motion may ultimately not even achieve their stated goal of reducing the U.S.' dependence on supply chains linked to China. Already, we can see in the trade data that while China's share in U.S. imports has fallen, its share in Europe's imports has risen. China has moreover stepped up its trade and FDI in both Vietnam and Mexico in recent years. This means that the U.S. could well remain indirectly connected to China through its trade and GVC links with these third-party countries.

Second, this ongoing reallocation of global supply chain activity comes attached with costs that need to be monitored and assessed more rigorously. There is now a body of empirical work showing that the U.S. tariffs on Chinese goods have been borne almost entirely by U.S. buyers through higher prices *(Amiti et al. 2019; Fajgelbaum et al. 2020; Cavallo et al. 2021)*. We will further show in this paper that

decreases in product-level import shares from China are associated with rising unit values for imports from Vietnam and Mexico, which likely reflects rising costs of production in these locations. More work is needed to investigate how much this reallocation away from direct imports from China might be contributing to higher U.S. prices and inflation. Likewise, there is a need for more frameworks to be developed to formally assess whether the dynamic gains from reshoring — arising say from agglomeration effects or increased innovation in the U.S. manufacturing sector — can in fact offset the static welfare losses incurred from pursuing this goal.

The rest of the paper is organized as follows. After making several data-related remarks in Section 2, we turn in Section 3 to describe longer-term patterns in U.S. import sourcing. Section 4 then focuses on the last five years (2017-2022), particularly the shifts toward friendshoring and nearshoring to Vietnam and Mexico. Section 5 describes the preliminary signs of reshoring. We conclude with a discussion of implications in Section 6.

2. Data Approach

Before presenting our findings, it is useful to briefly discuss the broader data approach we are taking in this paper to shed light on cross-border supply chain activity. In terms of data sources, our study uses most extensively the rich trade statistics from UN Comtrade. These have the advantage of being up-to-date (with the most recent available year being 2022), while providing a reasonable level of detail on products (which we will exploit at the HS4 digit level).

Readers who are familiar with the recent literature on GVCs will however recognize that these gross trade flows only pick up on patterns of direct sourcing. In an age of cross-border supply chains, goods that are received at U.S. ports in principle embody value added that has been contributed by multiple countries and industries further upstream. Focusing on the gross value of direct imports alone, one is likely to understate the extent of some countries' involvement in GVCs — and hence, the U.S.' dependence on these countries as supply chain partners — particularly for those source countries that are engaged in upstream stages.

To address this concern, researchers have over the past two decades developed accounting methodologies to trace and measure the value that is added at different stages along GVCs (Johnson and Noguera 2012; Koopman et al. 2014; Borin and Mancini 2023).[8] These draw on information contained in World Input-Output Tables — on transactions between country-by-industry pairs (e.g., purchases by the automobile industry in the U.S. from the auto parts industry in Mexico) — in order to infer the country and industry sources from which value added originates. However, the work that goes into assembling such World Input-Output Tables is extensive, and so these tables are only available with a time lag: For example, the latest release of the World Input-Output Database extends up to 2014, while the OECD Inter-Country Input-Output Tables are only available up to 2018. These are ill-suited unfortunately to the more pressing task of studying shifts in global supply chains over the past five years.

Absent the data to implement a full accounting of GVC trade, our approach will thus be to focus on the evolution of direct sourcing patterns as observed from product-level trade flows. To nevertheless shed light on countries' positioning within GVCs, we will combine the trade data with industry measures of upstreamness (Fally 2011; Antràs et al. 2012), in order to illustrate how the global production line positioning of the U.S. — as reflected in the profile of its imports and exports — has been shifting over time.[9] We will supplement the above with additional sources of information: (i) on multinational affiliate sales (from the U.S. Bureau of Economic Analysis) and on greenfield FDI (from fDi Markets), that shed light on GVCs that operate through multinational corporations; (ii) from company earnings conference calls (from NL Analytics), that facilitate a topical analysis of firms' priorities; and (iii) on the recent state of the U.S. manufacturing sector (from the Bureau of Labor Statistics), to speak to the issue of reshoring.

3. The U.S. in Global Value Chains: Background

In this section, we provide an overview of the rise of trade in GVCs over the last four decades. As the U.S.' participation in global supply

chains expanded, this period was one marked by shifts in sourcing locations, products, and modes. This discussion will form the backdrop against which to compare the more recent changes of the past five years.

3.1 Trade Flows: Trends

World trade grew steadily and in a virtually uninterrupted manner in the four decades leading up to the Global Financial Crisis. In the early nineties, the ratio of trade in goods and services to GDP stood at 38% for the World, 20% in the U.S., and 22% in China. By 2006, China's trade-to-GDP ratio had exploded to close to 65%, while that for the World and the U.S. had grown to 60% and 27% respectively.[10]

The reasons for this boom in international trade are well-documented. Favorable political developments — including the end of the Cold War, political and economic reforms in Latin America and Asia, and China's opening up to the world — brought more countries into the fold of the world trade system. This was further facilitated by policy moves that progressively lowered tariff and non-tariff barriers to trade, such as the establishment of regional trade agreements (e.g., the EU, NAFTA) and the expansion of the World Trade Organization (culminating in China's accession in 2001). Notably too, the fragmentation of production processes and supply chains across country borders generated an increase in trade in intermediate inputs, which by some estimates now constitutes as much as two-thirds of gross world trade flows (Johnson and Noguera 2012).

This growth in international trade, however, slowed down in the aftermath of the Global Financial Crisis of 2008-2009. By 2020, China's trade-to-GDP ratio had decreased to 35%, while that for the U.S. had slipped to 23%, prompting the observation that the world had perhaps reached "peak globalization" (Baldwin 2022).[11] With the benefit of hindsight, there appears to be a consensus now that the prior rate of increase in the trade-to-GDP ratio was unsustainable, and so some slowdown was inevitable (Antràs 2021; Baldwin 2022; Goldberg and Reed 2023). It would nevertheless be premature to interpret this slowdown as an outright "deglobalization" or the

"end of an age". While the past five years have been marked by various shocks — such as the U.S.-China tariff war and the Covid-19 pandemic — which dealt momentary setbacks to trade flows, global trade has held steady at just under 60% of world GDP rather than gone into freefall (see Appendix Figure 1).[12]

Turning to the U.S., its engagement in international trade over time mirrors this broad pattern of growth up till the mid-2000s, followed by a slowdown. Between 1994-2005, the U.S. saw the growth rates in the value of its goods exports and imports reach 5.3% and 8.8% per annum respectively.[13] This was followed by a distinct dropoff in the pace of growth between 2006-2022, to 4.5% for exports and 3.6% for imports (Table 1, Panel A). This slowdown was even more pronounced after accounting for price effects: In chained real dollar terms, U.S. exports and imports grew respectively at 2.6% and 2.2% per annum in this latter period (Table 1, Panel B).

Two further points are worth highlighting about these U.S. trade patterns. First, the overall growth rates mask a substantial shift in composition in U.S. trade, as the U.S. evolved from being a net importer of oil and gas products to being a net exporter. In 1994, petroleum products represented close to 4% of U.S. exports and 23% of imports; by 2022, the export share stood at 10%, while the import share had fallen to a mere 6%. In line with this shift, the annual growth rate in the U.S.' real petroleum imports turned negative (-3.0%) in 2006-2022, compared to a growth rate of 3.5% in 1994-2005. On the other hand, the U.S.' real imports of non-petroleum products recorded steady growth of 3.0% between 2006-2022 (Table 1, Panel B).

Second, it is useful (for the sake of completeness) to point out that there has been a similar slowdown in the U.S.' trade in services: between 2006-2022, the growth rate in the real value of U.S. service exports and imports moderated to 2.5% and 2.1% per annum respectively (Table 1, Panel B). That said, note that the U.S. maintained a surplus in services trade throughout this period. The rest of our analysis below will focus on goods trade, which has dominated the debate on the future of global supply chains.

Table 1
U.S. Trade, Growth Rates (1994-2022)

	1994-2022	1994-2005	2006-2022	2017-2022
	Panel A: Nominal USD Growth Rates			
Goods				
Exports	5.1%	5.3%	4.5%	5.9%
Imports	5.8%	8.8%	3.6%	6.7%
Services				
Exports	5.6%	6.0%	5.0%	2.1%
Imports	6.1%	8.1%	4.4%	4.7%
	Panel B: Chained 2017 Dollars Growth Rates			
Good Exports	3.8%	5.1%	2.6%	1.5%
Non-petroleum	3.5%	5.2%	1.9%	0.9%
Petroleum	7.1%	0.7%	11.5%	5.2%
Good Imports	4.7%	8.5%	2.2%	3.6%
Non-petroleum	5.4%	8.9%	3.0%	4.2%
Petroleum	-0.4%	3.5%	-3.0%	-3.6%
Services				
Exports	3.4%	4.3%	2.5%	-1.6%
Imports	3.8%	5.9%	2.1%	0.9%

Source: Trade data (Census Basis) from the U.S. Census Bureau; downloaded in June 2023. Real services data from the Federal Reserve Bank of St. Louis, FRED.

3.2 Trade Partners

Underlying these aggregate trends, Table 2 displays the evolution of the trade shares of the U.S.' main trade partners from 1994-2022. Several points, generally recognized, deserve emphasis.

The U.S. has over the years conducted most of its trade with high-income countries. In 1994, its primary trade partners were Canada, the European Union (cum UK), and Japan. Around 22% of U.S. exports in that year went to Canada, from which the U.S. received 19% of its imports. The EU cum UK accounted for a similar share of U.S. exports (22%) and imports (18%). Japan's share was slightly smaller, receiving about 10% of U.S. exports while being the source of about 18% of the U.S.' imports. Among the U.S.' other significant trading

Table 2
U.S. Trade, Partner Country Shares (1994-2022)

	1994	2000	2005	2010	2015	2017	2018	2019	2020	2021	2022
Exports of Goods, bn USD	**513**	**782**	**901**	**1,278**	**1,503**	**1,547**	**1,666**	**1,646**	**1,430**	**1,758**	**2,065**
as % exports											
European Union & UK	**22%**	**22%**	**21%**	**19%**	**18%**	**18%**	**19%**	**20%**	**20%**	**19%**	**21%**
France	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Germany	4%	4%	4%	4%	3%	3%	3%	4%	4%	4%	4%
UK	5%	5%	4%	4%	4%	4%	4%	4%	4%	4%	4%
NAFTA	**32%**	**37%**	**37%**	**32%**	**34%**	**34%**	**34%**	**33%**	**33%**	**33%**	**33%**
Canada	**22%**	**23%**	**24%**	**19%**	**19%**	**18%**	**18%**	**18%**	**18%**	**18%**	**17%**
Mexico	**10%**	**14%**	**13%**	**13%**	**16%**	**16%**	**16%**	**16%**	**15%**	**16%**	**16%**
Rest of Western Hem.	7%	6%	6%	9%	8%	8%	8%	8%	8%	8%	9%
Brazil	2%	2%	2%	3%	2%	2%	2%	3%	2%	3%	3%
Asia and Pacific	**30%**	**27%**	**26%**	**28%**	**27%**	**29%**	**28%**	**27%**	**30%**	**30%**	**28%**
China	**2%**	**2%**	**5%**	**7%**	**8%**	**8%**	**7%**	**6%**	**9%**	**9%**	**7%**
Japan	**10%**	**8%**	**6%**	**5%**	**4%**	**4%**	**5%**	**5%**	**4%**	**4%**	**4%**
South Korea	4%	4%	3%	3%	3%	3%	3%	3%	4%	4%	3%
Taiwan	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Hong Kong	2%	2%	2%	2%	2%	3%	2%	2%	2%	2%	1%
Singapore	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Vietnam	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%
India	0%	0%	1%	2%	1%	2%	2%	2%	2%	2%	2%
Reminder	9%	8%	10%	12%	12%	11%	11%	11%	10%	9%	10%
Imports of Goods, bn USD	**663**	**1,218**	**1,673**	**1,914**	**2,249**	**2,340**	**2,536**	**2,492**	**2,331**	**2,829**	**3,243**
as % imports											
European Union & UK	**18%**	**19%**	**19%**	**17%**	**19%**	**19%**	**19%**	**21%**	**20%**	**19%**	**19%**
France	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Germany	5%	5%	5%	4%	6%	5%	5%	5%	5%	5%	5%
UK	4%	4%	3%	3%	3%	2%	2%	3%	2%	2%	2%
NAFTA	**27%**	**30%**	**28%**	**27%**	**26%**	**26%**	**26%**	**27%**	**25%**	**26%**	**27%**
Canada	**19%**	**19%**	**17%**	**15%**	**13%**	**13%**	**13%**	**13%**	**12%**	**13%**	**13%**
Mexico	**7%**	**11%**	**10%**	**12%**	**13%**	**13%**	**14%**	**14%**	**14%**	**14%**	**14%**
Rest of Western Hem.	5%	5%	6%	6%	4%	4%	4%	4%	3%	4%	4%
Brazil	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Asia and Pacific	**42%**	**37%**	**36%**	**38%**	**42%**	**42%**	**42%**	**40%**	**42%**	**42%**	**41%**
China	**6%**	**8%**	**15%**	**19%**	**21%**	**22%**	**21%**	**18%**	**19%**	**18%**	**17%**
Japan	**18%**	**12%**	**8%**	**6%**	**6%**	**6%**	**6%**	**6%**	**5%**	**5%**	**5%**
South Korea	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%
Taiwan	4%	3%	2%	2%	2%	2%	2%	2%	3%	3%	3%
Hong Kong	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Singapore	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Vietnam	**0%**	**0%**	**0%**	**1%**	**2%**	**2%**	**2%**	**3%**	**3%**	**4%**	**4%**
India	1%	1%	1%	2%	2%	2%	2%	2%	2%	3%	3%
Reminder	8%	9%	12%	13%	8%	9%	9%	8%	9%	9%	9%
Serivces (BOP Basis), bn USD											
Exports of Services	200	298	378	582	769	837	866	891	726	801	929
Imports of Services	133	221	312	436	498	555	565	593	466	559	697

Source: Goods trade data (Census Basis) and services trade data (BOP basis) are from the U.S. Census Bureau; downloaded in June 2023. Differences between Census basis and BOP basis series are small; see: https://www.census.gov/foreign-trade/statistics/historical/goods.pdf. Regions are as follows: European Union & UK: All current 27 EU members, plus the UK. NAFTA: Canada and Mexico. Rest of Western Hemisphere: Argentina, Brazil, Chile, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Peru, Venezuela, Bermuda, Dominican Republic and UK Caribbean Virgin Islands. Middle East: Bahrain, Israel, Jordan, Oman and Saudi Arabia. Africa: All the countries within the continent.

partners, the East Asian economies of South Korea, Taiwan and Singapore comprised around 10% of both U.S. exports and imports.

By the dawn of the millennium, however, China and Mexico had emerged as major U.S. trade partners. China's rapid and dramatic

rise as an export powerhouse has been studied extensively.[14] China's share in U.S. imports leaped from nearly 6% in 1994 to a peak of around 22% in 2017, making China the single largest source country partner of the U.S. On the other hand, exports to China which were just 2% of total U.S. exports in 1994, peaked at 9% in 2020, and stood at approximately 7% in 2022. Turning to Mexico, the enactment of NAFTA in 1994 (known as the USMCA post-2020) was a pivotal moment for its bilateral trade with the U.S.[15] The U.S.' imports from Mexico rose consistently from nearly 7% in 1994 to 14% in 2022, while Mexico's share of U.S. exports expanded from around 10% in 1994 to nearly 16% in 2022.

As China and Mexico rose in prominence as U.S. trading partners, it has primarily been Canada and Japan who lost market share, particularly in their share of U.S. imports. In 2022, Canada accounted for 13% of U.S. imports (down from 19% in 1994), while Japan's share had fallen to only 5% (from 18% in 1994). One other country worth highlighting here is Vietnam, in anticipation of our later discussion on more recent supply chain shifts. Vietnam's exports to the U.S. have increased steadily since the 2000s, following its normalization of relations with the U.S. in 1995 and the entry into force of its bilateral trade agreement in 2001 *(McCaig and Pavcnik 2018);* this intensified after 2017, with Vietnam's share of U.S. imports doubling from 2% to about 4% by 2022.

In sum, the last four decades have seen a discernible shift in the origin countries of the U.S.' direct imports as the U.S. moved toward sourcing more from low-income, low-wage locations, specifically China, Mexico, and (to a lesser extent) Vietnam. There is nevertheless a sense in which the pattern of U.S. imports has remained stable since 1994, in that its import shares from broad geographical regions have held relatively steady: The EU (cum UK) continues to be the source of around 20% of the U.S.' imports, while the corresponding shares accounted for by NAFTA and the Asia-Pacific region remains around 30% and 40% respectively. This suggests that U.S. trading relationships continue to be characterized by regional value chains *(Baldwin and Gonzalez-Lopez 2015).*[16]

3.3 Products

We turn next to examine the product composition of U.S. trade flows, to shed light on the U.S.' positioning within GVCs and how this has evolved over time.

For this purpose, we adopt the approach in Chor et al. (2021) to compute measures that summarize the upstreamness of the U.S.' export and import profiles respectively, to characterize the positioning of these trade flows with respect to final demand. This is based in turn on the concept of industry upstreamness developed in Fally (2011) and Antràs et al. (2012): Making use of the information on production linkages across industries reported in Input-Output Tables, these papers define and construct a measure of the number of stages that an industry's output will on average traverse before it is absorbed in final uses (i.e., in consumption or investment).[17] The procedure for constructing this upstreamness measure at the industry level is detailed in the Appendix; we apply this on the U.S. Input-Output Tables, using 2012 as a convenient benchmark year that precedes the U.S.-China tariff actions, and further map these industry upstreamness values to HS4 product codes with the concordance in *Pierce and Schott (2012).*

The upstreamness measure we compute takes on a minimum value of 1 and ranges up to a maximum value of 4.58. An upstreamness value of 1 indicates that the entirety of the output of that product is directly absorbed in final uses (i.e., the product is exactly one stage removed from final demand). Products that have low upstreamness values include: automobiles, toys, furniture, and apparel. On the other hand, products that have high upstreamness values tend to go through multiple stages of production before they become final goods; examples of these include: raw materials and agricultural commodities, as well as petroleum-related and chemical products. (See Appendix Table 1 for the upstreamness values of the U.S.' largest traded products.)

To translate these into a country measure of import (respectively, export) upstreamness, we take a weighted average of the product-level upstreamness values as follows:

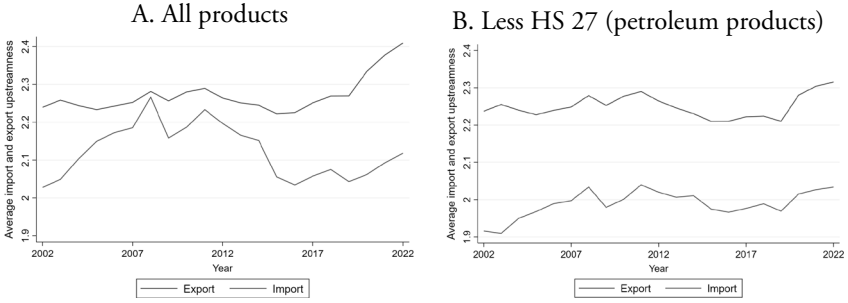
$$U^{M}_{US,t} = \sum_{p=1}^{N} \frac{M_{pt}}{M_t} U_p, \quad U^{X}_{US,t} = \sum_{p=1}^{N} \frac{X_{pt}}{X_t} U_p. \qquad (1)$$

where M_{pt}/M_t is the value of imports of product p expressed as a share of the U.S.' total imports in year t, and X_{pt}/X_t is the corresponding share of product p in total U.S. exports. A country's import (respectively, export) upstreamness naturally takes on higher values if a larger share of its imports (respectively, exports) is composed of relatively upstream products that tend to be separated by multiple stages from final demand.

We illustrate the export and import upstreamness of the U.S. over the two decades leading up to 2022. As seen in Figure 1, Panel A, the U.S.' exports are persistently more upstream than its imports (in relation to final demand). This reflects the fact that the U.S.' main exports include such goods as electronic integrated circuits, machinery, and other goods-in-process that are sent overseas for further assembly and processing. The U.S.' export upstreamness has moreover risen over this period, given the increases in the U.S.' agricultural exports and its transition to being a net exporter of petroleum products.[18] In exchange, the U.S. tends to import goods that are relatively finished, which are then used in final consumption or investment in the U.S. economy.[19]

Note that while there was a rise in the upstreamness of U.S. imports leading up to 2007, this was largely the result of the surge in oil prices following the 2001 dot-com recession until just prior to the Global Financial Crisis; in particular, Panel B confirms that the time series for the upstreamness of U.S. imports is much smoother when petroleum products (HS code 27) are excluded from the sample.[20] It is moreover useful to point out that the U.S.' exports continue to be more upstream on average than its imports even when we restrict the construction of the country-level measures in (1) to products classified as manufacturing goods (Appendix Figure 2), so the high upstreamness of U.S. exports is not driven by agricultural products *per se.*

Figure 1
U.S. Export and Import Upstreamness (2002-2022)



Notes: Authors' calculations based on the methodology in Chor et al. (2021), using UN Comtrade data and the 2012 U.S. Input-Output Tables.

3.4 Modes of Globalization: Trade and FDI

Multinational corporations (MNCs) have been instrumental in the growth of GVCs, given that a good share of cross-border production and trade occurs between MNCs and their foreign affiliates. For example, up to 40% of the value of U.S. trade takes place within the ownership boundaries of MNCs.[21] As we will see below, it is important to take multinational activity into account, without which we would end up with an incomplete picture of the extent of the U.S.' supply chain links to key countries.

While the U.S. has in recent years been sourcing more via trade from lower-income locations, the bulk of its foreign direct investment (FDI) remains of a North-North nature, taking place with countries with relative factor endowments and factor prices similar to the U.S. *(Antràs and Yeaple 2013; Alfaro and Charlton 2009)*.[22] Japan has been the leading source of FDI for the U.S., accounting for close to 15% of the stock of all U.S. inward direct investment; this is followed by Germany, Canada, and the UK (10-13% each), and Ireland and France (around 7% each). These nations, along with the Netherlands and Switzerland, contribute roughly 70-80% of FDI in the U.S.[23] More than 40% of this inward investment is in the manufacturing sector; most of this investment is in industries where GVCs feature prominently in firms' integration strategies, namely: chemicals, computers and electronic products, and transportation equipment.

It is instructive to examine the trajectory of Japanese firms in U.S. manufacturing over the last four decades, as this illustrates various mechanisms through which trade and institutional barriers have shaped firms' production and sourcing strategies. In the post-war era, Japanese FDI in the U.S. consisted mainly of trading companies and financial institutions whose goal was to facilitate Japan's trade with the U.S. (Wilkins 1990).[24] But in the 1970s, amid escalating U.S. trade deficits and rising concerns over U.S. protectionism, Japanese firms started to establish production facilities in the U.S. to get around potential import barriers against goods made in Japan. An antitrust lawsuit prompted Sony to break ground in 1971 on the first Japanese manufacturing factory. Similarly, an antitrust case against NEC in 1975 (though later dismissed) jolted the semiconductor sector, resulting in NEC purchasing its first American company in 1978.[25] In anticipation of protectionist measures, major Japanese electronics firms set up U.S. production facilities via acquisitions and greenfield investments.[26] This pattern was repeated in the automobile sector: In the 1980s, Japanese car manufacturers responded to the threat of U.S. protectionism by "voluntarily" limiting their exports to the U.S., moving their production for the American market to U.S. factories, and upgrading their products.[27]

This discussion brings forth two main implications. First, as a "mode" of globalization, FDI can either function as a complement or substitute to trade. Firms can replicate a subset of activities overseas by setting up plants and directly selling to the foreign market instead of exporting (horizontal FDI). But firms can also exploit GVCs via vertically-integrated plants (vertical FDI); if different stages of production are fragmented across country borders, trade in intermediate inputs is a complementary part of the rise of such multinational activity. Bearing this in mind, decreases in trade or in a country's share of U.S. imports need not signify deglobalization, since firms may be catering to the U.S. market through an alternative "mode" (e.g., horizontal FDI).

Underscoring this point, Figure 2 combines data on multinational affiliate sales in the U.S. (from the Bureau of Economic Analysis) together with the data on imports (used in the preceding sections).[28]

The affiliate sales of foreign-owned multinationals were three times the value of U.S. direct imports in 1995. While this ratio of affiliate sales to imports slipped to around two in 2020, affiliate sales for MNCs from advanced economies like Japan, Germany, the UK, and France still vastly exceed imports from those countries (see also Appendix Table 2).

Looking more specifically at the case of Japan, after accounting for affiliate sales in addition to import penetration, the share of sales of Japanese origin in the U.S. market is around 14%. Put otherwise, the 5% share that Japan holds in U.S. imports (reported earlier in Table 2) likely understates the continued role that Japanese goods and supply chains play in the U.S. economy. Moreover, after accounting for affiliate sales, advanced economies clearly hold a much larger share than China in the U.S. market, reflecting the relatively low level of affiliate sales by China-owned multinationals in the U.S.

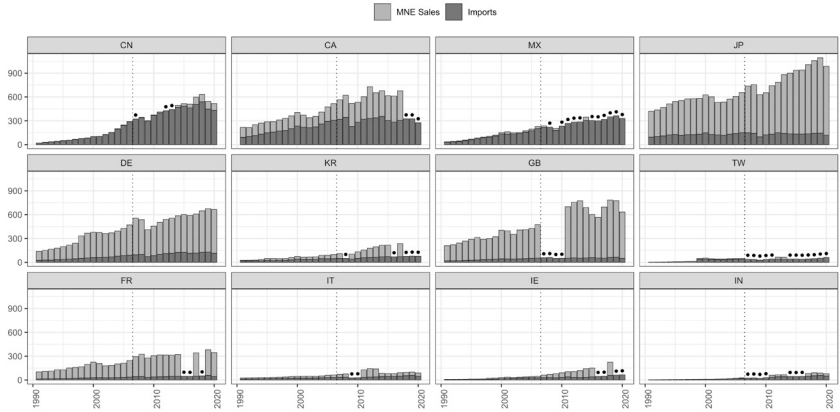
Second, the experience of Japan's MNCs shows that firms turned to FDI as a strategy both to navigate host-country restrictions on trade, as well as to mitigate the effects of rising production costs at home. In particular, the threat of U.S. tariffs on Japan prompted Japanese firms to expand their manufacturing capabilities in the U.S., and ever-rising costs at home eventually led many Japanese firms to relocate production also to lower-cost countries in Asia.[29]

There are some lessons to be drawn here for the current situation with China. Given the prevailing geopolitical climate, it seems improbable that China will be able to emulate the U.S.-based production approach that Japanese MNCs successfully implemented in terms of speed, scale, or scope. We will nevertheless see in Section 4.4 that there are already signs that Chinese firms have been expanding their FDI footprint in lower-cost locations, through which they potentially remain connected with U.S. supply chains.

4. The "Great Reallocation" in Global Supply Chains

In this section, we focus on key developments in the pattern of global supply chain activity over the last five years (2017-2022). Even as overall trade volumes have been resilient following the recent wave of policy and economic shocks, a significant reallocation in global

Figure 2
U.S. Imports and MNC Affiliate Sales,
by Source Country, USD bn (1991-2020)



Source: BEA; data downloaded in July 2023. Black dots indicate multinational affiliate sales data that are affected by disclosure redactions. The source country for MNC affiliate sales refers to the country of the ultimate beneficial owner. MNC sales are for nonbank affiliates from 1990-2006. From 2007 onward, the MNC sales data are for nonbank affiliates for CA, JP, DE, GB, and FR, but include bank affiliates for all other economies.

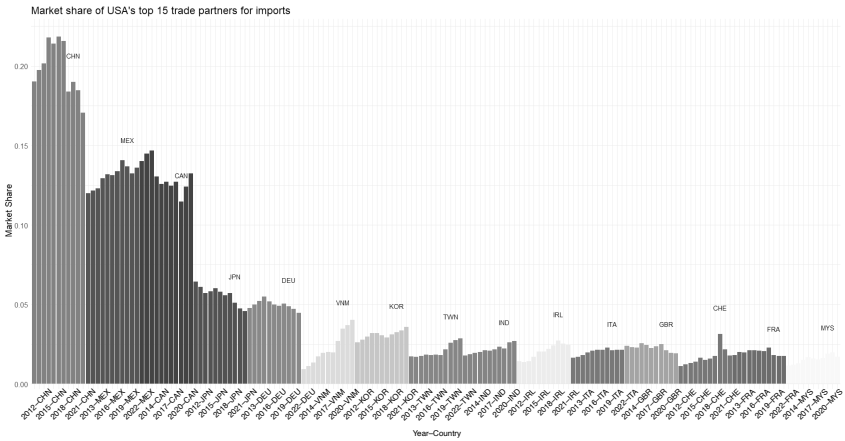
supply chains has been set in motion, most notably along the dimension of sourcing partner countries. We document the key shifts both at the country level, as well as in the cross-product variation.

4.1 Trade Patterns: Reallocation across Partner Countries

Figure 3 presents the year-to-year evolution of the share in U.S. imports held by the U.S.' top trade partners (based on the value of total U.S. imports by source country in 2017). This is illustrated for the years following the Global Financial Crisis, i.e., 2012-2022; this can be further divided into two subperiods of interest, respectively prior to and following the introduction of the U.S.-China tariffs in 2017. At a broad level, the figure confirms the gradual shift in U.S. imports away from richer and toward lower-income source countries: In the run-up to 2017, U.S. import shares were rising for China, Mexico, and Vietnam. However, China's import share peaked in 2017 at 21.6%, while that for Mexico and Vietnam continued to register steady growth.

The years following 2017 were marked by a series of shocks to the global economy, including the U.S.-China tariffs and the Covid-19

Figure 3
Evolution of U.S. Trade Partners' Import Market Shares



Source: UNComtrade. Top trade partners in 2017. Data Downloaded in April 2023.

pandemic. By 2022 though, world trade flows were rebounding strongly.[30] In level terms, the U.S.' imports from China in fact expanded from approximately $505.1 billion in 2017 to $531.3 billion in 2022; this represents an annual nominal growth rate of 1.2%. This growth came despite the sharp ups-and-downs in trade volumes in the intervening pandemic years, and despite the fact that Chinese goods were losing ground relative to imports from other source countries in the U.S. market during these five years.[31]

Figure 4 underscores the reallocation in sourcing patterns that has occurred, by zooming in on the change in import share in 2017 versus 2022 for the same set of top U.S. trade partner countries (as in Figure 3). Despite the growth in absolute levels, China's imports witnessed a significant loss in market share of around 5 percentage points. As seen from the figure and documented by others (Bown 2022; Grossman et al. 2023; Freund et al. 2023; Fajgelbaum et al. 2023), countries in Asia have emerged as big winners. Vietnam emerged as the most significant gainer, with a close to 2 percentage point increase in its share of U.S. imports. Higher-income East Asian economies such as Taiwan and Korea, and South Asian countries such as India, registered more modest but still noticeable gains. Despite their already high import share, NAFTA nations, particularly Mexico, also

emerged as beneficiaries; Canada even experienced a reversal in its declining share of the U.S. market. Elsewhere though, Japan and other high-income European countries, such as Germany, the UK, France, and Italy, saw their share of U.S. imports continue to fall.[32]

4.2 Reallocation Across Products and Partners

Thus far, we have shown that the U.S. has been moving away from China as a source of its imports. We now show that this reallocation toward other source countries, including Vietnam and Mexico, is evident across a wide range of traded products.

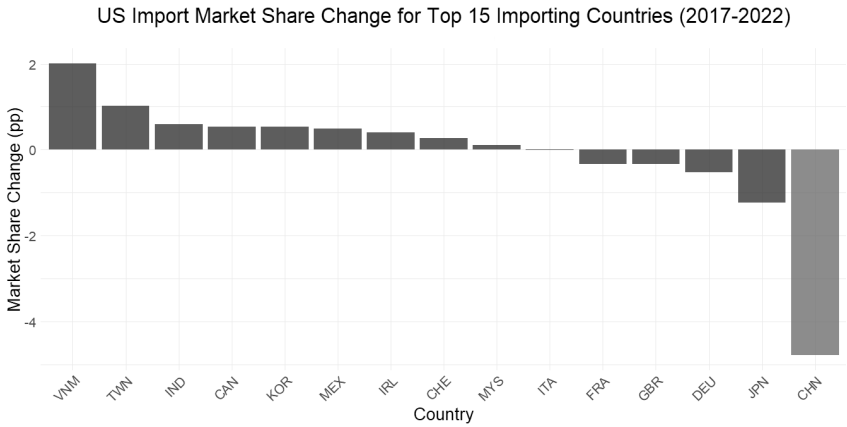
As a first take, Figure 5 visually represents the shifts in import market share within four sectors often central to U.S. trade and policy discussions: automobiles, auto parts, electronics, and semiconductors. In these sectors, direct imports from China are significant, except in finished automobiles. The decline in China's import share after 2017 is clear in auto parts, electronics, and semiconductors. The figure further highlights the gains by Mexico and Vietnam across these key product categories (except in autos, where imports by the U.S. from Vietnam are negligible). In semiconductors, high-income economies in Asia, such as Taiwan, have seen a notable increase in their market share.

Looking at more specific products, China lost import market share between 2017-2022 in such key items as telephone sets (HS 8517, close to 16.4 percentage points) and machinery (HS 8473, around 46.6 percentage points). Products such as tapes (HS 8523), printing machines (HS 8443), monitors (HS 8528), electrical equipment (HS 8504 and 8543), apparel (HS 6110) and footwear (HS 6403) also saw decreases in the China share of U.S. imports (of between 9.7 to 39.3 percentage points each).[33]

We now present more systematic regression-based evidence of these trends. We approach this by exploring whether product-level changes in the U.S.' share of imports from China are correlated with changes in the import shares and other observable dimensions of the U.S.' imports from third-countries, particularly from Vietnam and Mexico.

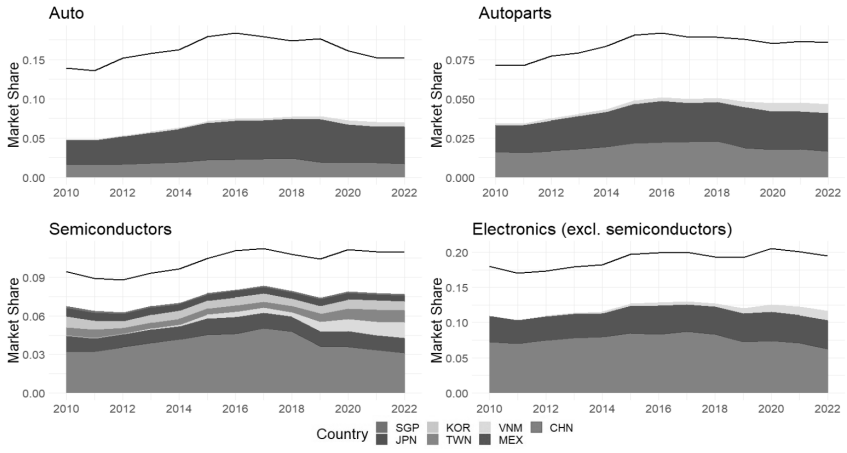
For this purpose, we use the following specification:

Figure 4
Changes in U.S. Import Market Share



Source: UN Comtrade. Data Downloaded in April 2023.

Figure 5
Change in U.S. Import Market Share (2017-2022)
Autos, Auto Parts, Semiconductors, and Electronics



Source: UN Comtrade. Sectors correspond to the following NAICS codes, which are matched to HS using the Pierce and Schott (2012) concordance. Autos (less parts): Motor Vehicle Manufacturing (3361), Motor Vehicle Body and Trailer Manufacturing (3362); Auto parts: Motor Vehicle Parts Manufacturing (3363); Semiconductors: Semiconductor and other Electronic Component Manufacturing (3344), Semiconductor Machinery Manufacturing (332442); Electronics and Electrical: Computer and Electronic Product Manufacturing (334) less 3344, Electrical Equipment, Appliance, and Component Manufacturing (335).

$$\Delta y_{p,22\text{-}17} = \beta_1 \Delta CHNsh_{p,22\text{-}17} + \beta_2 \Delta y_{p,17\text{-}12} + D_{p0} + \varepsilon_p \,, \qquad (2)$$

where $\Delta CHNsh_{p,22\text{-}17}$ is the change between 2017-2022 in the share of the U.S.' imports of HS4 product p that are from China.

The variable y denotes product-level outcomes drawn from the UN Comtrade data. For a start, we will explore as the dependent variable $\Delta y_{p,22\text{-}17}$ the corresponding five-year change in the U.S.' import share of product p from other source locations. As we have seen in Figure 3, the import shares from specific partner countries might exhibit pre-trends in the U.S.' propensity to source from that location, and so we also control in (2) for the lagged five-year change (between 2012-2017) in this outcome variable. The regression further includes HS2 fixed effects (denoted by D_{p0}) to account for differences in product characteristics at this broader level.

Note that we focus on a five-year difference rather than on year-to-year changes in trade patterns which have been very volatile over this period of study. In other words, we should interpret the regression as an assessment of the cumulative impact of the various major shocks — the U.S.-China tariffs, and the Covid-19 pandemic — that have occurred during the five-year period. The estimated coefficient β_1 is thus intended to capture at a descriptive level how shifts in the propensity to import from China are correlated with shifts in the propensity to import from alternative source locations.

Table 3 reports these regression results. We have grouped the alternative import locations as follows in successive columns: (i) Vietnam; (ii) Mexico; (iii) Canada; (iv) a set of four low-wage Asian economies (India, Indonesia, Malaysia, Thailand); (v) a set of high-wage Asian locations (Korea, Singapore, Taiwan); (vi) Ireland and Switzerland (from which there was an increase in imports of pharmaceuticals and medical goods); and (vii) the rest of the world. We use regression weights equal to the initial 2017 value of HS4-digit imports from China, and we report standard errors clustered by HS2-digit codes.

The negative and significant $\beta 1$ coefficient in Columns 1 and 2 implies that the share of U.S. imports from Vietnam and Mexico (respectively) indeed rose on average for products that saw a decline

Table 3
Change in U.S. Import Share (2017-2022)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	Δ US product-level import share from c (2017-2022)						
Import sources, c:	VNM	MEX	CAN	IND, THA, MYS, IDN	KOR, TWN, SGP	IRL, CHE	ROW
ΔCHN import share (2017-2022)	-0.198***	-0.079***	-0.012**	-0.136***	-0.440***	-0.011*	-0.101
	[0.025]	[0.020]	[0.005]	[0.044]	[0.134]	[0.006]	[0.062]
Lag Δ in c's import share (2012-2017)	0.768	-0.118	0.001	0.106	0.188	0.073	-0.453***
	[0.529]	[0.220]	[0.069]	[0.161]	[0.126]	[0.053]	[0.087]
Observations	1,149	1,149	1,149	1,149	1,149	1,149	1,149
R-squared	0.529	0.296	0.220	0.301	0.561	0.136	0.458
HS2 fixed effects?	Y	Y	Y	Y	Y	Y	Y

Notes: Based on HS4 product-level trade data from UN Comtrade. Estimation is by weighted least squares with HS2 fixed effects, with the 2017 value of U.S. imports from China for the respective HS4 products as weights. Standard errors are clustered by HS2 codes; ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

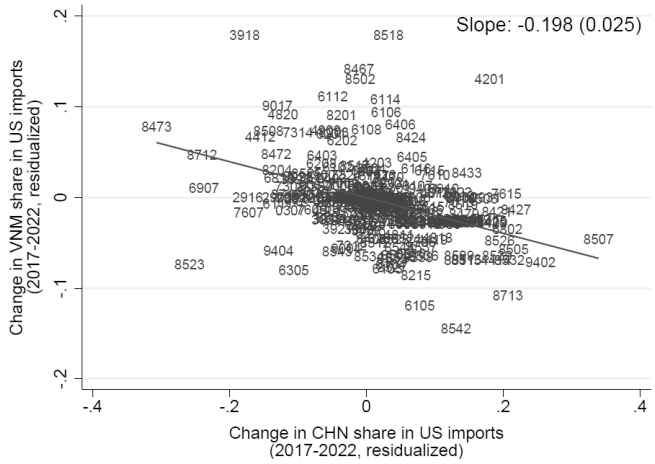
in the share imported from China. This confirms that the reallocation of import shares away from China is not just anecdotal but rather a systematic feature in the pattern of U.S. product-level imports. We see this pattern of substitution away from China play out too in favor of the other key import partners (Columns 3-6); note that after accounting for these alternative source locations, the share of U.S. imports for the residual rest-of-the-world category does not respond significantly to changes in the import share from China. When considering instead the log value (rather than the share) of imports for the outcome variable y, Appendix Table 3 verifies that product-level decreases in the import share from China were accompanied by a broad increase in the value of imports from across many other source countries, including Vietnam and Mexico (Columns 1-2).

In what follows, we will take a closer look at these two alternative source countries, Vietnam and Mexico, which are emblematic of "friendshoring" and "nearshoring." As mentioned earlier, Vietnam saw the most significant market share gain from the U.S.' shift away from China, while Mexico has seen its share of U.S. imports steadily rise since the 1990s and particularly in the past 5 to 10 years (Figures 3 and 4).

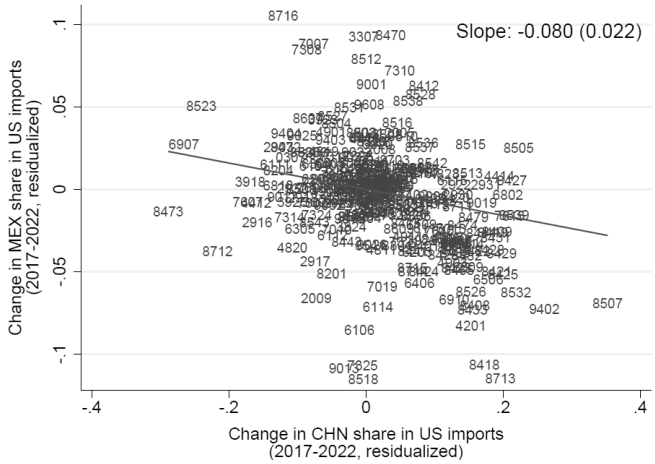
Figure 6 illustrates the negative relationship between shifts in import shares from China, on the one hand, and shifts in import

Figure 6
Correlations between Import Share from China versus Vietnam and Mexico (2017-2022)

A: Vietnam



B: Mexico



Notes: Residualized scatterplots based on the specification in (2), with the 2017-2022 change in the Vietnam (respectively, Mexico) share in U.S. imports on the vertical axes. For the top 300 HS4-digit products by 2017 import value from China.

shares from Vietnam and Mexico, respectively, focusing on the top 300 products by the 2017 value of U.S. imports from China.[34] The figures moreover provide a sense of the products in which Vietnam and Mexico picked up significant import share. Both countries gained ground in various types of electrical and electronic equipment, such as microphones (HS 8518), electric generating sets (HS 8502), and telephone sets (HS 8517) in the case of Vietnam, and discs, tapes and storage devices (HS 8523) and calculating machines (HS 8470) in the case of Mexico. But there have also been differences in the product mix of the observed shifts. Vietnam's import share in plastic floor coverings (HS 3918) and various forms of apparel (HS 6112, 6114) rose more than for the average product. Likewise, Mexico's imports in automobiles and automobile parts (HS 87), as well as glass, iron, and steel products (HS 7007, 7308, 7310), performed particularly well.

On a related note, we show in Appendix Table 4 that this negative relationship with changes in the import shares of Vietnam and Mexico is robust if we remove petroleum-related products (HS codes starting with "27"); if we were to run a purely cross-sectional regression without HS2 fixed effects; or if we were to focus on just the top 300 products by value that were imported by the U.S. from China in 2017.

Heterogeneity in responses: Table 4 further explores the heterogeneity in product-level responses across Vietnam and Mexico, vis-à-vis which products gained more import share in the U.S. market following decreases in the import share held by China. We do so by augmenting the regression specification in (2) with interaction terms with several product-level characteristics of interest, specifically: the upstreamness of the product p, the labor share (computed from 2012 U.S. Input-Output Tables), and the tariff on Chinese imports of product p imposed by the Trump administration.[35]

The results reveal interesting differences when comparing which products in Vietnam and Mexico experienced greater shifts in their market shares in tandem with corresponding decreases in China's import share. For Vietnam, a greater increase in its import share is seen for products that are more upstream, that have a lower labor

Table 4
Change in U.S. Import Share for Vietnam and Mexico (2017-2022) Interaction Terms with Upstreamness, Labor Share, U.S. Tariffs on China

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	Δ US product-level import share from c (2017-2022)							
Import sources, c:	VNM	VNM	VNM	VNM	MEX	MEX	MEX	MEX
ΔCHN import share (2017-2022)	0.097	-0.435***	-0.096	-0.180	-0.311***	0.170**	0.081	0.187
	[0.169]	[0.128]	[0.139]	[0.256]	[0.102]	[0.066]	[0.114]	[0.129]
Lag Δ in c's import share (2012-2017)	0.934*	0.941**	0.899*	0.938*	-0.144	-0.295***	-0.170	-0.318***
	[0.516]	[0.459]	[0.519]	[0.471]	[0.220]	[0.104]	[0.250]	[0.104]
Upstreamness	-0.016			-0.013	-0.001			-0.000
	[0.014]			[0.010]	[0.009]			[0.005]
… × ΔCHN import share	-0.143*			-0.018	0.113**			0.035
	[0.084]			[0.085]	[0.050]			[0.042]
Labor Share		-0.060		-0.126*		0.088		0.073
		[0.054]		[0.066]		[0.058]		[0.055]
… × ΔCHN import share		0.977**		0.768**		-0.991***		-0.919***
		[0.480]		[0.339]		[0.301]		[0.279]
US Tariff			-0.002	-0.001			0.000	0.000
			[0.001]	[0.001]			[0.001]	[0.000]
… × ΔCHN import share			-0.006	-0.010*			-0.010	-0.007**
			[0.008]	[0.005]			[0.006]	[0.003]
Observations	280	280	280	280	280	280	280	280
R-squared	0.551	0.593	0.550	0.609	0.344	0.469	0.342	0.491

Notes: Based on HS4 product-level trade data from UN Comtrade. Estimation is by weighted least squares with HS2 fixed effects (unless otherwise stated), with the 2017 value of U.S. imports from China for the respective HS4 products as weights. The sample excludes petroleum products (HS2 code 27), and is further restricted to the top 300 HS4 products by value in 2017 U.S. imports from China. Standard errors are clustered by HS2 codes; ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

share, or that saw their imports from China hit with higher U.S. tariffs (Columns 1-4). This is broadly consistent with the observation that Vietnam was, during these years, shifting more into the production of electrical and electronic parts and components that are relatively more upstream and less labor-intensive compared to goods (such as textiles) that it had previously been exporting. (Appendix Figure 3 provides corroboration for this finding that Vietnam has been inserting itself into progressively more upstream stages in U.S. supply chains. There, we show using a trade-weighted measure analogous to (1) that the upstreamness of Vietnam's bilateral exports to the U.S. has been rising, particularly over 2017-2022.)

For Mexico, on the other hand, the increase in import share has been more pronounced in products that are less upstream, that feature a higher labor share, and whose imports from China were subject to higher U.S. tariffs (Columns 5-8). That Mexico's imports

increased in relatively less upstream products could be a by-product of its proximity to the U.S., and hence its being a natural location for the final stages of assembly of goods, such as motor vehicles, destined for the U.S. market.

Interestingly, the one common thread uncovered for both Vietnam and Mexico in Table 4 is the negative and significant interaction effect involving the U.S. product-level tariff on China, a finding which underscores the policy-driven nature of this reallocation in the U.S.' sourcing patterns away from China.[36]

Implications for unit prices: Table 5 provides hints that the reallocation in the pattern of imports is likely already having an impact on the prices of goods that arrive in the U.S. from these alternative source countries. We run here the specification in (2), but use instead log product-level unit values — calculated as the value of import flows divided by recorded quantity — as the outcome variable y.

Of note, we find that decreases in the share of imports obtained from China are associated with increases in the unit values of goods purchased by the U.S. from Vietnam and Mexico (Columns 1-2).[37] This suggests that either cost-push or demand-pull factors associated with the rise in U.S. import purchases from Vietnam and Mexico have contributed to increases in goods prices from these locations. It is useful to recall here that the trade-weighted average decrease across products in the share of U.S. imports from China is around 5 percentage points. Taking our point estimates in Table 5 at face value, our analysis indicates that such a 5 percentage-point decrease in the China import share would be associated with non-trivial increases in the unit prices of imports; the size of the implied increases is respectively 9.8% for Vietnam (Column 1) and 3.2% for Mexico (Column 2). (Note that there is also a significant effect in Column 5 on the unit values of imports from Korea, Taiwan and Singapore; the size of this effect is smaller though, with a 5 percentage-point decrease in sourcing from China being associated with a 2.3% increase in goods prices from these locations.)

Figure 7 displays this relationship with import unit values. Similar to Figure 6, we focus on the top 300 products by initial import value

Table 5
Change in Import Unit Values (2017-2022)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	Δ Log US product-level import unit value from c (2017-2022)						
Import sources, c:	VNM	MEX	CAN	IND, THA, MYS, IDN	KOR, TWN, SGP	IRL, CHE	ROW
ΔCHN import share (2017-2022)	-1.960*	-0.630**	0.062	-0.905	-0.460*	-0.331	-0.700
	[1.001]	[0.282]	[0.367]	[0.905]	[0.245]	[0.622]	[1.110]
Lag Δ log import unit value from c (2012-2017)	-0.334***	-0.198***	0.045	-0.416***	-0.234***	-0.297***	-0.788***
	[0.086]	[0.027]	[0.086]	[0.090]	[0.056]	[0.077]	[0.151]
Observations	634	926	982	1,025	954	847	286
R-squared	0.342	0.355	0.424	0.350	0.404	0.325	0.306
HS2 fixed effects?	Y	Y	Y	Y	Y	Y	Y

Notes: Based on HS4 product-level trade data from UN Comtrade. Variables in log changes are computed using the Davis-Haltiwanger-Schuh approximation. Estimation is by weighted least squares with HS2 fixed effects, with the 2017 value of U.S. imports from China for the respective HS4 products as weights. Standard errors are clustered by HS2 codes; ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

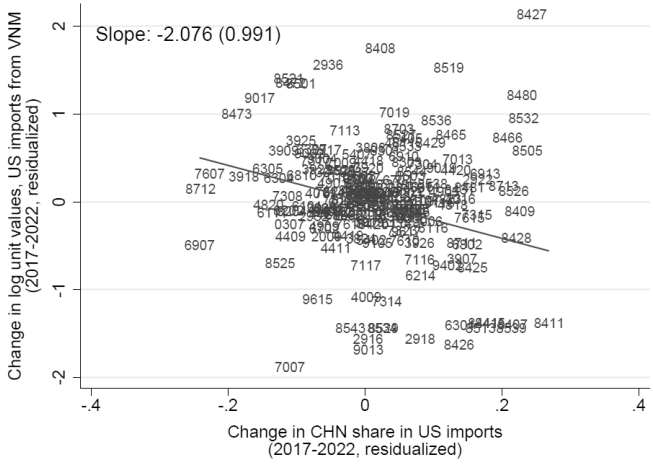
from China, and use the residualized log change in unit values from Vietnam and Mexico as the respective vertical axis variables. The two panels clearly highlight the strong correlation across HS4-digit products between decreased importing from China and higher unit prices of goods from Vietnam and Mexico.

These findings add a new dimension to a body of existing evidence on the price effects of the U.S. tariffs on China. While it is now well-understood that the U.S. tariffs have raised the unit prices of goods imported from China with a near-complete tariff pass-through (Amiti et al. 2019; Fajgelbaum et al. 2020; Cavallo et al. 2021), the above findings suggest that trade diversion to countries such as Vietnam and Mexico has also been associated with quantitatively significant increases in import prices from these alternative source locations. Although Amiti et al. (2019) highlight the complexity of aligning trade data with Consumer Price Index data in a comprehensive manner, it is likely that some portion of these rising prices from third-countries is being passed on to the U.S. firms or consumers purchasing these goods. This reinforces a concern that the policy-driven reallocation is likely to generate increased price and wage pressures in the U.S.

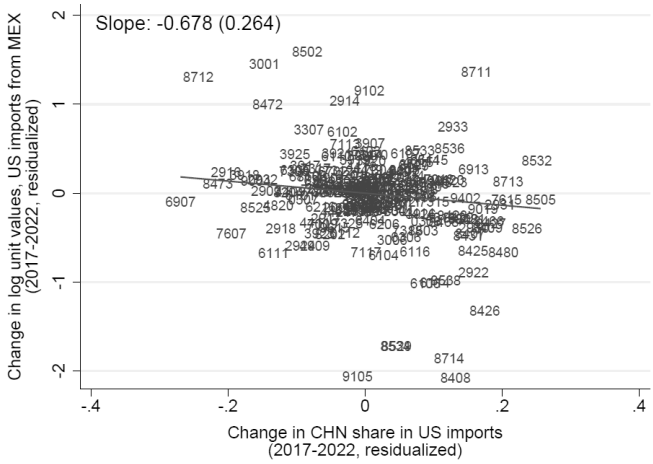
It has been argued that for several decades leading up to 2017, the correlation between prices and wage pressures in the U.S. has

Figure 7
Correlations between Import Share from China versus Unit Values in Vietnam and Mexico (2017-2022)

A: Vietnam



B: Mexico



Notes: Residualized scatterplots based on the specification in (2), with the 2017-2022 change in the log unit value of U.S. imports from Vietnam (respectively, Mexico) on the vertical axes. For the top 300 HS4-digit products by 2017 import value from China.

been attenuated due to increased importing and outsourcing (Forbes 2019; Obstfeld 2019). Consequently, the recent policy restrictions to shift sourcing patterns or even to encourage substitution toward domestic inputs are poised to add to wage and cost pressures in the U.S. (Amiti et al. 2023; Comin et al. 2023).

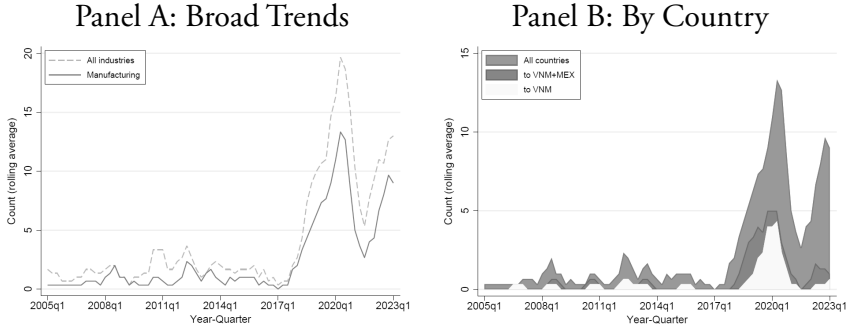
4.3 Corroborating Evidence on Friendshoring and Nearshoring

We provide two pieces of corroborating evidence that indicate that the changes in U.S. import patterns we have documented with trade data are indeed a reflection of purposeful decisions being made at the level of individual firms to shift activity away from China.

First, we examine the frequency with which the terms "friendshoring", "nearshoring", or "reshoring" appear in earnings conference calls conducted by listed firms, particularly when these terms are raised in the context of sourcing from China. This follows the novel work of Hassan et al. (2019) and Hassan et al. (2021), who demonstrate the feasibility of extracting this textual data to identify business-relevant issues commanding the attention of corporations and their investors. Figure 8 below illustrates the trends over time (by quarter) in the occurrence of such terms that speak to potential shifts in offshoring arrangements away from China; this draws on the call transcripts in Refinitiv Eikon that have been processed by NL Analytics.[38] While these data are subject to the caveat that earnings calls are typically conducted only by listed firms who need to engage publicly with their investors and stakeholders, these are nevertheless useful as a timely gauge of key issues of concern among major companies.

Figure 8 confirms a sharp rise in the use of phrases pertaining to friendshoring, nearshoring, or reshoring away from China. Two spikes are evident. The first coincides with the rise in U.S.-China trade tensions in mid-2017 under the Trump administration through to the early phases of the Covid-19 pandemic in mid-2020. After a short lull, there has been a resurgence in this topic in earnings calls starting in 2022, suggesting that a significant number of firms are engaging in discussions about their China sourcing strategies in light of the Biden administration's continued use of discretionary tariffs and its public

Figure 8
Friendshoring/Nearshoring/Reshoring in Earnings Calls (2005Q1-2023Q3)



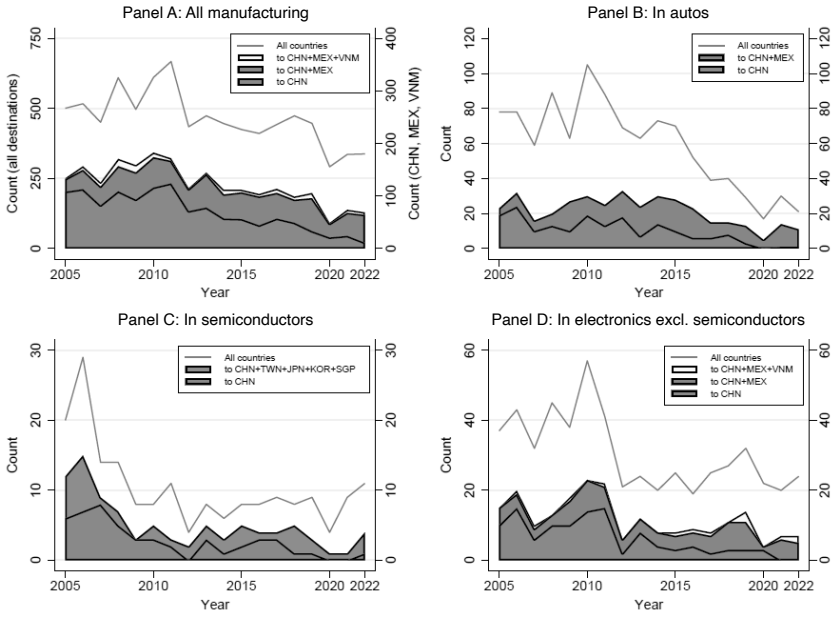
Notes: Friendshoring/Nearshoring/Reshoring in call transcripts in Refinitiv Eikon processed by NL Analytics; counts are three-quarter rolling averages.

turn toward industrial policy. This increased attention on whether to source from China was driven by manufacturing companies (Panel A). Vietnam features prominently — and Mexico to a lesser extent — among the countries that are mentioned alongside these discussions about shifting sourcing away from China (Panel B).[39]

A second piece of corroborating evidence comes from the pattern of foreign direct investment (FDI) flows, which as we have seen is an alternative mode through which firms can structure and organize their participation in GVCs. Below, we use data from the Financial Times' fDi Markets, which tracks news and announcements on new greenfield FDI projects around the world. What fDi Markets observes is a limited slice of global FDI activity, given that it excludes mergers and acquisitions. That said, with the high sunk and fixed costs that are incurred when firms undertake FDI, decisions over whether to commence greenfield FDI should, in principle, be particularly sensitive to country policies that actively seek to reorient patterns of global production and sourcing.

In Figure 9, we illustrate trends over time in the counts of outward greenfield FDI projects from the U.S.[40] Based on this measure, the U.S.' outbound manufacturing FDI was already on a downward trend since the early 2010s, with (not surprisingly) a steady

Figure 9
U.S. Outward Greenfield FDI (2005-2022)

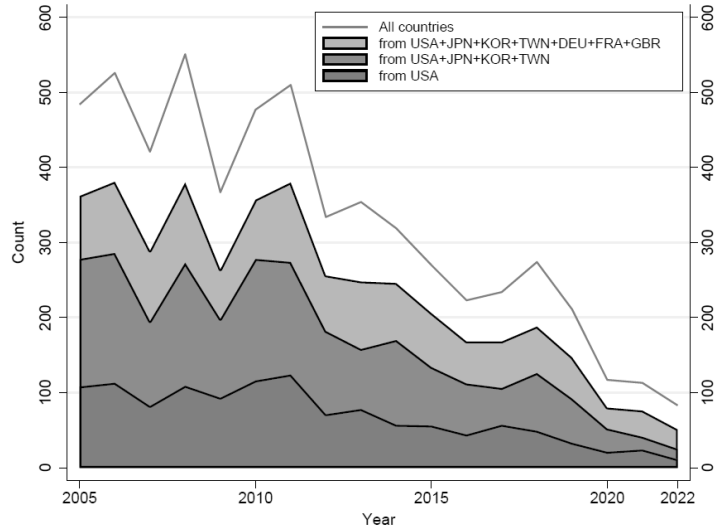


Source: Financial Times' fDi Markets.

but marked decrease in greenfield projects in China (Panel A).[41] This drop in FDI is visible across key sectors, including automobiles, semiconductors, and electronics (Panels B-D, respectively). In the case of automobiles and electronics (excluding semiconductors), FDI to Mexico has noticeably taken up some of the slack. By contrast, there has not been a perceptible increase in greenfield FDI by U.S. firms in Vietnam, perhaps reflecting the higher costs of FDI associated with this more distant location.

What about FDI from the perspective of China? Figure 10 shows that the greenfield FDI China has received in the manufacturing sector has, in fact, been on the decline since the end of the Global Financial Crisis. This is not driven by the fall in FDI from the U.S. per se, but is instead a broad-based decline from virtually all major FDI source countries into China, including the key Asian actors (Japan, Korea, Taiwan), and Europe (Germany, France, and Great Britain).[42] This strongly suggests that the underlying causes are factors domestic

Figure 10
Evolution of China's Inward FDI Position, Manufacturing (2005-2022)



Source: Financial Times' fDi Markets.

to China which were in place even prior to the U.S.-China trade tensions; this likely includes rising Chinese wages, restrictions on foreign ownership (such as joint venture requirements), or concerns over intellectual property protection.

The apparent decline in U.S. greenfield FDI in China is yet another symptom of the reallocation of U.S. economic activity away from Chinese shores. As of now however, we do not yet have a full accounting of the extent to which U.S. multinationals are relocating their operations to other host countries, nor of the extent to which they are onshoring production in domestic locations.

4.4 The Back Door: Does Friendshoring and Nearshoring Reduce Dependence?

Although the U.S.' direct economic engagement with China through trade and FDI has been falling, especially since 2017, it is important to pose a "reality check" question: Has this necessarily reduced the U.S.' dependence on supply chain links to China? As discussed in Section 2, we do not yet have the data resources — such as updated

World Input-Output Tables — to fully identify and decompose the country sources of value added that are ultimately embodied in U.S. gross imports. That said, we report on several trends below, which indicate that the U.S.' indirect supply chain links to China remain intact; along some dimensions — through China's economic ties with Vietnam and Mexico — these indirect links have even been intensifying.

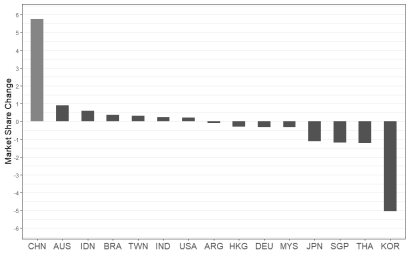
On the trade front, both Vietnam and Mexico have strong trade ties with the U.S. Nearly a quarter of Vietnam's exports are shipped to the U.S. In the case of Mexico, the U.S. is in fact its largest foreign market, absorbing nearly 80% of all Mexico's exported goods.

At the same time too, both Vietnam and Mexico have seen their import links with China step up progressively over time. For Vietnam, goods from China were 9% of its total imports in 1994, and this has surged to 26% in 2010 and approximately 40% by 2022; the main items that China ships to Vietnam include integrated circuits, telephone sets, and textiles. Between 2017-2022, the U.S. did see its share of Vietnam's imports grow, but China made even more substantial gains, increasing its share by around 5.5 percentage points during this period (Figure 11, Panel A). For Mexico, the share of its imports that originate directly from China has grown considerably from 1% in 1994 to 15% in 2010 and 20% in 2022. Conversely, the proportion of Mexico's imports that are from the U.S. has declined from 69% in 1994 to 44% in 2022. Over the last five years in particular, China was the source country that gained the most import share in Mexico, with much of this coming at the expense of the U.S. (Figure 11, Panel B).

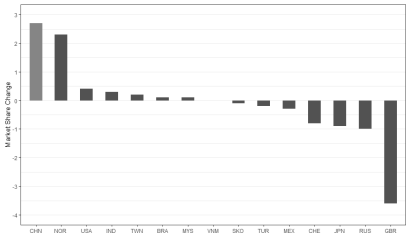
This trend is not confined to middle and lower-income countries. Figure 12 depicts the shift in import market share from 2017-2022 for the European Union's primary trade partners. China's share of EU imports rose by nearly 2.7 percentage points during this time frame, accounting for approximately 20.9% of imports by 2022; the peak of Chinese import penetration in the EU was in fact 22.4% in 2020. By contrast, the U.S. represents approximately 11.9% and only saw a modest increase of 0.4 percentage points over the same period.[43] Appendix Table 5 shows that this pattern of rising Chinese

Figure 11
Change in Import Market Share, Vietnam and Mexico (2017-2022)

Panel A: Vietnam



Panel B: Mexico



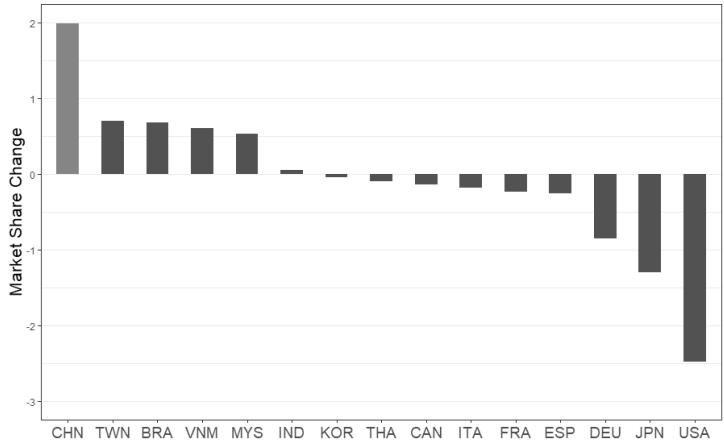
Source: UN Comtrade. For 2022, data on Vietnam's bilateral imports were available for a subset of countries; data for 2021 are used instead.

import shares has been the pattern for the leading U.S. trade partners, with the exception of Japan. To the extent then that Chinese firms' exports to these other locations comprise parts and components that are then assembled into final goods and sent thereon to the U.S. market, China would ultimately continue to be a relevant player in the upstream stages of U.S. supply chains.[44]

Turning to FDI, there is also evidence of a growing Chinese presence in the manufacturing sectors of Vietnam and Mexico. China's outward manufacturing FDI rose sharply in the mid- to late 2010s, although this came to a pause during the Covid-19 pandemic. Looking more closely, there is a modest but noticeable increase in Chinese FDI to Vietnam around 2018 (see the small bulge in Figure 13); this timing is suggestive, as it is in line with narratives that some Chinese firms set up operations in Vietnam in part to circumvent the U.S. tariffs on direct exports from China. Of note too, there has been an uptick in China's outward FDI to Mexico over the last five to eight years.

This pattern of rising FDI by Chinese firms in Vietnam and Mexico is borne out too in the data that is available from these respective countries. Let us start first with Mexico, for which the available national statistics on inward FDI is more detailed and up-to-date.[45] The U.S. has an entrenched position as the largest source country

Figure 12
Change in Import Market Share, European Union (2017-2022)

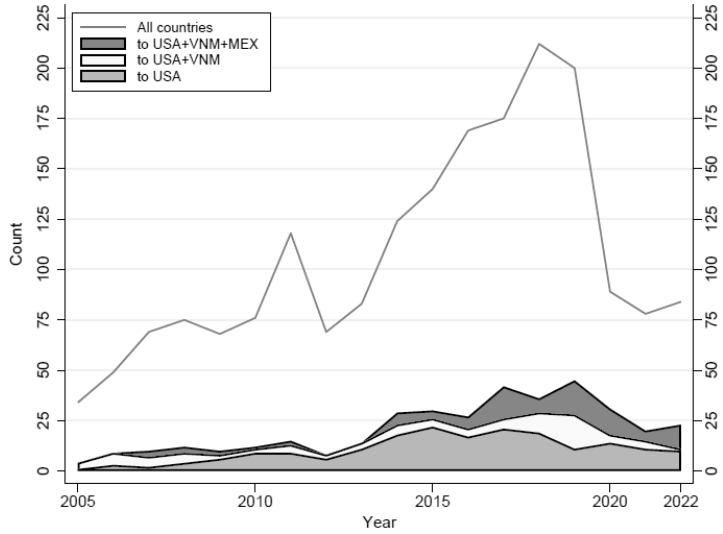


Source: Eurostat (EXT_LT_MAINEU), Updated 15/06/2023.

for FDI into Mexico, with U.S. firms accounting for slightly more than 50% of the value of all inbound manufacturing FDI in Mexico in 2022. As for China, in line with the trends from the fDi Markets database, the value of Chinese FDI in Mexico has indeed picked up: Chinese firms' direct investment in the Mexican manufacturing sector grew fivefold from US$31.6 million in 2017 to US$151.5 million in 2022. The vast majority (close to three-quarters) of this Chinese inward FDI between 2017-2022 has been in two industries that are particularly relevant for GVCs, namely: computer and peripheral equipment (NAICS 3341) and motor vehicle parts (NAICS 3363).[46] Admittedly though, Chinese FDI in Mexico is taking off from a low base — in 2022, China's share in all manufacturing FDI flows into Mexico was slightly over 1% — so it will be interesting to monitor how large a player China eventually becomes in Mexican FDI.

The FDI data for Vietnam are less widely available, but if anything, the role of China as a source of inward FDI into the country is even more pronounced. Using proprietary Vietnam Annual Enterprise Data, McCaig et al. (2022) report that China's share of inward FDI by value rose from 0.004% in 1999 to 7% in 2017 (see their Figure 4). Public data from Vietnam's General Statistics Office confirm that this trend has been sustained even through the Covid-19

Figure 13
Evolution of China's Outward FDI Position, Manufacturing (2005-2022)



Source: Financial Times' fDi Markets.

pandemic: China's share by value of all FDI projects granted licenses by Vietnam in 2021 was 7.7%. By comparison, U.S. multinationals have a smaller presence in Vietnam, with a 2% share of all new FDI projects in 2021.[47]

Chinese firms have thus been increasingly active as a source of FDI into both Vietnam and Mexico, with the timing of this rise coinciding with the U.S.' imposition of discretionary tariffs on direct imports from China. Although we have argued that China may find it challenging to replicate the U.S. local production strategy adopted by Japanese firms in the 1970s and 1980s as outlined in Section 3.4, it is nevertheless catering to the U.S. main trade partners via exports and FDI. The upshot of this is that even though the U.S. may be reallocating its sourcing and imports toward Vietnam and Mexico, it may de facto remain connected with and dependent on China through third-countries, including through Vietnam and Mexico. These indirect supply chain links that the U.S. may be retaining with China deserve closer investigation as more detailed data comes to light.

Before proceeding to the next section, it is useful to highlight that this "great reallocation" away from China is likely to be highly consequential for domestic economic outcomes within Vietnam and Mexico. Already, there is anecdotal evidence that the expansion of manufacturing activity has pushed up workers' wages and industrial real estate rents in both Vietnam (New York Times, 1 September 2022) and Mexico (Kearney 2022). Several more formal empirical studies have also emerged that exploit the variation across industries or districts in Vietnam in their exposure as a third-country standing to benefit from the U.S.' imposition of tariffs on China. These have found positive responses in employment, hours worked, and wages, particularly for women (Mayr-Dorn et al. 2023, Rotunno et al. 2023), as well as in transitions from informal agriculture to formal manufacturing work (Nguyen and Lim 2023). Note though that these should be viewed strictly as short-run responses, given that the Vietnam Labor Force Survey data these studies use is available only up till 2020; future work to determine how long-lasting these consequences are would clearly be useful.[48]

5. Reallocation of Domestic Production: Evidence from Business Patterns

Is the "great reallocation" away from China prompting a reshoring of U.S. economic activity? We take a brief look in this section at emerging trends in the U.S. manufacturing sector to address this question. We draw on data from the Bureau of Labor Statistics, on establishment and employee counts by industry; this data is updated regularly and provide us with snapshots of the state of manufacturing in the U.S. up till the end of 2022. Overall, there are tentative signs of an uptick in manufacturing activity in several subsectors, particularly in semiconductors, although we should stress that this prognosis should be seen as a preliminary one: The developments and shifts in the U.S. manufacturing sector are clearly ongoing, and what we are seeing are likely just the early-stage responses to the industrial policies introduced in the past two years.

The U.S. manufacturing sector employed close to 12.9 million workers at the end of 2022, representing 3.4% of all establishments and 9.9% of total employment in all private industries.[49] From

2017-2022, manufacturing employment increased by 2.8% in the whole period for an average growth rate of 0.6% (Table 6). However, manufacturing's share of total private sector employment decreased marginally by 0.2 percentage points, from 10.1% in 2017 to 9.9% in 2022; this is slightly less than the 0.5 percentage point decrease observed in the preceding five years (2012-2017).

We focus on several sectors that have drawn attention of late in the calls to bolster domestic manufacturing capabilities, namely: automobiles, automobile parts, electronics, and semiconductors. In December 2022, these four sectors comprised 19.8% of manufacturing employment, a slight increase from 19.5% in 2017; these sectors also accounted for 11.4% of all establishments in 2022, up from 10.6% in 2017 (Table 6). Given the spotlight placed on the importance of domestic manufacturing jobs in recent debates about reshoring, it is useful to point out that these sectors differ substantially in their labor intensity: The ratio of employee compensation to intermediate input use is around 2 in electronic computer manufacturing (NAICS 33411), but this ranges downward to 1.3 in semiconductor manufacturing (NIACS 334412), 0.45 in machinery manufacturing for semiconductors (NAICS 33422), 0.2 in auto and auto parts (NAICS 3361, 3362, 3363) and just 0.04-0.08 in truck manufacturing (NAICS 336112, 336120).

At first glance, it would appear that each of the four sectors has experienced some upturn (to varying degrees) in terms of both establishment and employment counts between 2017-2022. The one exception to this would be employment in the auto parts sector (which fell 1.1%), though it should be noted that this was a sector particularly hard-hit by disruptions during the Covid-19 pandemic. (Appendix Figure 5 plots in more detail the evolution over time in these establishment and employment variables — in both level terms and when expressed as a share of total manufacturing activity — for each of the four sectors.)

Note, however, that one cannot entirely attribute these changes to policy developments — such as the U.S.-China tariffs, the Inflation Reduction Act, or the CHIPS Act — that have occurred only in the past five years. There is in particular a stronger positive pre-trend in

Table 6
Establishment and Employment Counts (2012, 2017, 2022)
Autos, Auto Parts, Electronics, and Semiconductors

	2012	2017	2022	Annual Growth		2012	2017	2022	Share Change	
	Thousands			2012-17	2017-22	(%) Share of Manufacturing			2012-17	2017-22
Private Manufacturing[a]										
Establishments	335.3	348.9	385.5	0.8%	2.0%	3.8	3.6	3.4	-0.16	-0.26
Employment	11950	12509	12862	0.9%	0.6%	10.6	10.1	9.9	-0.56	-0.23
Auto										
Establishments	2.5	2.7	3.3	2.0%	3.9%	0.7	0.8	0.9	0.05	0.07
Employment	307	390	455	4.9%	3.1%	2.6	3.1	3.5	0.55	0.42
Auto parts										
Establishments	5.6	5.7	6.2	0.4%	1.7%	1.7	1.6	1.6	-0.04	-0.03
Employment	498	594	562	3.6%	-1.1%	4.2	4.7	4.4	0.58	-0.38
Electrical										
Establishments	20.5	22.5	27.6	1.9%	4.1%	6.1	6.5	7.2	0.34	0.70
Employment	1077	1072	1116	-0.1%	0.8%	9.0	8.6	8.7	-0.44	0.11
Semiconductor										
Establishments	6.0	6.1	7.0	0.5%	2.9%	1.8	1.7	1.8	-0.03	0.08
Employment	394	387	425	-0.4%	1.9%	3.3	3.1	3.3	-0.21	0.21

Notes: BLS. Quarterly Census of Employment and Wages. Data from December of each year. Sectors correspond to the following NAICS codes matched to HS using the Pierce and Schott (2012) concordance. Autos (less parts): Motor Vehicle Manufacturing (3361), Motor Vehicle Body and Trailer Manufacturing (3362); Auto parts: Motor Vehicle Parts Manufacturing (3363); Semiconductors: Semiconductor and other Electronic Component Manufacturing (3344), Semiconductor Machinery Manufacturing (332442); Electronics and Electrical: Computer and Electronic Product Manufacturing (334) less 3344, Electrical Equipment, Appliance, and Component Manufacturing (335). Average growth rates are reported. Sector shares are of manufacturing employment. aPrivate manufacturing shares are to total employment.

the automobile and auto parts industries: Both of these sectors experienced employment growth (4.9% and 3.6%, respectively) in the preceding five years (2012-2017), which likely reflects the rebound from policies enacted during the Global Financial Crisis to revive and support the auto industry and its supplier network.

On the other hand, the trends in electrical and semiconductor manufacturing point to hints of a bottoming out in these sectors. These two sectors witnessed a decline in employment between 2012-2017, but worker headcounts have since picked up in 2017-2022, expanding by 0.8% in electrical manufacturing and by 1.9% in semiconductors. This five-year change, though, masks a good amount of volatility: Appendix Figure 5 shows that employment in electrical manufacturing actually suffered during the onset of the Covid-19 pandemic in 2020 before bouncing back by 2022; on the other hand, much of the increase in semiconductor employment has come in

the past two years (since 2021), in line with the Biden administration's push to bolster domestic manufacturing capacity in this strategic industry.[50]

On balance, there are some tentative signs in the data of reshoring in that establishment, and employment counts have picked up in recent years in manufacturing sectors that have been the focus of U.S. industrial policies. That said, there is some unevenness across sectors in the precise causes and timing of this apparent turnaround, and much remains to be seen as to how strong and sustainable these recent trends are moving forward.

6. Concluding Discussion

In this paper, we provide a comprehensive analysis of the evolution of global value chains with a particular focus on the post-2017 period, a time of unparalleled upheaval struck by both the U.S.-China tariffs and the Covid-19 pandemic. We rely on readily available data such as product-level trade statistics, measures of upstreamness, greenfield FDI announcements, earnings call transcripts, along with recent information on employment and establishments in U.S. manufacturing. We paint a wide-ranging picture of the evolving pattern of U.S. participation in GVCs across different partner countries, products, and modes, and describe how this reflects recent shifts toward friendshoring, nearshoring, and reshoring.

Rather than signaling a trend towards deglobalization, the available data hints at a looming "great reallocation" of U.S. supply chain activity. This shift is marked by a decline in direct U.S. sourcing from China, with a corresponding rise in import share from low-wage locations, chiefly Vietnam, and regional trade areas, particularly Mexico. While U.S. imports have become more upstream in their production line positioning, suggestive of the reshoring of production stages, the economic activity data presents a more nuanced picture. The semiconductor sector, for example, has shown a resurgence post-2021, while other sectors display changes that either precede 2017 or have yet to regain a loss in overall market share. These trends are subject to lags and delays in policy effects, and as fresh data unfolds, a reevaluation of these patterns will eventually be needed.

We also illustrate through our analysis that recent policy efforts may ultimately not succeed in their objective to reduce U.S. dependence on supply chains tied to China. Despite a decrease in the U.S.' direct reliance on China, there has been an increase in China's import share in "friendly" nations, including the EU, Mexico, and Vietnam. And, although geopolitical forces may prevent China from circumventing policy restrictions via domestic production in the U.S. through FDI (as Japan did in the 1970s and 1980s), Chinese firms are stepping up FDI and production facilities in Vietnam and Mexico in critical sectors, albeit from a low base. This suggests that plants in which China is the ultimate owner may continue to play a significant role in U.S. value chains.

A second concern we register is that this push toward reallocation will incur costs. Conceptually, policies that reallocate economic activity away from their market-determined equilibrium will incur static welfare losses.[51] Already, there is evidence from the literature that the U.S. tariffs have been costly from a consumer surplus perspective, as these have raised unit prices of imports from China. We have supplemented this with further evidence that the U.S. tariffs have also raised unit import prices from alternative source locations, principally Vietnam and Mexico. For a more comprehensive understanding, future research should examine the effects on firms' profitability and productivity as additional data becomes available.

Policies in favor of friendshoring, nearshoring or reshoring may nevertheless be justifiable if these generate dynamic gains that offset or exceed the static losses. As surveyed by Harrison and Rodriguez-Clare (2010), such theoretical justifications for industrial policy involve spillovers or external economies of scale, wherein the social marginal benefit from expanding production exceeds the private benefit that firm-level decision-makers internalize (see also Barteleme et al. 2019). The arguments here often hinge on the presence of Marshallian externalities or agglomeration economies, which stress the benefits of geographic proximity between individuals or firms in realizing product- and factor-market externalities and innovation.[52] In principle, the policy interventions ought also to satisfy the Mill test, whereby the assisted sector should ultimately be able to withstand

competition once the policy support is removed, as well as the Bastable test, which requires that the discounted future benefits ought to outweigh the policy's cumulative implementation costs.

However, what is arguably missing amid current debates is an articulation of the need to evaluate these welfare tradeoffs, as challenging as it is to develop general equilibrium frameworks to perform such formal assessments. Recent policies instead appear to have eliminated "exhibitions of indecision"[53] within the U.S., garnering widespread political backing and are thus poised to persist, even though periodic re-appraisals might be useful.

Along these lines, there is the concern that the costs of following through with current U.S. industrial policies may be broader and more extensive than publicly realized. The effective revival of manufacturing hubs requires integrating dependable, efficient supply chain networks and transportation systems with an adaptable, skilled labor force. Moreover, attaining optimal efficiency levels for certain sectors requires sufficient demand or scale to build specialized production facilities. The announced delays to the construction of TSMC's semiconductor plants in Arizona, arising from a shortage of skilled labor, is a case in point (Financial Times, 20 July 2023).[54]

Endnotes

[1]These studies focus on the direct impact of the "China shock" in displacing local manufacturing jobs. On the other hand, other studies have shown that low-priced inputs from China have made U.S. manufacturing firms more competitive *(Amiti et al. 2020)* and allowed for non-manufacturing employment growth that has more than outstripped job losses in manufacturing *(Caliendo et al. 2019)*. These potential gains however do not appear to have as much traction in shaping the general public's views on trade liberalization with China; see *Alfaro et al. (2023)* for survey-based experimental evidence on this front.

[2]This stands in contrast to the situation in Europe, which remains reliant on imports of energy-related resources.

[3]Several other articles have noted this trend, including: *Nicita (2019), Bown (2022), Grossman et al. (2023), Freund et al. (2023),* and *Fajgelbaum et al. (2023).* Relative to these studies, we further show that products in which China lost ground in the U.S. market also tend to be products in which Vietnam and Mexico gained in import share, and document movements in the unit values of these imports from Vietnam and Mexico.

[4]For example, *Aiyar et al. (2023)* attributes much of ongoing geoeconomic fragmentation to countries' pursuit of protectionist policies.

[5]For a detailed timeline on the U.S.-China tariff actions, see *Bown (2023).* See *Flaaen and Pierce (2019), Fajgelbaum et al. (2020), Flaaen et al. (2020),* and *Handley et al. (2020)* for studies of the impact of the tariffs on economic outcomes in the U.S., including on employment and the performance of firms in the U.S. manufacturing sector. See *Chor and Li (2021)* for evidence of the effects of the tariffs on economic activity in China.

[6]Companies have likely taken their cue from statements by Biden administration officials signaling that a unilateral easing of U.S. tariffs on China remains unlikely. For example, in testimony to the U.S. Senate Appropriations Committee in June 2022, U.S. Trade Representative Katherine Tai noted that: "The China tariffs are, in my view, a significant piece of leverage, and a trade negotiator never walks away from leverage" *(Reuters 2022).*

[7]For example, at an address to the Atlantic Council in April 2022, U.S. Treasury Secretary Janet Yellen stated that: "Favoring the friendshoring of supply chains to a large number of trusted countries, so we can continue to securely extend market access, will lower the risks to our economy as well as to our trusted trade partners" *(Yellen 2022).*

[8]See *Johnson (2018),* as well as Section 2 in *Antràs and Chor (2022),* for an overview of GVC measurement issues and methodologies.

[9]This follows the approach in *Chor et al. (2021).* We use the UN correspondences across different Harmonized System vintages to concord the data over time consistently to HS 2017 codes.

[10]Sum of exports and imports of goods and services as a share of GDP (from the World Bank's World Development Indicators, WDI).

[11]*Baldwin (2022)* cautions against over-interpreting these trends, noting that the so-called peak in trade as a share of GDP has not been synchronized across countries: While the ratio has tapered off in China, it has not peaked in some large trading economies. He further notes that some of the apparent slowdown in the value of world trade has been an artefact of the decline in commodities prices in the mid-2010s. On a separate note, there have been changes over time in the system of national income accounts, for example relating to the treatment of software in 1999 and intellectual property in 2013. The Balance of Payments methodology was moreover substantially updated from BPM5 to BPM6 in 2009; countries adopted the new methodology and harmonized older series at different times, with the U.S. incorporating these changes in 2014. To our knowledge, there is no systematic analysis of how these accounting changes might have affected observed trends in trade in goods and services over GDP. Note that there is evidence that these account for some of the perceived reduction in labor shares *(Koh et al. 2020)*.

[12]*Goldberg and Reed (2023)* have made the cogent observation that "global trade was remarkably resilient during the pandemic, and supply shortages would likely have been more severe in the absence of trade".

[13]Table 1 starts in 1994 due to the availability of the real goods trade data from the U.S. Census Bureau. The date marks the enactment of NAFTA, the conclusion of the Uruguay Round of GATT-WTO negotiations, and the early years of China's trade liberalization. Casting an eye further back, the U.S. trade balance turned negative in 1971 for the first time since 1893; see *Bordo (1992), Eichengreen (1996, 2000),* and *Irwin (2017)* for historical perspectives on U.S. policy on trade and capital flows.

[14]See, for example, *Hanson (2012)* and *Frankel (2016)* for an overview of trends in China's external trade. After the U.S. ended a longstanding trade embargo, President Nixon landed in the People's Republic of China in 1972 and established formal diplomatic relations in 1978. The 1980 bilateral trade agreement conditionally granted China the "Most Favored Nation" treatment reducing tariffs on Chinese imports to the U.S. The U.S. became a net importer of Chinese goods in 1985. See *Greenland et al. (2020)* for an evaluation of the U.S.' granting of Permanent Normal Trade Relations (PNTR) to China.

[15]In 1965, the U.S. and Canada entered the Auto Pact, agreeing to the duty-free, two-way movement of new vehicles and parts. That same year, the Mexican government introduced the Border Industrialization program, lifting foreign ownership restrictions along its border and allowing U.S. manufacturers to build

factories, import materials duty-free, hire local labor for assembly, and reexport the finished products; this eventually served as a basis for the NAFTA agreement *(Hansen 2003).* Given that the NAFTA agreement dominates the analysis period, we will refer to the trade agreement between Mexico, Canada, and the U.S. by that name in most of this paper.

[16]Note that the stable import share held overall by the EU (cum UK) masks some subtle shifts, as high-income trade partners (Germany, France, the UK) have each lost market share to lower-wage source countries in Eastern Europe.

[17]See also *Antràs and Chor (2018)* for a further discussion of the theoretical foundations and properties of the upstreamness measure. *Antràs and Chor (2013)* and *Alfaro et al. (2019)* show that industry upstreamness is relevant for understanding whether firms tend to source inputs from that industry by integrating their supplier within firm boundaries or via an arm's-length outsourcing relationship instead.

[18]From Appendix Table 1, the U.S.' main exported products by 2017-2022 average value include petroleum oils (HS2709), petroleum gases (HS2711), soybeans (HS1201), electronic integrated circuits (HS8542), machines for semiconductor manufacture (HS8486), motor vehicle parts (HS8708), and civilian aircraft (HS8800).

[19]From Appendix Table 1, the U.S.' main imported products by 2017-2022 average value include motor cars (HS8703), telephone sets (HS8517), medicaments (HS3004), and furniture (HS9403). Note that there is a fair amount of two-way trade in some product categories, such as motor vehicles and various forms of machinery.

[20]The price of a barrel of West Texas intermediate crude rose from $26 to $99 during this time; prices from the U.S. Energy Information Administration, retrieved from the Federal Reserve Bank of St. Louis, FRED.

[21]From the U.S. Census Bureau Related Party trade database, for the year 2021.

[22]Beyond the U.S., the picture is more nuanced. From the IMF CDIS database (stock, BOP FDI positions), around half of all FDI assets globally are North-North in nature, and this share has been stable over our period of study. From fDi Markets data (flows, greenfield projects), North-South FDI in the manufacturing sector has instead grown in importance in terms of both counts and capital expenditures. See *Horn et al. (2021, 2022)* and *Alfaro and Kanczuk (2022)* for the role of China as an international lender.

[23] Data from the U.S. Bureau of Economic Analysis, for 2022; by country of the ultimate beneficial owner. The total inward position in the U.S. of FDI from abroad was close to $5.25 trillion at the end of 2022, while that of U.S. FDI abroad was close to $6.58 trillion.

[24]Mitsui & Co's New York office in 1870 was the earliest recorded Japanese FDI. See *Wilkins (1990)* and *Yoshino (1974)* for a historical overview, and for later trends, see *Oldenski and Moran (2015).*

[25]Hitachi, Fujitsu, Toshiba, and Mitsubishi opened plants between 1979 and 1983. As a result of U.S. Defense Department concerns, several Japanese corporations – including Toyo Bearing in 1971 and Fujitsu in 1988 – opted instead to start their own factories on U.S. soil.

[26]Matsushita set up domestic facilities in 1974, Sanyo in 1977, Toshiba in 1978, and Sharp and Hitachi in 1979.

[27]Honda transitioned its motorcycle plant to cars in 1982; Nissan, Isuzu-Subaru and Toyota followed in 1983-1988. See jama.org. Interestingly, Japanese industrial policy did not explicitly target passenger vehicles as a high-priority sector nor did it directly support Honda: the 1961 Specified Industry Promotion Bill aimed for only Toyota and Nissan to export large cars and sought to merge smaller manufacturers (see Spar 1988).

[28]The U.S. Bureau of Economic Analysis does not disclose information from select data cells for confidentiality reasons; such instances of redactions are denoted by a black dot in Figure 2. The MNC sales used are for nonbank affiliates from 1990-2006. From 2007 onward, the data are for nonbank affiliates for Canada, Japan, Germany, the UK, and France, but includes bank affiliates for all other economies. The figure is qualitatively similar if data on all affiliates (bank and nonbank) is used consistently throughout the period (available on request).

[29]The first round of *Endaka* or high yen following the Plaza Accord of 1985, led Japanese firms to produce in the U.S., while the second round in the mid-1990s, led them to Asia.

[30]With the large year-to-year swings observed in trade flows at the height of the Covid-19 pandemic, one needs to exercise caution about start and end dates when computing changes over time, to avoid comparisons that might be skewed by the peak-pandemic years.

[31]At the same time, U.S. exports to China expanded at an annual rate of 3.4% from $129.9 billion in 2017 to $154.0 billion in 2022. The U.S.' trade with most of its significant trade partners grew in level terms between 2017-2022. In 2022, U.S. imports were lower than in 2017 for only Venezuela, Hong Kong, Russia, Nigeria, Kuwait, and Iraq; for U.S. exports, these were lower than in 2017 for Hong Kong, Russia, Saudi Arabia, Venezuela, Kuwait, Afghanistan, and Norway.

[32]Due to the health emergency during the pandemic, trade in vaccines and other pharmaceutical products intensified; the increase in trade in such products (HS codes 3002 and 3004) accounts for the rise in Ireland's and Switzerland's share of U.S. imports.

[33]On the other hand, products where China gained share in U.S. imports during this period include: electric storage batteries (HS 8507), medicaments (HS 3002 and 3004), and diagnostic reagents (HS 3822).

[34]To generate these scatterplots, we follow the specification in (2) to residualize each horizontal and vertical axis variable by the variation explained by HS2-digit fixed effects and the respective lagged dependent variable in each panel, while weighting by the initial value of product-level imports from China.

[35]The upstreamness measure is as described in Section 3.3; the labor share measure is computed as the ratio of employee compensation to total output, as computed from the 2012 U.S. Input-Output Tables, and mapped to HS4 product codes using the *Peirce and Schott (2012)* concordance (in an analogous manner as for the upstreamness measure); the tariff measure is based on *Bown (2021),* as processed by *Chor and Li (2021).*

[36]Using HS10-digit level trade data, *Freund et al. (2023)* find that the decline in U.S. imports from China was stronger for products on which the U.S. levied tariffs. Also, among products in which China lost import market share, third-country exports grew more strongly for those products that feature more two-way trade between China and the country in question; this provides suggestive and complementary evidence that the U.S. could well remain connected to China through supply chain links routed through third-countries.

[37]We compute the change in unit values over time using the Davis-Haltiwanger-Schuh approximation to a log change, in order to accommodate products which were not imported from Vietnam or Mexico in 2017, but for which importing commenced in 2022.

[38]Specifically, to capture text that speaks to a potential shift in sourcing from China to another country (say Vietnam), our measure counts the number of occurrences of: (i) the root form of "reshor*", "nearshor*", or "friendshor*" that appear in tandem with "China" and "Vietnam", and: (ii) the phrase "China to Vietnam".

[39]The earnings call data unfortunately do not permit a breakdown by detailed manufacturing industries.

[40]Using FDI values yields qualitatively similar patterns (available on request), although those illustrations are noisier due to the presence of imputed observations on project capital expenditures.

[41]This is consistent with *Ahn et al. (2023),* who document a similar broad decline in global greenfield FDI, as well as a shift in outward U.S. FDI away from China toward countries which can be viewed as the U.S.' geopolitical "friends".

[42]This decrease in greenfield FDI in China can also be seen within key sectors, including autos, semiconductors, and electronics (see Appendix Figure 4).

[43]In the United Kingdom, China also gained import market share (4 percentage points) compared to the 2.7 percentage points of the U.S. (data from UN Comtrade).

[44]Any such shifts that lengthen U.S. supply chains by involving third-country locations are likely to require firms to incur increased working capital costs *(Kim and Shin 2023)*, adding to the cost pressures that might ultimately be felt by final-good consumers.

[45]The data are obtained from the Government of Mexico, Secretary of the Economy, Economic Global Intelligence Unit, July 2023 version, available at: https://www.gob.mx/se/acciones-y-programas/competitividad-y-normatividad-inversion-extranjera-directa?state=published.

[46]This upward trend in Chinese FDI in Mexico is corroborated by media reporting; see for example "Why Chinese Companies Are Investing Billions in Mexico" in The New York Times (3 Feb 2023) and "Chinese Firms Skip Over U.S. Tariffs by Setting Up Shop in Mexico" in Bloomberg (14 Sep 2022). Both news articles draw a direct connection from the Trump administration's tariffs on China to this rise in Chinese firm FDI in Mexico.

[47]See: https://www.gso.gov.vn/en/px-web/?pxid=E0416&theme=Investment

[48]On a related note, *Utar et al. (2023)* is one of the first studies to use Mexican firm-level customs data to document an apparent increase in exports to the U.S. by firms that are participants in Mexico's export platform program, in response to the U.S. tariffs on China. This would be consistent with "nearshoring", and there is scope for work to be done to link this finding to firm-level employment and wage outcomes within Mexico.

[49]Total employment across all industries was close to 112.3 million in 2012, 124.0 million in 2017, and 130.5 million at the end of 2022. The total number of establishments in these same years went from 8.87 million, to 9.64 million, to 11.48 million, respectively.

[50]New semiconductors factories feature prominently among the sectors highlighted on the White House's "Investing in America" website: https://www.whitehouse.gov/invest/

[51]See for example *Eppinger et al. (2021)* and *Javorcik et al. (2022)* who provide assessments of the static welfare losses associated respectively with pursuing policies that decouple economies from each other or that encourage friendshoring; these are based on extensions of the multi-country, multi-sector quantitative trade model of *Caliendo and Parro (2015).* As *Goldberg and Reed (2023)* note however, there is no framework and quantitative benchmark for assessing "resilience". For a fiscal impact analysis of recent U.S. industrial policies, see *Bistline et al. (2023).*

[52]Researchers have highlighted gains derived from reduced costs of moving goods across space and proximity to suppliers and customers *(Krugman 1991)*;

labor market pooling *(Marshall 1890; Rotemberg and Saloner 2000)*; and the flow of ideas facilitating human capital development, innovation, and technology diffusion *(Jacobs 1969)*. *Head et al. (1995)* is an early piece of empirical research pointing to the presence of agglomeration effects in Japanese MNCs' decisions over their U.S. manufacturing locations. *Alfaro and Chen (2014)* find multinational foreign subsidiaries to be more agglomerative than domestic plants in capital-, skilled labor-, and R&D-intensive industries while evidence in *Alfaro, Chen and Fadinger (2019)* suggests heterogeneity in the ability of regional policies to build superstar-centered industry clusters.

[53]*Kennan (1947).*

[54]See also *Shih (2018).*

[55]Following *Antràs et al. (2012),* we scale d_{ij} by the factor $Y_i/(Y_i - X_i + M_i - NI_i)$, where $X_i - M_i$ is equal to the net exports of *i,* and NI_i is the net change in inventories of *i* reported in the Input-Output Tables. This correction accounts for industry-*i* flows across country borders, as well as into and out of inventories; as *Antràs et al. (2012)* show, this is the correction term implied by a proportionality assumption, that these industry-*i* flows are used as inputs across industries j in the same proportion as what is observed in domestic cross-industry flows.

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Data Appendix: Upstreamness Measure

In this data appendix, we provide more background on the construction of the industry upstreamness measure, that is used in Section 3.3 to compute the export and import upstreamness of the U.S.' external trade profile. This relies on the information on production linkages that is contained in Input-Output Tables.

The upstreamness of industry *i, Ui,* is a weighted average of the number of stages that output from industry *i* will traverse before it is absorbed in final demand (i.e., consumption or investment). Following the methodology in Fally (2012), Antràs et al. (2012), and Antràs and Chor (2018), we calculate *Ui* as follows:

$$U_i = 1 \cdot \frac{F_i}{Y_i} + 2 \cdot \frac{\sum_{j=1}^{N} d_{ij} F_j}{Y_i} + 3 \cdot \frac{\sum_{j=1}^{N} \sum_{j=1}^{N} d_{ik} d_{kj} F_j}{Y_i} + \cdots, \qquad (3)$$

where $N \geq 1$ is the number of industries in the economy; Y_i is gross output in industry *i;* and F_i is the value of that output that goes directly to final uses (i.e., consumption or investment). D_{ij} is the direct requirements coefficient; this is equal to the value of *i* that is used directly as an input to produce one dollar's worth of industry *j* output.[55]

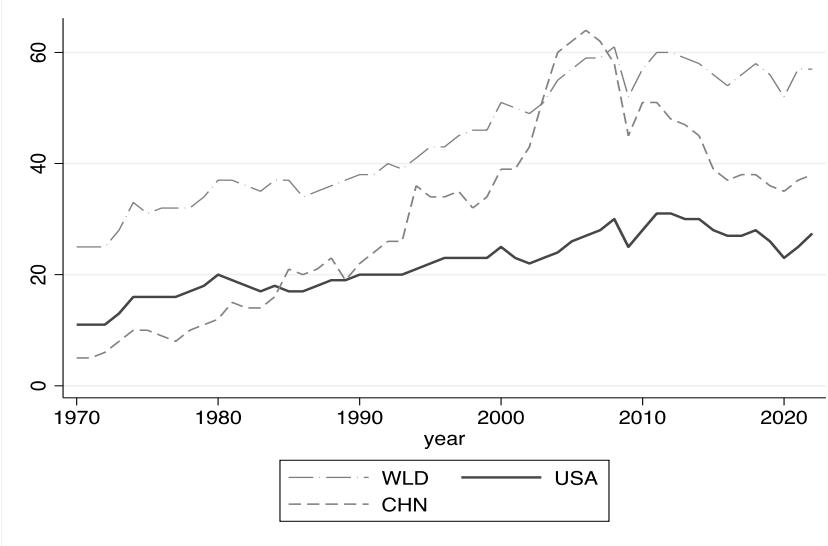
The formula in (3) assigns a weight of 1 to the share of industry-*i* output that goes directly to final use, 2 to the share that arrives at final use through exactly one other industry, and so on. By construction, $U_i \geq 1$, with equality if and only if the entirety of industry *i*'s output goes directly to final use. If, instead, the industry *i* tends to enter production chains as an intermediate input multiple stages prior to final demand, this would be reflected in a larger value of U_i. Not surprisingly, the largest U_i values tend to be seen in the extraction

and processing of raw materials, agricultural products, petrochemical manufacturing, and chemicals.

We construct U_i using the 2012 U.S. Input-Output Tables as a benchmark. This yields industry upstreamness values for a detailed set of 405 BEA IO industries. We map these to NAICS industries (2012 vintage) using a cross-walk provided by the BEA, and in turn map the NAICS industries to HS 4-digit codes (2017 vintage) using the Pierce and Schott (2012) concordance (specifically its 2018 update). When a HS4 code could not be directly associated with an IO industry, we assigned that HS4 code the upstreamness value of its HS2 digit counterpart; the latter is computed as an output-weighted average of the upstreamness of the IO industries that map to the HS 2-digit code in question.

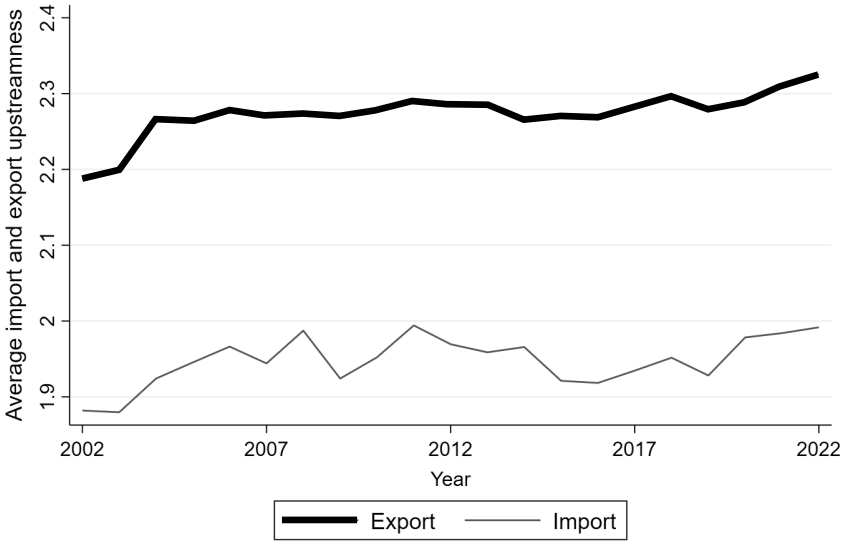
Appendix Figures and Tables

Appendix Figure 1
Trade to World GDP (1970-2022)



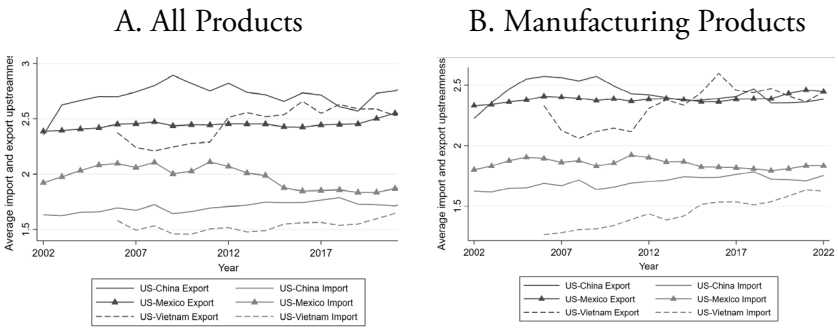
Notes: Calculated as the sum of exports and imports of goods and services divided by gross domestic product from the World Bank's World Development Indicators.

Appendix Figure 2
U.S. Export and Import Upstreamness, Manufacturing Goods Only (2002-2022)



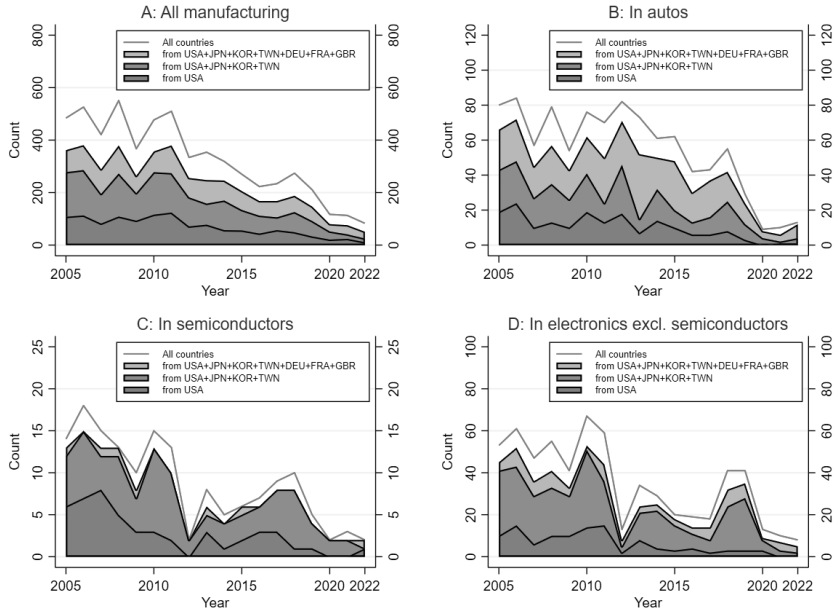
Notes: Authors' calculations based on the methodology in Chor et al. (2021), using UN Comtrade data and the 2012 U.S. Input-Output Tables.

Appendix Figure 3
U.S. Bilateral Export and Import Upstreamness China, Mexico, Vietnam (2002-2022)



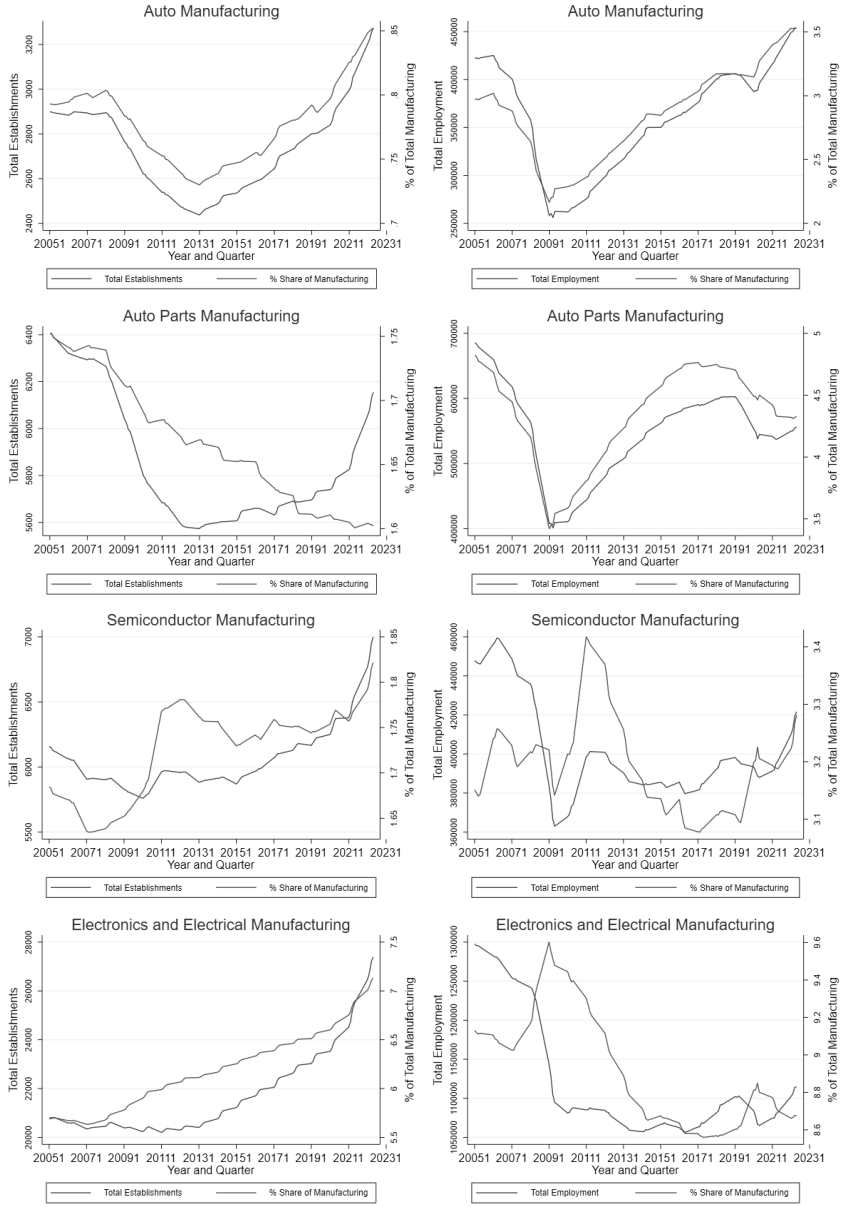
Notes: Authors' calculations based on the methodology in Chor et al. (2021), using UN Comtrade data and the 2012 U.S. Input-Output Tables. The Vietnam trade-weighted upstreamness measures start in 2006 due to limited prior trade data.

Appendix Figure 4
China Inward Greenfield FDI (2005-2022)



Source: Financial Times' fDi Markets.

Appendix Figure 5
Establishments and Employment (Quarterly Data, 2005-2023)
Autos, Auto Parts, Electronics, and Semiconductors



Source: BLS. Each series is illustrated taking rolling averages over three quarters. Sectors correspond to the following NAICS codes matched to HS using the Pierce and Schott (2012) concordance. Autos (less parts): Motor Vehicle Manufacturing (3361), Motor Vehicle Body and Trailer Manufacturing (3362); Auto parts: Motor Vehicle Parts Manufacturing (3363); Semiconductors: Semiconductor and other Electronic Component Manufacturing (3344), Semiconductor Machinery Manufacturing (332442); Electronics and Electrical: Computer and Electronic Product

Manufacturing (334) less 3344, Electrical Equipment, Appliance, and Component Manufacturing (335).

Appendix Table 1
Average Value, Share, and Upstreamness of U.S. Exports and Imports (2017-2022)

		A. Exports					B. Imports		
HS Code	Sector Name	Value (USD bn)	Share	Upstr.	HS Code	Sector Name	Value (USD bn)	Share	Upstr.
8800	Civilian Aircraft, Engines, And Parts	104.0	6.7	1.6	8703	Motor cars and other motor vehicles; principally designed for the transport of persons (other than those of heading no. 8702), including station wagons and racing cars	163.8	6.2	1.0
2710	Petroleum oils and oils from bituminous minerals, not crude; preparations n.e.c, containing by weight 70% or more of petroleum oils or oils from bituminous minerals; these being the basic constituents of the preparations; waste oils	89.7	5.8	2.1	2709	Petroleum oils and oils obtained from bituminous minerals; crude	137.5	5.2	3.2
2709	Petroleum oils and oils obtained from bituminous minerals; crude	62.4	4.0	3.2	8517	Telephone sets, including telephones for cellular networks or for other wireless networks; other apparatus for the transmission or reception of voice, images or other data (including wired/wireless networks), excluding items of 8443, 8525, 8527, or 8528	108.0	4.1	2.1
8703	Motor cars and other motor vehicles; principally designed for the transport of persons (other than those of heading no. 8702), including station wagons and racing cars	53.7	3.5	1.0	8471	Automatic data processing machines and units thereof, magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, not elsewhere specified or included	101.3	3.9	1.4
2711	Petroleum gases and other gaseous hydrocarbons	46.6	3.0	3.5	9801	Expts Of Repaired Impts; Impts Of Returned Expts	81.0	3.1	1.9
8542	Electronic integrated circuits	45.0	2.9	3.1	3004	Medicaments; (not goods of heading no. 3002, 3005 or 3006) consisting of mixed or unmixed products for therapeutic or prophylactic use, put up in measured doses (incl. those in the form of transdermal admin. systems) or packed for retail sale	78.2	3.0	1.2
8708	Motor vehicles; parts and accessories, of heading no. 8701 to 8705	40.8	2.6	2.2	8708	Motor vehicles; parts and accessories, of heading no. 8701 to 8705	68.8	2.6	2.2
8517	Telephone sets, including telephones for cellular networks or for other wireless networks; other apparatus for the transmission or reception of voice, images or other data (including wired/wireless networks), excluding items of 8443, 8525, 8527, or 8528	31.7	2.1	2.1	2710	Petroleum oils and oils from bituminous minerals, not crude; preparations n.e.c, containing by weight 70% or more of petroleum oils or oils from bituminous minerals; these being the basic constituents of the preparations; waste oils	57.1	2.2	2.1
3002	Human blood; animal blood for therapeutic, prophylactic or diagnostic uses; antisera, other blood fractions, immunological products, modified or obtained by biotechnological processes; vaccines, toxins, cultures of micro-organisms (excluding yeasts) etc	30.3	2.0	2.3	3002	Human blood; animal blood for therapeutic, prophylactic or diagnostic uses; antisera, other blood fractions, immunological products, modified or obtained by biotechnological processes; vaccines, toxins, cultures of micro-organisms (excluding yeasts) etc	46.8	1.8	2.3
9018	Instruments and appliances used in medical, surgical, dental or veterinary sciences, including scintigraphic apparatus, other electro-medical apparatus and sight testing instruments	29.5	1.9	1.6	8542	Electronic integrated circuits	36.1	1.4	3.1

Source: UN Comtrade, U.S. Bureau of Economic Analysis, U.S. Census Bureau. Upstreamness measures are calculated based on Antràs et al. (2012).

Appendix Table 2
Foreign Country Share of Imports + Multinational Affiliate Sales in the U.S., percentages (1995-2020)

Country	1995	2000	2005	2010	2015	2020
Canada	14.0	11.7	12.0	10.2	9.6	8.4
Mexico*	3.5	4.4	4.9	4.5	4.7	4.6
France	6.2	6.5	5.4	5.8	0.6	4.8
Germany	9.6	10.9	10.8	8.7	9.3	9.3
Great Britain	14.1	11.6	10.8	0.8	9.3	8.8
Netherlands*	4.8	7.7	7.0	6.2	4.9	4.8
Ireland*	0.6	1.0	1.1	1.8	2.3	0.9
Switzerland*	4.4	4.0	4.1	5.0	4.0	4.8
Japan	26.4	18.1	15.3	12.5	14.5	13.8
South Korea*	2.3	2.2	2.3	2.5	3.4	1.1
China*	2.5	2.9	6.2	7.2	8.0	7.2
Taiwan*	0.4	1.6	1.2	0.7	0.6	0.8
Singapore*	0.1	0.7	0.6	0.4	0.7	0.8
Hong Kong*	0.3	0.6	0.4	0.1	0.1	0.6
India*	0.3	0.3	0.5	0.6	0.7	1.1
Cayman Islands*	0.1	0.3	0.4	0.2	0.0	0.0
All (USD tn)**	2.1	3.5	4.0	5.2	6.4	7.2
Imports	0.5	1.2	1.6	1.8	2.1	2.2
MNE Sales	1.5	2.3	2.4	3.4	4.3	5.0

Source: UN Comtrade, U.S. Bureau of Economic Analysis. The BEA data on multinational affiliate sales are for nonbank affiliates except where denoted by a *; the latter indicates that the data for 2010, 2015, and 2020 for the country is for all affiliates (including bank affiliates), due to data disclosure redactions. ** indicates the variables reported in the lower panel are in trillions of USD. BEA data downloaded in July 2023.

Appendix Table 3
Change in U.S. Import Values (2017-2022)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	Δ Log US product-level import value from c (2017-2022)						
Import sources, c:	VNM	MEX	CAN	IND, THA, MYS, IDN	KOR, TWN, SGP	IRL, CHE	ROW
ΔCHN import share (2017-2022)	-0.583*	-1.769***	0.102	-0.819***	-1.191**	-0.615	-0.637
	[0.311]	[0.228]	[0.229]	[0.227]	[0.463]	[0.819]	[0.457]
Lag Δ log import value from c (2012-2017)	-0.157***	-0.312**	-0.121*	0.026	0.005	-0.157***	-0.482***
	[0.038]	[0.123]	[0.066]	[0.051]	[0.076]	[0.049]	[0.077]
Observations	726	1,056	1,120	1,102	1,058	956	347
R-squared	0.340	0.439	0.238	0.246	0.400	0.254	0.418
HS2 fixed effects?	Y	Y	Y	Y	Y	Y	Y

Notes: Based on HS4 product-level trade data from UN Comtrade. Variables in log changes are computed using the Davis-Haltiwanger-Schuh approximation. Estimation is by weighted least squares with HS2 fixed effects, with the 2017 value of US imports from China for the respective HS4 products as weights. Standard errors are clustered by HS2 codes; ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Appendix Table 4
Change in U.S. Import Share, Robustness (2017-2022)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	For US product-level imports from:					
Import sources, c:	VNM	MEX	VNM	MEX	VNM	MEX
Robustness check:	Sans Petroleum products		Sans HS2 fixed effects		Top 300 products	
	Panel A: Δ US product-level import share from c (2017-2022)					
ΔCHN import share (2017-2022)	-0.198***	-0.079***	-0.195***	-0.077***	-0.198***	-0.080***
	[0.025]	[0.020]	[0.028]	[0.017]	[0.025]	[0.022]
Lag Δ in c's import share (2012-2017)	0.768	-0.118	0.693*	0.096	0.936*	-0.134
	[0.529]	[0.220]	[0.383]	[0.220]	[0.542]	[0.256]
Observations	1,136	1,136	1,151	1,151	280	280
R-squared	0.529	0.296	0.296	0.064	0.540	0.308
	Panel B: Δ Log US product-level import value from c (2017-2022)					
ΔCHN import share (2017-2022)	-0.584*	-1.771***	-0.426	-1.325***	-0.487	-1.825***
	[0.311]	[0.228]	[0.472]	[0.416]	[0.334]	[0.236]
Lag Δ log import value from c (2012-2017)	-0.157***	-0.306**	-0.077	-0.247**	-0.164***	-0.322**
	[0.038]	[0.123]	[0.048]	[0.122]	[0.045]	[0.153]
Observations	722	1,045	737	1,057	266	280
R-squared	0.341	0.439	0.018	0.141	0.352	0.462
	Panel C: Δ Log US product-level import unit value from c (2017-2022)					
ΔCHN import share (2017-2022)	-1.968*	-0.630**	-0.936*	-0.897**	-2.076**	-0.678**
	[1.002]	[0.281]	[0.494]	[0.342]	[0.992]	[0.264]
Lag Δ log import unit value from c (2012-2017)	-0.337***	-0.198***	-0.228**	-0.144***	-0.347***	-0.195***
	[0.086]	[0.027]	[0.095]	[0.027]	[0.103]	[0.029]
Observations	630	915	644	927	198	203
R-squared	0.339	0.352	0.091	0.084	0.335	0.395
HS2 fixed effects?	Y	Y	N	N	Y	Y

Notes: Based on HS4 product-level trade data from UN Comtrade. Estimation is by weighted least squares with HS2 fixed effects (unless otherwise stated), with the 2017 value of US imports from China for the respective HS4 products as weights. Variables in log changes are computed using the Davis-Haltiwanger-Schuh approximation. Columns 1-2 exclude products with HS codes starting in "27" (petroleum products); Columns 3-4 exclude HS2 fixed effects; while Columns 5-6 restrict the sample to the top 300 HS4 products by value in 2017 US imports from China. Standard errors are clustered by HS2 codes; ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Appendix Table 5
Selected Countries' Import Market Shares (2012, 2017, 2022)

	2012		2017		2022	
Ranking			**MEX**			
1	USA	50.1%	USA	46.4%	USA	43.9%
2	**CHN**	**15.4%**	**CHN**	**17.6%**	**CHN**	**19.6%**
3	JPN	4.8%	JPN	4.3%	KOR	3.7%
4	DEU	3.6%	DEU	3.9%	DEU	3.1%
5	KOR	3.6%	KOR	3.7%	JPN	3.0%
6	CAN	2.7%	CAN	2.3%	TWN	2.5%
			CAN			
1	USA	50.6%	USA	51.4%	USA	48.6%
2	**CHN**	**11.0%**	**CHN**	**12.6%**	**CHN**	**14.0%**
3	MEX	5.5%	MEX	6.3%	MEX	5.5%
4	JPN	3.3%	DEU	3.2%	DEU	3.1%
5	DEU	3.1%	JPN	3.1%	JPN	2.5%
6	GBR	1.8%	GBR	1.6%	ITA	1.7%
			JPN			
1	**CHN**	**21.3%**	**CHN**	**24.5%**	**CHN**	**21.0%**
2	USA	8.8%	USA	11.0%	USA	10.1%
3	AUS	6.4%	AUS	5.8%	AUS	9.8%
4	SAU	6.2%	KOR	4.2%	ARE	5.1%
5	ARE	5.0%	SAU	4.1%	SAU	4.7%
6	KOR	4.6%	TWN	3.8%	TWN	4.3%
			DEU			
1	**CHN**	**8.8%**	**CHN**	**10.2%**	**CHN**	**12.0%**
2	NLD	8.6%	NLD	7.8%	NLD	7.5%
3	FRA	7.0%	USA	6.3%	USA	6.1%
4	USA	5.8%	FRA	6.2%	POL	5.7%
5	ITA	5.3%	ITA	5.1%	ITA	5.4%
6	GBR	4.6%	POL	4.8%	FRA	5.1%
			VNM			
1	**CHN**	**25.5%**	**CHN**	**27.5%**	**CHN**	**33.2%**
2	KOR	13.7%	KOR	22.0%	KOR	17.0%
3	JPN	10.2%	JPN	7.9%	JPN	6.8%
4	TWN	7.5%	TWN	6.0%	TWN	6.3%
5	SGP	5.9%	THA	5.0%	USA	4.6%
6	THA	5.1%	USA	4.4%	THA	3.8%
			EU			
1	**CHN**	**14.7**	**CHN**	**18.2**	**CHN**	**20.9**
2	RUS	12.2	USA	11.5	USA	11.9
3	GBR	11.3	GBR	10.8	GBR	7.2
4	USA	10.1	RUS	7.8	RUS	6.8
5	CHE	5.3	CHE	5.6	NOR	5.3

Source: UN Comtrade and Eurostat for European Union (EU). For 2022, data on Vietnam's bilateral imports were available for only a subset of countries; data for 2021 are used instead. For EU, data for 2012 is not available in Eurostat; data for 2013 are used instead.

Commentary: Global Production Networks – The Looming "Great Reallocation"

Katheryn Russ

1. Overview

This is a most welcome initial study evaluating the responsiveness of supply chains to U.S. trade policy from two of the world's foremost experts on multinational production and global value chains, Laura Alfaro and Davin Chor. They ask the important question: "What has been the impact of U.S. tariffs and other measures on the direction of trade and foreign direct investment?" The paper is by nature descriptive, an adjective I use as praise. At this point, really we just want to know what is going on — and the paper is very illuminating on this front.

At the same time, a conceptual framework would be helpful to provide benchmarks for whether outcomes are moving toward or away from some goal. It would be missing the point to use the usual modeling frameworks here. The shift in U.S. policy is occurring precisely out of a concern that our canonical frameworks do not capture geopolitical concerns or key human and environmental aims. The authors have chosen, perhaps wisely, an agnostic framework centered on shifts in U.S. demand both toward friends (called "friend-shoring") and toward domestic production (called "reshoring").

However, given the focus of this symposium on issues of policy relevance, I will take a risk. I will discuss the authors' analysis within the new conceptual framework for trade policy emerging from the two most recent presidential administrations and raise a few considerations for monetary policy.

2. Three objectives of modern U.S. trade policy

Some will mock the suggestion that there is a coherent conceptual framework underlying the direction of recent U.S. trade policy. However, three optimizing objectives for modern trade policy and its adjacent industrial policy have definitively emerged:

1. Improving the lives of U.S. workers.
2. Promoting national security through secure supply chains.
3. Addressing climate change.

2.1 Wellbeing of U.S. workers

Both the 45th and 46th U.S. Presidents have declared themselves champions of the wellbeing of U.S. workers. Alfaro and Chor take a top-line look at trends in manufacturing employment before versus after 2017. They find the most convincing evidence of a pickup in employment in semiconductor production, but only mixed signs in automotive and electrical manufacturing. Since 2017, business entry and expansion in these targeted sectors appears quite a bit more robust than trends in the jobs numbers.

2.1.1 Can industrial policy focused on businesses benefit workers?

Alfaro and Chor speculate as to several reasons for the lackluster response in employment so far, including the pandemic, lack of labor with appropriate skills, and lags in "agglomeration" effects. Others have noted the role of technology in reducing the demand for labor in manufacturing even when production increases, including *Collard-Wexler and de Loecker (2015)* in an analysis of mini-mills in the *American Economic Review* and *Kurutz (2016)* in a *New York Times* profile of Ms. Gina Locklear, a business owner leading the resurrection of sock production in Fort Payne, Alabama.

Regardless, it is important to know if complementary measures are a prerequisite for protectionism and corporate subsidies to result in benefits for workers. We might take note that Singapore, South Korea, and Japan pursued aggressive workforce development when launching their industrial policy in the 1950s and 60s, investing heavily in vocational training like metallurgy and strengthening public K-12 education *(Studwell 2013). They also are reported to have (in some cases brutally) suppressed union activity*. But an alternative approach in Germany, the birthplace of industrial policy (Studwell 2013), suggests that unions can be a mechanism both to enhance worker benefit from industrial policy and a way to facilitate the industrial policy itself *(Drubner 2017).*

2.1.2 Workers in industries where policy increases input costs

When tariffs and industrial policy raise the cost of inputs, they present headwinds that also must be confronted for workers broadly to benefit. In a rigorous analysis, Federal Reserve Board Economists *Aaron Flaaen and Justin Pierce (2019)* do not find any statistically significant impact of the 2018 steel and aluminum tariffs on jobs in steel and aluminum production after 2 years. But they do show that the tariffs on metals and Chinese goods imposed in 2018 and 2019 raised input prices for producers, resulting in a reduction of close to 200,000 manufacturing jobs in the U.S. by 2020.

Interestingly, Alfaro and Chor show that it is not just the cost of goods exported by China that have increased with the tariffs. We are also paying more for imports from our friends in industries where we have diversified away from China — whether due to increased costs or increased markups we don't know.

This begs the question — should worker-centered trade policy also be concerned about jobs in businesses that use the intermediate goods we are friend-shoring and re-shoring at higher cost?

2.1.3 Policy implications related to Objective 1

Thus, Alfaro and Chor's results underscore that worker-centered trade policy is not a panacea for employment. In terms of the Fed's dual mandate, if Alfaro and Chor's conjectures about skill mismatches

are correct, these sectoral shifts already may be affecting the level of structural unemployment. Over the longer term, sectoral shifts induced by these changes in U.S. policy may increase levels of labor force participation if they provide higher-paying jobs that do not require a 4-year college degree.

2.2 National security goals

The increasing emphasis on national security in justifications for trade and industrial policy measures over the last 7 years is unmistakable. In 2018, the Trump administration issued an extensive interagency report led by the Department of Defense outlining national security arguments for protecting supply chains across a range of industries collectively defined as the U.S. "defense industrial base" (United States Department of Defense 2018). The Biden administration issued a supply chain task force report in its first 100 days echoing a number of messages from that report, especially critical minerals and semiconductors (The White House 2021).

2.2.1 Sourcing

Policy interventions related to national security have focused on shifting sourcing away from geopolitical rivals, both by diversifying toward friendlier countries and by encouraging relocation to the U.S. Alfaro and Chor's work shows that in some respects, these interventions may be accomplishing their goal. Their careful look at the U.S. trade data shows that even though U.S. imports from China reached a 10-year high last year, the tariffs and other measures are associated with a relative shift in U.S. demand away from China toward countries seen by the U.S. as "friendlier."

At the same time, they reveal that bilateral shifts in U.S. trade flows do not equal diversification. Diversifying away from China is basically a game of whack-a-mole. Where U.S. import demand shifts, Chinese producers naturally follow — either by increasing direct investment in Mexico and Vietnam, or due to our friends importing more inputs from China as they expand their exports to us.

2.2.2 On the topic of securing supply chains

I worry about the authors repeatedly advertising the forthcoming update to the World Input-Output Tables as central to better understanding the diversification and resilience of supply chains.

Alonso de Gortari's (2019) work illustrates how we may vastly underestimate the content of imports sourced from a particular country if we use broad sectoral input-output tables instead of data on firm-level transactions. As *Ralph Ossa (2015)* shows, another reason is that the market for materials that are hard to substitute can be extremely concentrated. Maybe auto producers buy paint from many different sellers, but if all the pigments that go into the paint come from the same place *(Wheatley and Ramsay 2011),* then a shock to this seemingly minor player can severely impair auto manufacturing in far-flung places. Even though pigment is a tiny portion of value added in the input-output matrix. Finally, the World Input-Output Tables look only at the country of origin for good shipments, not at the owner's national origin, so it would not characterize Chinese-owned companies in Vietnam as being a source of dependence on Chinese goods.

2.2.3 Policy implications related to Objective 2

Thus, the only way to trace the full extent of exposure to geopolitical risk or bottlenecks is through data on firm-level transactions. This poses challenges for both research and policy.

The recent report commissioned by the Biden administration from the National Academy of Sciences on fragility in pharmaceutical supply chains is an excellent illustration of these challenges *(National Academies of Sciences, Engineering, and Medicine 2022).*

In terms of the Fed's mandate, the shifts in trade patterns and unit values documented by Alfaro and Chor suggest that policies used to redirect supply chains may affect the sensitivity of prices and investment to monetary policy by creating frictions and uncertainty in goods markets and prompting changes in firm's markup behavior. They may also affect monetary transmission by distorting flows of cross-border trade and foreign direct investment, important channels of transmission.

2.3 What about addressing climate change?

There are two ways that the shift in U.S. trade and industrial policy may be helping to address climate change manifest in Alfaro and Chor's results. Neither of them relate to subsidies of electric vehicles.

2.3.1 An unintended but not unwelcome consequence?

Work by *Joe Shapiro (2020)* presented at the Federal Reserve Bank of San Francisco Pacific Basin Research Conference in 2019 shows that goods with the highest carbon footprint are upstream goods. Think metals and semiconductors. Shapiro showed that many countries like the United States charge substantially lower tariffs on these inputs used in production than on final goods. That means we charge the lowest taxes on the dirtiest goods, effectively subsidizing their production. Shapiro estimates that if we simply evened out tariffs across all goods — whether high or low — the resulting shift in demand away from imports with a high carbon footprint could reduce carbon emissions more than the most prominent plans for reduction of global greenhouse gas emissions, including the Paris Accord.

As *Flaaen and Pierce (2019)* point out, the new trade policy is making upstream goods — inputs — more costly to U.S. firms. Alfaro and Chor's results suggest this is true even for upstream goods imported from countries other than China. The one study we have of consumer prices — by *Alberto Cavallo, Gita Gopinath, Brent Neiman, and Jenny Tang (2021)* — shows far less impact. So, by making dirty upstream goods more expensive compared to final consumer goods, the new U.S. trade policy may be shifting demand away from goods with the highest carbon footprint, helping to fight climate change.

Further, Alfaro and Chor conclude that reshoring appears to be shifting U.S. production toward upstream goods. Moving production of goods with a high carbon footprint to countries with tighter environmental standards also may help chip away at carbon emissions.

2.3.2 Policy implications related to Objective 3

For these two reasons, Alfaro and Chor's analysis is supportive of the notion that the new trade barriers and efforts to reshore manufacturing of upstream goods may help fight climate change by indirectly

inducing a reduction in carbon emissions. It is unclear whether this unintended effect will sufficiently affect volatility in climate conditions to have implications for the practice of monetary policy.

3. Summary

In summary, Alfaro and Chor provide a fascinating analysis of changes in trade patterns connected to the new U.S. trade and industrial policies. The most definitive finding is that shifting U.S. import demand away from China may not result in diversification away from Chinese suppliers. The study leaves as an open question whether there are substantial employment effects or benefits to workers from the policies, but provides some supportive evidence that a welcome but unintended consequence of the policies may be to help reduce global carbon emissions.

The potential implications of the phenomena that Alfaro and Chor document for the behavior of employment, prices, investment, transmission and even climate change mitigation as they relate to monetary policy are manifold, and likely will take years to fully identify and measure.

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General Discussion: Global Production Networks

Chair: Christina D. Romer

Christina Romer: Thank you. And now we are going to open it up for questions. All right, so the first person I had on my list was Jacob Frenkel.

Jacob Frenkel: Thank you very much. This was a fascinating set of presentations. I'd like to make a couple of points. There is one area that there is the largest gap between economic consensus and political consensus. It is the area of the gains from trade. You ask economists, they know exactly what are the great benefits and what are the cost of losing those benefits. And you go to the politicians or the public debate, you don't see it. And that's something that we have had with us for generations.

With this in mind, however, the concepts of de-globalization, fragmentation, de-risking are relatively new. There was the period just a couple of decades ago where globalization was taken as effect. It was not a policy choice. And basically we were asking how to make the best out of a situation and that's how to compensate the losers if there are losers in all the literature about the gains from trade. And the focus was therefore compensation, fiscal instruments to use it, but not asking should we give up, throw the baby out with the bath water. But the entire debate now is about how much water should we pour out and how can we maintain the baby?

The focus is economic of course, but yet most of the discussions in the last couple of years or three have come from political motivations, sanctions. So if you have sanctions on Russia or sanctions on China or sanctions on Iran, they of course have impact on all the languages that we're talking about. But the analysis of them and the cost and benefit are obviously not fully captured with the economic perspective. And the focus on goods is important of course, because that's what makes distance relevant and transportation costs. And yet the interaction among countries today is much more in the services or in the financial area where distance does not matter and the speed is there, et cetera. And those are not two sides of the balance sheet. Those are basically two things that have changed the relative weight. And I think that we need really to look at this.

Christina Romer: Why don't we pass the microphone over to Maury Obstfeld?

Maury Obstfeld: Thank you. This is a great paper Laura Alfaro, and I loved the way you lay out the facts regarding global supply chains.

Madame Lagarde referred yesterday to the recent proliferation of protectionist trade measures. And we've talked a lot in general about fragmentation and deglobalization. But I would argue that there has to date been less of a trend toward overt official restrictive or protective measures in the realm of international capital movements than in trade.

That observation brings to mind a famous paper Bob Mundell wrote in 1957, in which he showed that trade and capital mobility can be perfect substitutes. Think of a Heckscher-Ohlin world. You can equalize wages and the rental on capital through trade. Or, if you put in place even minuscule trade barriers, capital will move from the capital-abundant country to the capital-scarce country, giving you factor-price equalization in another way, through the migration of production.

This insight is very consistent with something Laura Alfarodid in one of her first charts, namely, adding MNE sales to imports. That is a very Mundellian way of looking at things. So is Kadee Russ's reference to the game of whack-a-mole that can occur if investment flows

and FDI offset what happens on the trade front. The general point is that in an idealized world, free FDI may produce consumption allocations close to those produced by free trade, even when trade is subject to barriers.

Of course, international investment is in reality subject to myriad frictions. And we are now starting to see more geopolitical influences on FDI and international portfolio flows as well as more government-imposed restrictions and incentives, often related to security or industrial policy concerns. There are also voices calling for restricting international capital flows for balance of trade reasons. If these new trends continue, then we would see a deglobalization much more significant than what we're seeing so far.

Christina Romer: Thank you. Anusha Chari.

Anusha Chari: I would like to ask you, in terms of the ultimate content, Chinese content in goods imports, how do you think that the Chinese belt and road ambitions are going to play into that in terms of China's increasing influence in other parts of the world where a lot of this manufacturing may be shifting to? Do you see the Chinese growth slowdown as a countervailing force in that regard? And I'm going to put you on the spot and ask in terms of the rising unit costs and from the perspective of monetary policy, if you want to venture a guess on the impact on inflation?

Christina Romer: Great. Why don't we take one second. We'll let Laura or Kadee respond for a few minutes.

Laura Alfaro: Thank you. Let me start with Jacob Frenkel. I am a child of globalization and as I said, I'm from a small open economy. I came from one country, married someone from a different one, study here. And so as a member of a small open economy, I do worry about this new world in which as you said, we're not considering that there were widespread benefits in many countries. The backlash, it is mostly in rich countries, it is not in developing countries. I look at some data for Latin America. And in Latin America, it's interesting that there is still favorable views despite what people think. And I'm not counting Argentina. Argentina is just too weird. On trade, even though trade with China has also increased.

But the point you made is what we have been doing in this paper. For the last five years, we took this, if you want naive view that what was happening is that economist had not explained the benefits of trade to normal people. And so what we did is we conducted this survey. It's a national representative survey when we expose participants to facts. We exposed them to different facts and we randomized. We told them if you increase trade with China, that's actually associated with the growth in employment. And that's a fact. The United States has never seen these very low unemployment numbers, mostly it's on services. If you have trade you'll see lower prices. We also told them tariffs increase prices. And we did tell them trade was associated with loss of jobs in manufacturing. When you tell them trade is associated with loss in manufacturing, you get them to be more protectionists and no one is shocked about that.

When we told them trade is associated with more jobs, we got them to be more protectionists. When we told them trade is associated with lower prices, they were more protectionists. When we told them that tariffs were associated with higher prices, they were more protectionists. So we're like, let's do this again. Maybe we have a problem of significance and let's just ratchet it up, the number of observations. And we did it again. We have been doing it for five years, we get the same result.

And so we decided we have a fact. We finally went and asked them, we just told you trade is good, why are you against it? And they said, "I don't want trade with China. I am worried about jobs." Even when I was telling them about prices. And it was not the case that they were against trade with NAFTA. It was a very specific thing about trade with China. And so we decided that maybe we learned something.

And again as the discussant mentioned, we don't have a very good framework for national security. In fact, this is a point that Penny Goldberg makes in a great Brookings paper that I recommend everyone reads. We don't have a good economic national security framework. We don't have a benchmark. But I am going to argue a little bit against the discussant. We can still evaluate. I'm a student of Harberger, and I did learn you can evaluate social benefits, you can even evaluate social costs. We do have frameworks that allow us to include

social and environmental concerns and others. We just need to have the right prices. I'm not saying it's easy. We need to find the right prices that consider externalities, so on and so forth. And I do think it is worth evaluating.

We cannot evaluate yet because a good true evaluation happens once the support is taken away. We are still supporting and thus we're going to see changes, but it can perform a proper evaluation once we take away the support. There is also a very nice paper by Grossman and Helman that they do show diversification is better than re-shoring in terms of benefits. And Amiti, Weinstein and Redding do show that the tariffs for every job they saved, cost three times. So there is a cost and I do think we need to evaluate.

On Maury Obstfeld, I agree. I do have a data set that has tracked capital flows. Controls, they didn't increase, but that is why we wanted to compliment the paper with FDI. They're different modes of entry.

And to Anusha Chari, it will be interesting. They were everywhere under the Belt and Road initiative At least in Latin America, it's very interesting and some of these initiatives, and again the expert here is Carmen Reinhart, have gone sour, Ecuador and so on, but it is about commodities.

Christina Romer: Great. Let me go to Jay Shambaugh.

Jay Shambaugh: This is a great paper and great discussion. I really thought you're framing that we're not seeing de-globalization, but a great reallocation is a terrific way to frame this.

I had a question of how much we think this would've been happening anyway absent policy. And the reason I ask is just as China's getting richer, normal global product cycle, we would've expected a lot of these goods to be moving out of China to other countries. And I know you do a little bit with trends in a couple spots, but I was just curious how much more you'd explored that. And your FDI result, which I thought was really interesting and where you note in the paper this is not a U.S./China result, this is a China centric result. The fact that all the FDI is going down long before any of the policy shifts made me think that. And the reason I'm asking most of all is

because you're really interesting result on the unit values. If the cost would've been going up in China anyway, then if you hadn't done the reallocation, the goods would've been getting more expensive anyway. And so you're not paying quite as much for this diversification from what the counterfactual in that world is just what I was thinking about. So many more questions I'll ask you later. Thanks.

Christina Romer: Heather Boushey. Right up here.

Heather Boushey: A really interesting paper that I enjoyed. And I enjoyed your comments, Kadee.

I had two questions and one actually riffs off of something that Kadee noted. I wanted to hear if you could connect this to the conversation around trade in emissions, which Kadee put on the table. But that was one of my questions after reading the paper. Because as you noted, one of the administration's goal with our trade policy is about climate emissions.

And that gets to my second question, which is that you outlined a series of sectors where we are particularly focused on what's happening with trade and supply chains, automobiles, semiconductors, and the like that you focused on in the paper. And those are important now. But we're also thinking about the sectors that are going to be important moving forward, particularly around clean energy and the really important supply chain considerations there. And my instinct is that you don't have data on that, but I was wondering if you could say anything to how we should be thinking about these sectors that we think are so important to get the supply chains right moving forward?

Christina Romer: Let's move to Marcus Brunnermeier.

Marcus Brunnermeier: I would like to make two points to this very nice paper: First, the word "resilience" didn't appear much, and I also missed the word "multi-sourcing." I was wondering whether you can expand your analysis to include these concepts? Do you have data which show that replacing one single supplier with multiple suppliers? In other words, is there empirical evidence that multi-sourcing

that increases resilience is more prominent in addition to a simple "great reallocation"?

Second, is there a way to capture that small open economies suffer particularly from the fragmentations of the global economy? When large strategic global players play among themselves small countries might become collateral damage. Is it possible to include this aspect in the analysis?

Nina Pavcnik: Great paper. I like how you put together all these different data sources to try to make progress on a really difficult question. I want to follow up on the question that Jay Shambaugh had. How much of this would be happening already in the absence of the changes in the U.S. trade policy vis-à-vis China? With the data from Vietnam, there are a lot of pre-trends there. But one thing that's very different is that there was retaliation in response to U.S. trade policy. And I'm curious about your thoughts, how is that positioning the U.S. and U.S. companies relative to other high-income countries like Japan and EU and how they are dealing with the challenges of resilience of global supply chains?

And the second question relates to the issues of distributional consequences that Kadee Russ and Jacob Frenkel raised. Perhaps the backlash against the globalization in the United States is so much higher because we haven't dealt with distributional consequences as well as for example some of the European countries. And moving forward, what do we do with that?

Christina Romer: Laura, I'm going to let you have time to respond.

Laura Alfaro: So many questions. Figure 3 in my article: we put it there to show pre-trends. You do see there are pre-trends. It was happening. You do see an increase after 2017. Look at Vietnam, you see it. So it does there was a movement for some reallocation. But, we pushed, it so it's more expensive. And so it's not only that normal process.

We don't have emissions. And so I'm going to be an economist and not venture in things we're not doing. But I do have another paper that is looking at rare elements and you cannot do clean energy

without magnets. And so those magnets are in different countries. And also I have to say we really have not evaluated the cost of all clean energy supply chain. Producing these rare magnets, some of these rare elements, it can be very, very polluting and there's a reason it went to the countries it went. So we need to do it properly, the whole value-chain. Tesla is more expensive and more polluting in the short run. You need to keep your Tesla for a long time to be cost-benefit. Where I live, everyone has a Tesla and another car, so they're not depreciating the Tesla. I also don't know what we're going to do with all the solar panels. They last 30 years. Is anyone counting what we're going to do with those solar panels and incorporating it in the cost of emissions? But as I said, we don't have the data, we don't go there.

Resilience, it can be done with the data. We haven't done it. But it's interesting; we are doubling down on Mexico, which could be a good thing. It's a friend. Nicaragua used to be a friend. But let me just mention again, that the U.S. value chains are not really global, they're more regional. That might be different from Europe.

Christina Romer: Let me move over to Kadee Russ.

Kadee Russ: Two questions just jumped out at me. So I didn't want to cite our work in my discussion, but I agree with Jay Shambaugh that some of this would've been happening anyway. We already [pre-trade-war] saw production moving from China to Vietnam. We also saw production moving from Mexico to Vietnam I think. But I think that in [the trade war] case increased costs for Chinese goods would give way to lower geographic frictions with Mexico. And what Laura and Davin Chor show is that it is more assembly type work moving toward Mexico and the higher tech goods are going to Vietnam, which would be consistent all around with product cycle.

And then finally on this political economy question, I just can't resist saying I really think that we have to be careful about how much we know about gains from trade and especially as they apply to individual people and communities. I think in economics we tend to think about it in an aggregate sense, but the effects are really unevenly distributed. And so the truths are different depending on where you live and who you are.

And I think that's why when we do surveys of people and say, "Oh, well look what the impact on prices is, look at this evidence and then what do you think?" And they still say, "Screw you." I mean I spoke about this with some political scientists and they basically said that it's a bunch of elites saying these things and respondents are refusing to participate. And so I think we really need to listen more carefully to these messages from political scientists and I guess maybe be a little bit more cautious carrying this flag.

Christina Romer: All right, let's get another round of questions in.

Ilan Goldfajn: That's a great paper Laura and co-authors and great evidence of the reallocation. You have been using near-shoring and friend-shoring, interchangeable. I will say moving to Mexico have some component of near-shoring. Vietnam, more in the friend-shoring part. When we are concerned about fragmentation and distortions, maybe thinking about the United States as a regional trade and integrating with the Americas may be less fragmented, less distortionary. So maybe you can see Latin America the rest and see if it's a control if we are talking more about friend-shoring or more about near-shoring. The evidence from Mexico that's not yet in the data is that we are getting quite a lot of demand and reallocation to the north from Mexico.

Jared Bernstein: Laura, this is an awesome paper, great work. And Kadee Russ, your comments are so welcome and so resonant.

I have a comment but before I make my comment, the most important thing about this paper from my perspective is you need to keep updating it. So I'm sure you have lots of other work to do, but I can tell you that we in the administration are going to want to follow these numbers very carefully so you've provided a valuable resource.

Just a quick comment by one of the many people who was an author of the Biden industrial policy. In my view, this policy implies neither more nor less trade. That may sound a little controversial, but I believe it's true. I think there are margins where trade go either way. Certainly we want to do more domestic production. But as Laura just said and as the paper demonstrates, nature and her wisdom put many of the goods we'll need in other countries. So imports of intermediate

goods should persist. I certainly took one of the messages from the paper thus far that what I said holds in the data, although it's too early days to measure that. But I want to be very clear because I think the debate has gotten pretty distorted on this point in my and many of my colleagues view, the strategy that we're pursuing despite a lot of heated rhetoric implies neither more nor less trade.

Pierre-Olivier Gourinchas: I thought it was a terrific paper and I thought the discussion was also fantastic, so thanks for this.

So as you can imagine at the IMF, we're particularly concerned with anything that might get in the way of global economic integration and could unravel some of the gains that we've realized and accomplished in the last 50 years or so in that space. And we've been doing a lot of work trying to think about different scenarios, different channels, different types of costs that could arise from increased fragmentation. And in our own estimates, the costs range from fairly modest in some cases to fairly large for some countries depending again on the type of channels. But let me take it to the capital flow side for a minute and maybe building on the comment by Maury Obstfeld earlier.

There, I think one of the things we found is if you look at FDI, and we had a whole chapter in our April world economic outlook report, you find very significant evidence that FDI flows are increasingly driven by geopolitical distance as opposed to geographical distance. It's a stronger driver of bilateral FDI and increasingly so. So, I think in the context of what we are seeing already, I think this is an important observation.

The second observation is when we think about current accounts, so that's another space where we don't see de-globalization. I mean if you think about the pattern of current account balances last year for instance, which are the large surplus countries? Well, that's China, that's Russia, that's Saudi Arabia. Those are not necessarily countries that you would put into the western camp without any qualifiers. And where are the current account deficits? Well, they're in the U.S. and other western advanced economies.

But what we see there is something that is similar to what Laura describes in the context of trade in her paper. Which is in the past these countries that are running current account surpluses, they would tend to accumulate reserves. And they would accumulate the reserves that would be held in the form of U.S. treasuries. And we're seeing much less of that. What we're seeing instead is a lot of opacity in the balance of payment data where these countries are accumulating surpluses and these surpluses are channeled through third parties and they're probably ending up in the form of U.S. treasuries and other reserve assets, but through ways that are much, much harder to trace. I think that's another evidence that we're getting a more complex space there both in the trades space but also in the capital flow space.

Christina Romer: I want to get one last question in. Kristin Forbes?

Kristin Forbes: You have a room full of central bankers. So I was hoping you and maybe Kadee Russ and Christina Romer, if you want to jump in, could comment on what this implies for monetary policy. More specifically, you cite this quite striking statistic that re-shoring leads to an increase of unit costs of 3% if you go to Mexico and 10% if you go to Vietnam. If that's a one-off hit to the price level, that's a hit to living standards that is painful, but the appropriate monetary policy response could be to largely look through it. If this is going to be a hit to productivity growth every year hereafter, however, then this has implications for the "stars" and big implications for central banks and monetary policy. So I was hoping you could elucidate.

Sebnem Kalemli-Ozcan: To answer Kristin Forbes, I'm sure Laura Alfaro also has an answer, but since we did this paper, I thought I will tell what we find. We look at the inflationary implications of a possible fragmentation, both analyzing the drivers of the last three years of inflation and future effects of a possible fragmentation and what does this say on monetary policy. We found inflation would be much higher in a world when supply is constrained. Fragmentation is going to increase supply constraints due to intensity of the sectoral shocks. This does not all have to be via trade as in Laura's work but rather can play out in domestic sectors using traded inputs through complementarity.

Laura Alfaro: Ilan Goldfajn, in the case of the Americas, it is near-shoring. You see it in Mexico, you see it in Costa Rica, but you don't see it in South America. Jared Bernstein, that's the title of our paper, the Great Reallocation. Pierre-Olivier Gourinchas, I agree, it's hard to track capital flows, and in the U.S., a lot comes from Cayman Islands. And again, Carmen Reinhart is the expert on trying to find Chinese capital flows. However, having said that, the U.S. remains in terms of capital flows, very North-North. So it's interesting that in capital flows, it's still North-North, while in trade, we have seen significant North-South reallocation.

Kristin Forbes, and this also to Anusha Chari's question before, and to one of the discussant's points. I think Alberto's paper is a way lower bound on the CPI cost because of the timing of the data they had and because we captured more than the 2017 tariffs in the time-period we're using. Because again, now it is not only the tariffs but also subsidies. But also it's the reallocation because as we put in the paper, firms were in a moment, I don't know, should I reallocate or not? Now they're like, "No, no, this policy will stay." The following I can declare independently on who wins in the next election: these policies and subsidies will stay as I mentioned, there is also wide-spread support or rather backlash against China's trade. And that means that a lot of firms giving green lights to plans to start plants in the U.S. And we have seen it in the press, they don't find enough materials, they don't find enough skilled labor, costs are going up.

So what conceptually it could be just a one-off relative price effect, as Kristin Forbes mentioned. But because of the sheer volume of fiscal support, and lags in investment, the effects will be slowly dripping with pressures on inflation, and then the job is to try to manage those expectations. But Amiti, Weinstein, and Redding find that just the tariffs was 1%. I still think that's a lower bound. I think it's going to be a little bit more.

Christina Romer: I was going to let Kadee Russ have the last word to answer Kristin's question.

Kadee Russ: On monetary policy, I think the panel yesterday would be best placed to say whether this is a one-time hit to productivity

versus a longer run dynamic hit. But I will say that these kinds of frictions. I won't call it central planning, but when you start introducing these kinds of frictions, that's going to make large segments of the economy less sensitive to monetary policy. At the same time, while these actions may make us more resilient to geopolitical shocks, they may make us less resilient to any other kind of shock. And so there's more need for monetary policy to act as a stabilizer. There are really big challenges ahead for monetary policy if we and other countries continue to pursue this.

Global Financial Flows: Living with High Public Debt

Serkan Arslanalp and Barry Eichengreen[1]

1. Introduction

Public debts have soared to unprecedented peacetime heights. These high debts pose economic, financial and political challenges.[2] Multilateral financial institutions and others have consequently laid out scenarios for bringing them back down.

Our thesis in this paper is that high public debts are not going to decline significantly for the foreseeable future. Countries are going to have to live with this new reality as a semi-permanent state of affairs. These are not normative statements of what is desirable; they are positive statements of what is likely.

First, large, persistent primary budget surpluses are not in the political cards. Over the last half century, episodes where countries have run primary surpluses of, say, 3 to 5 percent of GDP for extended periods are very much the exception to the rule. Maintaining large primary surpluses requires favorable economic conditions and a degree of political solidarity that does not exist. Divided government and slow growth make this route to debt consolidation even more challenging than in the past.

Second, it is difficult to imagine more favorable interest-rate-growth-rate differentials (favorable interest-rate-growth-rate differentials reducing debt ratios in an accounting sense). Real interest

rates have trended downward to very low levels. It is hard to foresee them falling still lower. Faster global growth is pleasant to imagine but difficult to engineer.[3] History suggests that the reorganization required of firms to capitalize on Generative Artificial Intelligence and other new general-purpose technologies, in ways that translate into faster aggregate growth, may take a decade and more.

Third, inflation is not a sustainable route to reducing high public debts. Only unanticipated inflation has this effect. Although an anticipated increase in inflation may reduce debt ratios in the short run by raising the denominator of the debt-to-GDP ratio, in the long run it is apt to raise interest rates and shorten maturities. At both horizons, these effects are unlikely to be economically important.

Fourth, statutory ceilings on interest rates and related measures of financial repression are less feasible today than in the past. Investors opposed to the widespread application of repressive policies are a more powerful lobby. Financial liberalization, internal and external, is an economic fact of life. The genie is out of the bottle.

All of which is to say that, for better or worse, high public debts are here to stay.

These high debts are more of a problem for emerging market and developing economies (EMDEs) than for most major advanced economies. There exists robust demand for the high-quality public-label securities of advanced-country governments by economies around the world, and by emerging markets in particular. Demand comes not only from emerging-market central banks, which hold the AAA-rated bonds of the United States and other advanced-countries as reserves, but also from the private sector. We highlight this private sector demand, which is on the same order of magnitude as foreign official demand. Private financial institutions hold safe assets as capital and reserves. Investors hold them because they are free of adverse selection. Individuals hold them as insurance against idiosyncratic shocks. Since emerging market governments have limited capacity to produce safe assets, this demand is satisfied by the governments of advanced countries like the United States. This structural source

of demand suggests that the high public debts of advanced-country governments, if not optimal, are in most cases manageable.[4]

The public debts of emerging markets and developing economies do not benefit from this additional demand. Their debt ratios may be lower, but they are more difficult to sustain for this reason and for reasons of debt maturity and composition. Given high inherited debts, there is an argument for debt restructuring in a range of developing economies. Unfortunately, history shows that an extended period, marked by serious difficulties in highly-indebted developing economies, must pass before stakeholders acknowledge this reality and organize themselves accordingly. Indeed, recent changes in the structure of global financial markets make that acknowledgment and organization even more difficult. Not surprisingly, a lengthy period of little to no progress is what we have seen. Developing economies continue to be saddled with heavy debts and limited capital-market access.

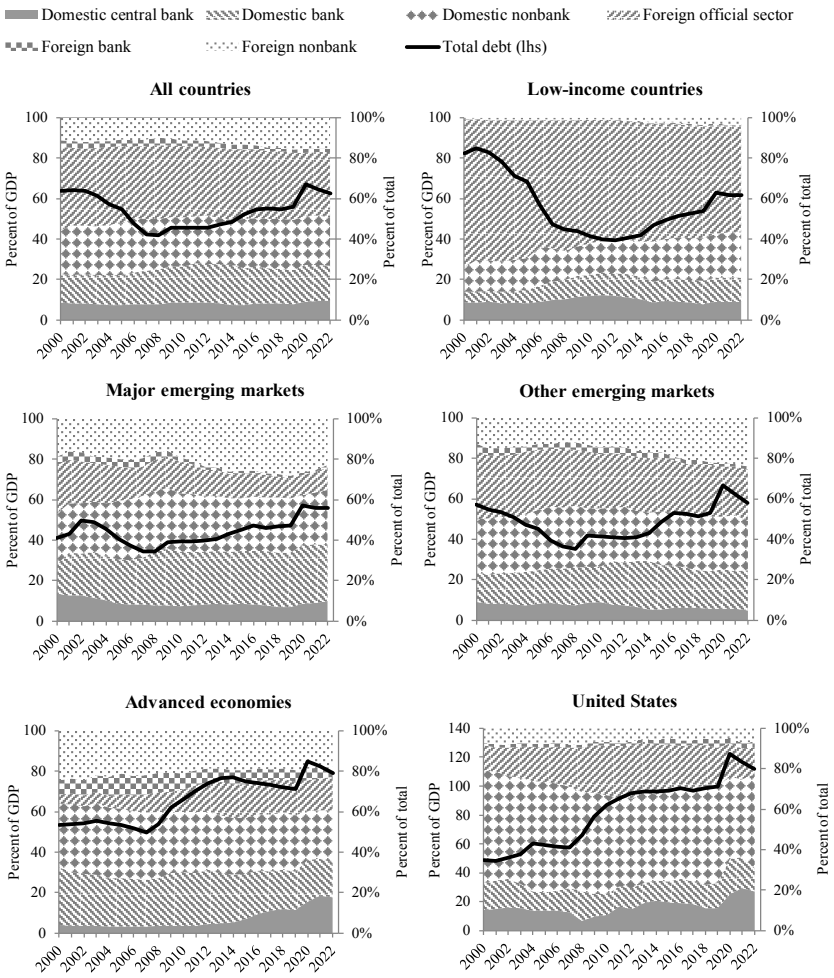
2. Global Stock of Public Debt

Figure 1 summarizes in one page the evolution of public debt since the turn of the century. The data cover government debt in the form of both securities and loans in domestic and foreign currencies. This is in contrast to data sets that consider only debt securities, long-term debt securities or external debts, and which cover fewer countries. We consider a total of 182 countries: 67 developing economies, 81 emerging markets, and 34 advanced economies.[5]

The figure shows gross government debt on a consolidated basis (i.e., excluding intergovernmental holdings but including debt in the hands of the central bank), scaled by GDP and aggregated as an unweighted average across countries.[6] Globally (top left panel), debt ratios trace out a u-shaped pattern, falling prior to the Global Financial Crisis (GFC) and rising thereafter, followed by a jump with the onset of COVID-19. There is then a decline in debt ratios in 2020-21, reflecting the impact of unexpected inflation and the resumption of growth. Most of this is well known, although progress in reducing debt ratios prior to the GFC, when debt ratios fell on average from roughly 60 to 40 percent, is relatively little remarked upon.

Figure 1
Holders of Government Debt, 2000–22

(Total in percent of GDP; Components in percent)



Note: Government debt indicates general government gross debt on a consolidated basis, which excludes intergovernmental holdings. Domestic banks are depository corporations residing in the country (IFS definition.) Foreign banks are BIS reporting banks residing outside the country. Foreign official includes foreign bank holdings and foreign official loans. Foreign nonbanks and domestic nonbanks are imputed from external and total debt.
Source: Arslanalp and Tsuda (2014, updated).

These patterns are pronounced among developing economies. On average, indebtedness fell by half before the GFC (again, relative to GDP). This reflected debt relief under the Heavily Indebted Poor Countries (HIPC) Initiative between 2001 and 2005, when annual debt service payments by 36 eligible countries declined by about

1.5 percentage points of GDP, together with fiscal reforms put in place to qualify for the initiative. This was followed in 2005 by the Multilateral Debt Relief Initiative (MDRI) under which countries completing the HIPC process received 100 percent relief on debts to the IMF, World Bank and African Development Bank. 31 of 36 eligible countries saw their debt loads reduced substantially. Some such as Ghana had 70 percent of their debts cancelled, while others such as Liberia and Malawi had 90 percent written off. The contrast between the sharp debt relief achieved under these programs and lack of progress to date under the G20's Common Framework for Debt Treatments is evident and painful. This contrast reflects the rise of non-Paris Club creditors and of market finance relative official lending (more on which below).

Debt ratios in developing economies then rose sharply in the most recent decade, facilitated by accommodative global credit conditions. Debts averaging 40 percent of GDP a decade ago are now half again as high at 60 percent. 40 developing economies (according to Chuku et al. 2023) are in debt distress, their capacity to repay having been damaged by shocks to global food and fuel prices, depressed tourism revenues, and fallout from climate events and natural disasters. These include a number of countries that received debt relief in the early 2000s, which is a reminder that debt restructuring alone is not sufficient to ensure sustainability.

Emerging markets similarly show sharply increasing debt ratios, again rising from the range of 40 to 60 percent of GDP on average over the last decade. Half of this increase is concentrated in recent years, despite the favorable impact of inflation on debt ratios in 2021-2. The optimistic take is that deficits have persisted and debts have risen because government revenues respond with a lag to reopening and recovery from the COVID crisis; as these revenues materialize, fiscal balances will strengthen. The pessimistic take is that economic growth in emerging markets, and growth of the associated revenues, will slow with higher inflation and interest rates and due to disruptions associated with Russia's invasion of Ukraine (Kose and Ohnsorge 2023). Such disagreements are what make markets (and vigorous conference discussions).

In the advanced country world, as seen at the bottom of Figure 1, debt ratios remained essentially flat in the run-up to the GFC, reflecting success at growing the denominator of the debt-to-GDP ratio — success that, in the event, was not sustained.[7] Debt ratios then rose sharply between 2008 and 2014, reflecting bank bailouts, budget deficits, and sluggish economic recovery. This was followed by modest fiscal consolidation until the COVID crisis, when debt ratios shot up.

The final panel of Figure 1 focuses on the United States. There is no visible tendency for the U.S. debt-to-GDP ratio to fall at any point since the turn of the century, in contrast to elsewhere.[8] The debt ratio then jumps up with the onset of the GFC and again with COVID-19.

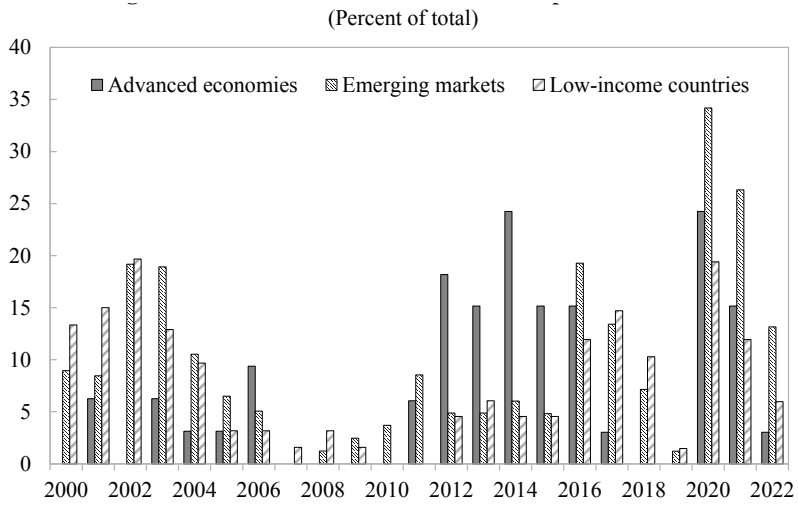
These cross-country averages impart a sense of gradual change and thus disguise the extent to which exceptional events alter the debt landscape. Figure 2 brings out this aspect by highlighting debt spikes, defined as episodes when the increase in the debt ratio in a period of five or fewer years is in the 80th percentile of such increases.[9] Episodes then end in the first year in which the debt ratio falls. If the debt ratio rises strongly in 2007-11 but then falls in 2012, for example, the spike is dated as occurring in 2012.

This is what we see for the advanced economies, more than 70 percent of which experienced debt spikes in the Global Financial Crisis. In contrast, the share of advanced countries experiencing sharp increases in debt ratios in the COVID-19 crisis is less. The opposite is true of emerging market and developing economies, a larger share of which saw their debts spike in response to COVID than the GFC. COVID was a global shock, whereas the GFC was centered in the advanced economies. In addition, there was a stark difference in the magnitude of fiscal stimulus provided by advanced economies versus that provided by emerging market and developing economies during COVID.[10] The contrasting implications for public finances in different parts of the world are direct.

3. Structure of Global Debt

Globally, the most notable shift in terms of who holds public debt is the rising share of foreign nonbank investors — mutual funds,

Figure 2
Percent of Countries with Debt Spikes, 2000–22



Notes: A debt spike episode begins with an increase in debt (as a percent of GDP) in five years above the 80th percentile and ends with a decrease in debt in the following year.
Source: Arslanalp and Tsuda (2014, updated)

pension funds, insurance companies and hedge funds, among others — and the declining share of the foreign official sector. This is the tendency for financial markets to supplant official bilateral and multilateral lenders as more countries tap domestic and international capital markets.

The retreat of foreign official finance is especially evident in developing economies.[11] But the retreat of official lending is also visible in emerging markets, matched in this case by the rising share of debt held by foreign nonbank investors. The contrast with developing economies, where the rise of foreign nonbank investors is not equally apparent, is a reminder that institutional investors looking to emerging and frontier markets continue to focus mainly on the former. The growing footprint of foreign nonbank investors in emerging markets has implications for volatility: Fang, Hardy and Lewis (2022) show that demand for emerging market debt by private nonbank foreign investors, and investment funds in particular, is highly reactive to yields. Their results suggest that this change in investor composition can accentuate capital-flow reversals when rates rise in advanced

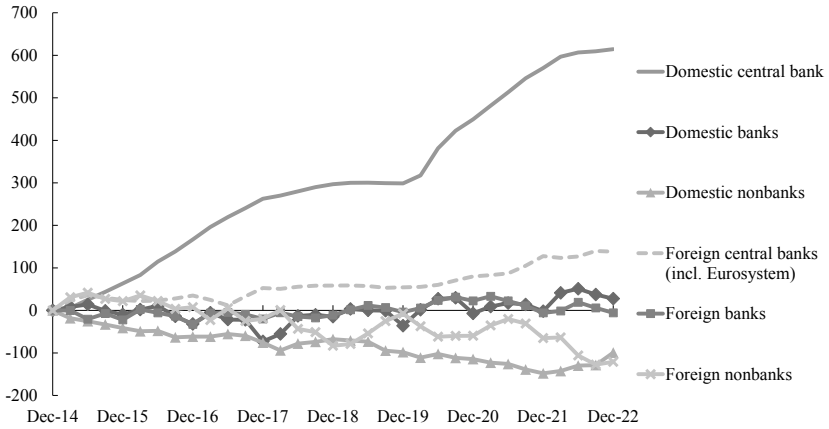
countries. These observations also speak to the literature on the global financial cycle (Miranda-Agrippino and Rey 2021) and its growing importance over time (Potjagailo and Wolters 2023).

There is also some tendency in emerging markets and developing economies for domestic banks (and in developing economies also nonbanks, meaning local pension funds and insurance companies) to hold a larger share of government debt. This rising share of banks will not reassure those wary of the diabolic loop (the tendency for sovereign debt problems and banking problems to compound one another). Large bank holdings also create problems for debt restructuring, since forcing losses on banks can create recapitalization costs for taxpayers that more than offset any interest savings, whereas exempting the banks may require severe haircuts of other investors, jeopardizing their cooperation.

Two compositional changes dominate the picture for advanced countries. One is the reduction in the share of government debt held by domestic banks. This reflects developments in Europe, where the Euro Crisis drove home the riskiness of bank holdings of government bonds, causing banks to pare them down and authorities to toughen provisions regulating bank portfolios.[12] The other is the rise in the share of government debt held by central banks. In the case of central banks holding their own governments' bonds, this reflects unconventional monetary policies, the balance-sheet effects of which have been unwound only slowly (if at all). In some cases, Italy for example, the vast majority of net public debt issuance since the end of 2014 has been purchased by the national central bank (see Figure 3). This renders us wary about the impact on spreads and debt sustainability of quantitative tightening (Arnold et al. 2023).

The increase in central bank holdings of advanced-country bonds also reflects the accumulation of reserves by developing countries. This accumulation centered on 2002-15, after which reserve growth slowed or moved into reverse. The share of U.S. Treasury securities held by foreign central banks rose through 2013, after which some deaccumulation took place as central banks expended dollar reserves to support their currencies.[13] In particular, China's foreign exchange reserves peaked in 2013-14 but then declined with financial-market

Figure 3
Italy: Cumulative Net Purchases of General Government Debt by Investor Type, since end-2014 (in billion euros)



Source: Arslanalp and Tsuda (2014, updated).

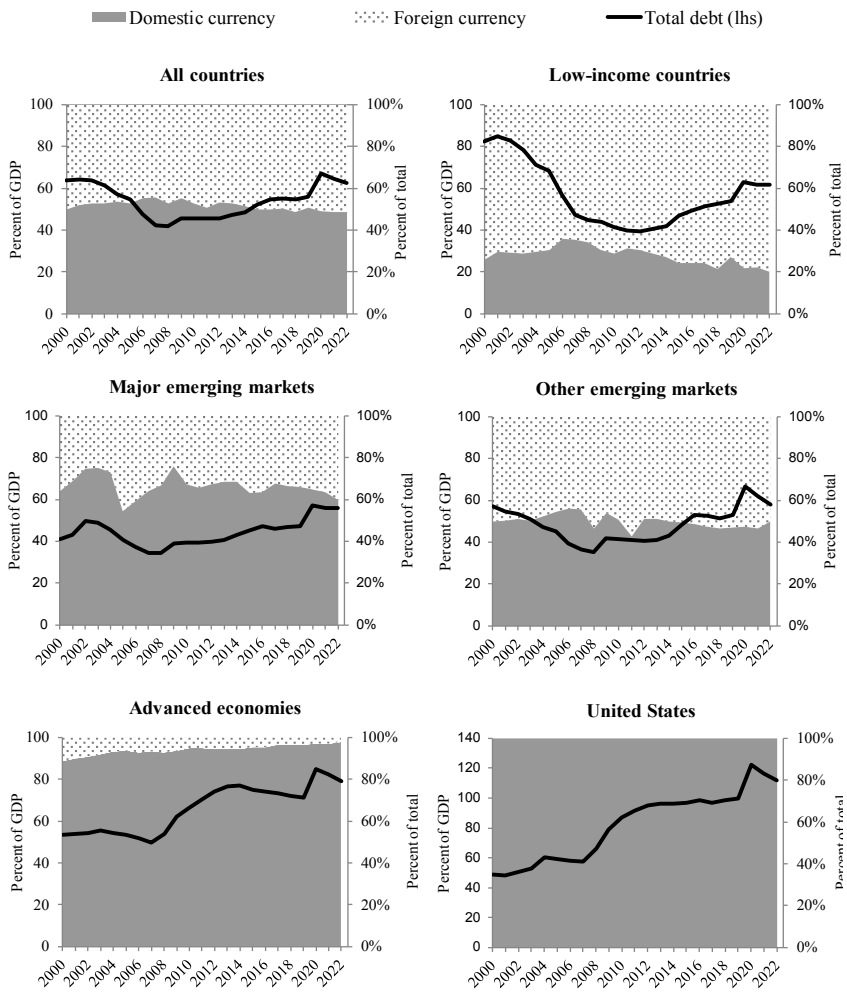
volatility and capital outflows in 2015. The PBoC remains the single largest holder of foreign exchange reserves, although it has been trimming the share held in U.S. Treasuries.[14] More generally, there has been gradual diversification by central banks away from the dollar, again most visibly since 2015 (Arslanalp, Eichengreen and Simpson-Bell 2022). The run-down of foreign reserves, and growing geopolitical tensions prompting some central banks to contemplate diversification away from dollar reserves, raise questions about whether foreigners will remain an equally important source of demand for U.S. public debt going forward.

There was a push following the Asian financial crisis to develop bond markets in order to diversify the population of investors (and insulate the government's finances from flighty foreigners), while limiting dependence on foreign-currency debt (the Asian crisis having pointed up currency-mismatch problems). Figure 1 confirms some progress in developing domestic bond markets as gauged by the share of debt held by domestic nonbank investors.[15]

Figure 4, in contrast, shows the breakdown of government debt (both securities and loans) by currency denomination. Contrary to

Figure 4
Currency Composition of Government Debt, 2000–22

(Total in percent of GDP; Components in percent)



Source: Estimates based on Arslanalp and Tsuda (2014, updated).

what is sometimes asserted, little movement is evident in the shares of domestic- and foreign-currency debt, looking across all countries on average. Much has been made of the success of large emerging markets, such China and India, that issue the entirety of their sovereign debt in their own currencies. The figure confirms that the share of debt in local currency is relatively high for these major

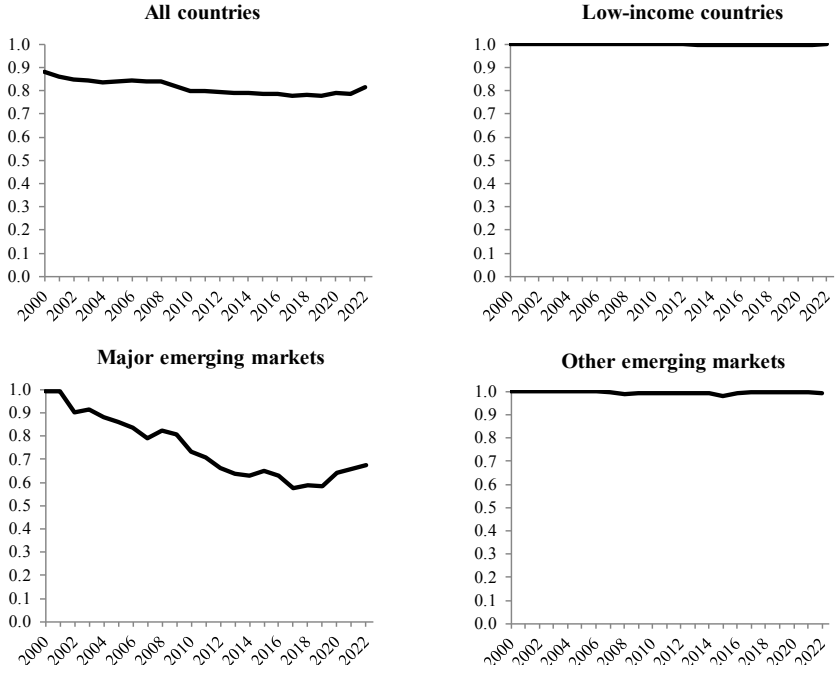
emerging markets. But it also confirms that these cases remain exceptions to the rule.

Policymakers have paid special attention to the currency denomination of sovereign debt held by foreign investors. Historically, foreign investors have preferred foreign-currency debt, something that created currency mismatches and financial fragilities for emerging-market sovereigns. Considerable effort has been devoted to solving this problem of "original sin," as the failure of sovereigns to sell local-currency debt to foreigners is known. Figure 5 shows a measure of original sin, computed as [1 — (Securities held externally and external loans taken by country i in currency i/Securities held externally and external loans taken by country i)]. (To be clear, securities held externally *include* debt issued domestically but held by foreign investors.) Figure 5 suggests that assertions of redemption from original sin are exaggerated.[16] Some readers will find this surprising, but the fact is that significant progress has been limited mainly to larger emerging markets and not shared by the many smaller countries in our global sample.

Two interpretations suggest themselves. First, even if a substantial share of new issues purchased by foreigners are in the local currency, it takes time to transform the outstanding stock. Figure 6 looks at the currency composition of new debt issuance, both domestic and foreign, by year. In major emerging markets, this has risen strongly over the last two decades, from roughly 40 to nearly 80 percent of new issuance. For other emerging markets and low-income countries, however, domestic-currency-denominated securities are typically half or less of new issuance, something that works only slowly to transform the outstanding stock.

The other interpretation focuses on country size and foreign investor appetite.[17] For small countries, the costs of placing domestic-currency bonds with foreign investors (underwriting fees and interest premia, for example) exceed the risk-reduction and other benefits. Foreign investors are slow to add bonds denominated in exotic currencies, given modest diversification benefits and significant information costs. These constraints bind less tightly for large countries. Many emerging markets that have made substantial progress on this

Figure 5
Original Sin Index, 2000–22

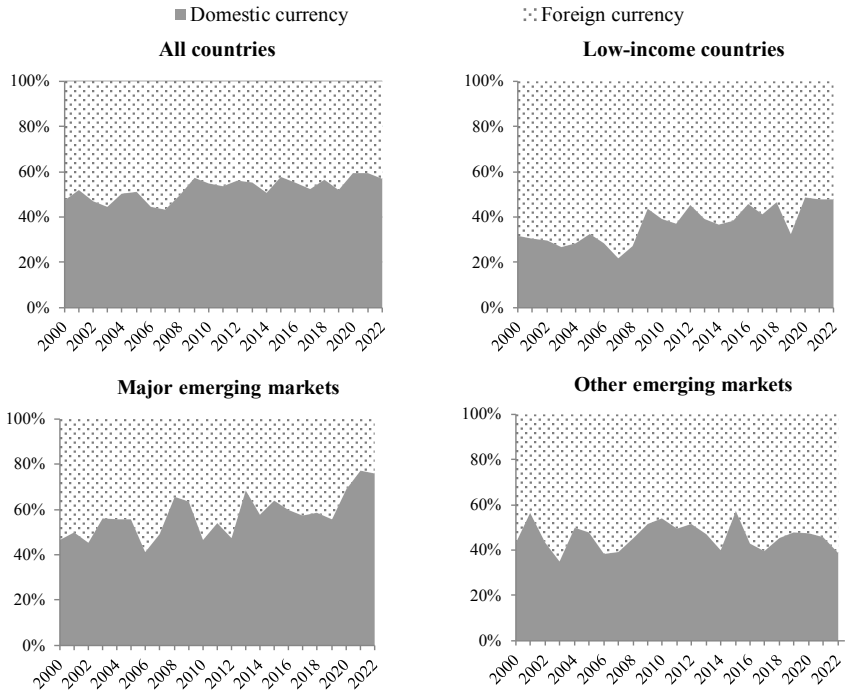


Source: Estimates based on Arslanalp and Tsuda (2014, updated).

front (China, India, Brazil, Indonesia) are notably larger than the median emerging market or developing country.

Ho (2019), Bertaut, Bruno and Shin (2022) and Shin, Onen and von Peter (2023) provide two further reasons for not getting too excited about the trend toward issuing local currency debt. First, that trend has not been continuous. There were sudden stops and reversals in 2015 and 2018-19. These episodes were mainly associated with exchange rate depreciations, which inflict capital losses on foreign investors in local-currency bonds. Second, and relatedly, these episodes are a reminder that local currency issuance doesn't eliminate the currency mismatch; it only shifts it from the balance sheet of the sovereign to the balance sheet of foreign investors. In troubled times, foreign investors now suffer the double whammy of losses in local currency (due to higher interest rates) and further losses in dollars (due to local currency depreciation). The result may be more capital

Figure 6
Currency Composition of Government Debt Issuance, 2000–22
(Components in percent)



Source: Estimates based on Arslanalp and Tsuda (2014, updated).

flow volatility, not less, given foreign investors' wish to liquidate their positions in advance of such events.

In sum, this global perspective suggests a combination of continuity and change. The most glaring change is the rise in debt ratios since the mid-2000s. The largest absolute and proportional increase is in the advanced economies, where debts have risen from 50 to 85 percent of GDP on average, these countries having made extensive use of their fiscal capacity in response to crises. In emerging markets and developing economies, the absolute and proportional increase is less, from 40 to 60 percent of GDP on average. This should not reassure, however, given these countries' more limited revenue-raising capacity. Meanwhile, private finance has increasingly supplanted official lending.

In terms of continuity, there has been less change in the currency denomination of the debt of the vast majority of sovereigns than popular commentary suggests; in the median country, the foreign-currency share remains on the order of 50 percent. The share of debt held by foreign investors that is denominated in foreign currency is still higher: only a limited number of emerging markets have succeeded in significantly increasing the share of the stock of debt held by external investors that is denominated in their own currency. This suggests that, along with new potential fragilities created by higher debt ratios, preexisting fragilities remain.

4. r – g

By now, analysts are used to thinking about "$r - g$," the real-interest-rate-real-growth-rate differential, as a factor in public debt sustainability. The importance of $r - g$ can be gleaned from the familiar equation summarizing the dynamics of the debt-to-GDP ratio:

$$\Delta b = d + (r - g)b_{t-1} + sfa \quad (1)$$

where b is debt as a share of GDP and Δb is its change. The right-hand side is made up of the primary budget deficit (deficit net of interest payments) relative to GDP, denoted d; $r - g$ interacted here with the inherited debt ratio; and defaults, restructurings, conversions, assumptions by the public sector of private debt, other off-budget spending, and exchange rate effects, denoted *sfa* for stock-flow adjustment.

The $r - g$ differential is especially convenient for back-of-the-envelope calculations for a country such as the United States with debt in the hands of the public of roughly 100 percent of GDP: in this case it equals the primary budget deficit-to-GDP ratio consistent with a stable debt ratio. The primary deficit for calendar year 2023 is projected at 2.9 percent.[18] At the time of our Jackson Hole conference, the U.S. 10-year Treasury yield was 4.2 percent, while the CBO's inflation forecast for that horizon was 2.4 percent. If one adopts the CBO's GDP growth forecast of 1.7 percent per annum, then the primary deficit consistent with a stable debt ratio is –0.1 percent of GDP. If one instead assumes that r returns to 0.5 percent, its level before the pandemic, then the primary deficit consistent with a stable debt ratio

is 1.0 percent. Either way, the U.S. will be required to expend fiscal effort to narrow the primary deficit sufficiently even to keep the debt ratio stable in the short run. Whether it and other countries in its position possess the capacity to do so a question we turn to below.

In projecting a path for *r*, analysts typically focus on the determinants saving and investment, where the real rate rises and falls to equate the two aggregates. So what should we expect of their determinants going forward?

Studies typically start with the demographic determinants of aggregate savings rates. They generally find that the negative impact of a larger old-age population, whose low savings rates are a prediction of the life-cycle model, is more than offset by the positive impact of increased longevity, which encourages more saving while of working age in order to support more years in retirement (Bloom, Canning and Graham 2003, IMF 2023a). A key point, however, is that these demographic variables are slowly moving. They are unlikely to deliver sharp changes in real interest rates in a short period.

Working in the other direction is the supply of saving from China and other emerging markets (Bernanke's 2005 global savings glut). Since growth in China is slowing, this source of saving should decline.[19] Insofar as China now seeks to rebalance from saving to consumption as part of its "dual circulation" strategy, this movement will be reinforced.[20] Although we have seen notable growth collapses (see Hausmann, Rodriguez and Wagner 2006), changes in growth rates in heavily controlled economies such as China's tend to be gradual rather than precipitous. Again, the implication is that such factors are unlikely to produce sharp changes in real interest rates over short horizons.[21]

A guess, then, is that changes in these determinants of global and U.S. savings supply will be gradual, not abrupt. Insofar as they work in opposite directions, they will tend to cancel out.

If forecasting *r* is hard, then forecasting *g* is harder. The World Bank projects that global growth will slow to a three-decade low by 2030, reflecting protectionist pressures that limit the growth of international trade, weather-related disasters, and the spread of

labor-force aging to emerging market and developing economies (Kose and Ohnsorge 2023). It posits a slowdown in total factor productivity growth, reflecting a decline in investment rates and the traditional view that TFP growth in developing countries comes packaged with fixed investment (DeLong and Summers 1991). As for why investment growth has slowed, the authors point to slower output growth (less investment means less growth, but less growth also means less investment), declining net capital flows (a corollary of slowbalization), and deteriorating terms of trade for traditional energy exporters as other countries shift to renewables.

This view suggests that evolution of the g component of $r - g$, and therefore debt sustainability, will be problematic in countries that depend heavily on trade, that are vulnerable to climate-related shocks, and that have experienced demographic transitions such that the labor force is now expanding more slowly. These factors are likely to weigh on growth, and hence on debt sustainability, in a wide range of countries, in other words.

Those of more optimist bent will point to technical change with the potential of delivering faster productivity growth. Most widely commented upon recently is Generative Artificial Intelligence that uses deep learning and adversarial neural networks to create text, video, computer code and 3D renderings.[22] Generative AI has the potential to relieve those in word-intensive occupations of routine tasks, freeing them for more productive work.[23] In the past, such general-purpose technologies have provided a powerful boost to growth. But these growth and productivity effects materialize only with delay, after firms learn how to capitalize on new technologies and reorganize, and as workers acquire new skills. The decade and a half delay between introduction of the first practical office desktop computer, the IBM PC, in 1981 and advent of the "New Economy" (the acceleration of TFP growth starting around 1995) is a familiar example, but there are many precedents (Eichengreen 2015).

This perspective suggests caution before concluding that we will see a boost to productivity growth from this new wave of general-purpose technologies in the time frame relevant to meeting debt-management challenges (over the next decade or so). Even if faster growth

materializes more quickly than in the case of earlier GPTs, it will then prompt additional investment, putting upward pressure on real interest rates (following logic in Hamilton et al. 2015), offsetting the positive impact of growth on debt ratios. Another caution is that the impact of these GPTs may be least positive for developing economies whose traditional entry point into sustained economic growth is labor-intensive manufacturing and services. Economies specializing in labor-intensive manufacturing may find it difficult to compete with advanced economies utilizing AI-enabled robotics (Rodrik 2015). Anyone who has had a "conversation" with a chatbot instead of the expected call-center operative in India or the Philippines will know that internationally-traded services are not immune from this pressure.

A high degree of uncertainty thus attaches to any forecast of $r - g$. Our own view is that $r - g$ is likely to move up modestly over the next decade.[24] Up because of smaller glut of global savings and the limited immediate productivity impact of new technologies. Modestly because many of the underlying drivers, such as demographics, Chinese growth and the impact of new technology, evolve slowly.

If $r - g$ remains negative, as it has in many countries now for more than a decade, economic growth will erode debt burdens, other things equal. But other things are not equal. They were not equal in the last decade, when budget deficits more than offset the impact of growth. It is to this issue that we now turn.

5. Primary Surpluses

The conventional way of bringing down high public-debt ratios, in addition to hoping for a favorable $r - g$, is by running primary budget surpluses. IMF (2023b) relies on this observation when projecting a consolidation path for heavily-indebted advanced economies.

There are instances in history where governments have succeeded in doing just this. But while the logic is impeccable in an accounting sense, it may be problematic in a political sense, in that the political conditions allowing heavily-indebted governments to run primary budget surpluses for extended periods are not present today.

Eichengreen, El-Ganainy, Esteves and Mitchener (2021) apply eq. 1 above to three 19th century instances of sharp debt reduction: Britain after the French and Napoleonic Wars, the United States after the Civil War, and France after the Franco-Prussian War. In all three cases, wartime exigencies bequeathed heavy debt burdens: Britain's debt ratio approached 200 percent of GDP in the early 1820s; France's approached 100 percent of GDP in the 1870s. U.S. federal government debt was lighter, at some 30 percent of GDP, but this case is still notable for the country having essentially extinguished that debt over the subsequent half-century.

The corresponding decompositions are shown in Table 1.[25] Notably, the primary balance *more* than fully accounts for decline in the debt/GDP ratio in all three cases. Britain ran primary surpluses for over nine decades. Those primary surpluses were continuous (though they declined gradually over time, from 6 percent of GDP in the 1820s to 1-2 percent on the eve of World War I), interrupted solely by a modest deficit at the time of the Boer War. The extent of debt reduction is all the more remarkable given how the interest-rate-growth-rate-differential was pushing in the other direction. While assertions of Victorian Britain's economic "failure" are contested (McCloskey 1970), the relevant fact here is that a GDP growth rate of 2 percent fell short of a consol rate of 3 to 4 percent, together with a price level that was virtually the same at the start and end of the period.[26]

This string of surpluses was made possible by ideology and politics. Ideology refers to the Victorian philosophy of "Sound Finance," which saw a limited role for government in normal times while acknowledging the need to ramp up spending in emergencies. As Campbell (2004, p.9) describes, "'Sound Finance' as a fiscal system was simple but strict: it entailed balanced budgets, increased taxation to help finance exceptional expenditures, reduction of existing debt, and accurate and transparent annual budget statements." It was integral to the fiscal philosophy of both Peel and Gladstone, who emphasized budget surpluses and limited government. Conveniently, there were no costly conflicts between the Napoleonic Wars and the end of the 19th century to strain the fiscal position. Britain's limited wars in South Africa, Afghanistan, Egypt and Sudan in the 1880s

Table 1
Composition of Large Pre-1914 Debt Reductions

Country	Period	Debt/ GDP ratio		Decomposition (in ppt)					Average real GDP growth	Average real interest rate
		Start	End	Primary Balance	Interest rate growth rate differential	g	r	SFA		
UK	1822–1913	194.1	28.3	180.5	–95.6	88.4	–184.0	15.1	1.9	3.5
USA	1867–1913	30.1	3.2	151.1	–46.3	48.2	–94.5	–4.8	4.2	4.3
France	1896–1913	95.6	51.1	100.4	–1.9	96.3	–98.2	1.6	2.6	2.9

Source: Eichengreen, El-Ganainy, Esteves and Mitchener (2021).

could be met entirely with increased taxation. Additional spending on the Navy, in preparation for a military conflict closer to home, was financed by increasing taxes on income, beer and spirits. "The taxation response to these shocks and developments provides a telling endorsement of 'Sound Finance,' for these revenue requirements were accommodated within the framework of the existing revenue system..." as Campbell puts it.[27]

Politics refers to the dominance of creditors in Parliament. Property owners — and bondholders — had the vote, whereas the franchise and influence of the working class, whose members might have favored more extensive social spending even if it jeopardized debt reduction, were still limited.[28]

In the case of the United States, debt reduction was again more than fully achieved by running primary surpluses. It is often assumed that the United States, as a country of immigration with a westward-moving frontier, grew out from under its Civil War-era debt. But while growth was high, interest rates were higher: here too the interest-rate-growth-rate differential contributed negatively to debt reduction.

Even more than in Britain, debt reduction rested on limited government, belief in which flowed from the country's culture of rugged individualism (Bazzi, Fiszbein and Gebresliasse 2020). Representatives of Southern states, in particular, opposed expansive federal spending, given that the social priorities of the federal government were not their own. Real wages that were high by international standards meant that the median voter's income was close to that of the

wealthy, lessening the pressure for redistributive taxes and transfers (Lindert 1994). Federal government spending remained less than 5 percent of GDP prior to U.S. entry into World War I. The budget provided for a sinking fund to finance retirement of 1 percent of the debt each year. After 1887, the debt was so small that the Treasury found it impossible to put these funds to work without having to go into the market and buy bonds at a premium (Ratchford 1947).

In France, yet again, primary surpluses entirely accounted for the halving of the debt ratio in the decades leading up to World War I. French politicians saw debt retirement as a prudential policy enhancing the country's capacity to borrow in the event of another German war. They blamed the country's serial defeats, from the Seven Years War to the Franco-Prussian War, on the weakness of the state's finances and on its consequent limited ability to borrow, which they now sought to remedy. Although new taxes on income from real estate and securities were imposed in the 1870s, the majority of revenues continued to derive from sales and consumption taxes, whose incidence was regressive (Morgan and Prasad 2009), something that did not deter wealthy French legislators. Meanwhile, spending was restrained until the Moroccan crisis in 1905, which created pressure for additional military outlays. The central government ran primary surpluses in every year from 1896 through 1913. Those surpluses exceeded even British levels in the 1890s, after which they declined, though remaining sufficient for continued debt retirement.

History thus shows that heavy debts can be reduced and even retired by running persistent primary surpluses over long periods of time, as IMF (2023b) imagines today's advanced countries might do. Unfortunately, the economic and political conditions making this possible in the past are no longer present. Nineteenth century debt retirement preceded the rise of social spending and its competing claims on the government's resources. The franchise today is no longer limited to creditors, so those claims are more intense. The need to devote revenues to defense spending rather than debt retirement is back with a vengeance. Governments will have to devote yet additional revenues to meeting the existential crisis of climate change.

Eichengreen and Panizza (2016) enumerated large and persistent primary surplus episodes, of the sort foreseen by IMF (2023b). Their finding, for 54 advanced and emerging-market economies between 1973 and 2013, was of few such episodes. Of 235 nonoverlapping five-year periods in the dataset, there were just 36 five-year nonoverlapping episodes with an average primary surplus of at least 3 percent of GDP (15 percent of the sample), 18 five-year episodes with an average primary surplus of at least 4 percent of GDP (8 percent of the sample) and 12 five-year episodes with an average primary surplus of at least 5 percent of GDP (5 percent of the sample).[29] Ten-year episodes are still rarer: there were 5 episodes with an average primary surplus of at least 4 percent of GDP (5 percent of the sample) and 3 episodes with an average primary surplus of at least 5 percent of GDP (about 2.5 percent of the sample).

We updated these tabulations using an additional decade of data (through 2021). Table 2 shows the result for 5-year episodes.[30] The only additions are Norway, which regularly runs surpluses in order to put aside for future generations revenues from oil and gas extraction; Greece after 2015, which just qualifies at the 3 percent level and whose exceptional fiscal crisis is well known; and Iceland starting in 2014, where debt exploded with the 2008-9 banking crisis and whose new government committed to debt reduction once that crisis was finally under control. The role of exceptional circumstances is clear.

In that earlier work, we similarly found just three episodes of nonoverlapping 10-year periods of 5 percent primary surpluses: Norway after 1999 (when it was salting away oil and gas revenues in its sovereign wealth fund), Singapore after 1990 (with its strong technocratic government and exposed geopolitical position), and Belgium after 1995 (which despite high inherited debt was desperate to qualify as a founding member of the Euro Area). Extending the dataset yields only one additional case: Norway after 2010. The previous conclusion again applies.

Eichengreen and Panizza reported regressions analyzing the economic and political determinants of the likelihood of observing a five-year episode with a primary surplus of at least 3 percent of GDP. We re-estimated those regressions using our updated data set,

Table 2
Nonoverlapping Primary Surplus Episodes, 5-year periods

3% of GDP		4% of GDP		5% of GDP	
BEL1998	6.0	BEL1998	6.0	BEL1998	6.0
BRA2004	3.6	CAN1997	5.0	CAN1997	5.0
CAN1997	5.0	CHL2004	5.3	CHL2004	5.3
CHL1991	3.5	DNK1985	5.5	DNK1985	5.5
CHL2004	5.3	DNK2004	4.8	IRL1996	5.3
DNK1985	5.5	FIN1998	4.8	**ISL2014**	**5.9**
DNK1997	3.5	IRL1988	4.8	NOR1981	5.4
DNK2004	4.8	IRL1996	5.3	NOR2004	13.7
FIN1976	3.4	**ISL2014**	**5.9**	**NOR2010**	**9.6**
FIN1998	4.8	ITA1996	4.8	**NOR2018**	**6.9**
GRC1996	3.9	NOR1981	5.4	NZL1993	5.7
GRC2015	**3.1**	NOR2004	13.7	PAN1994	6.8
HKG2007	3.2	**NOR2010**	**9.6**	SGP1991	12.3
IRL1988	4.8	**NOR2018**	**6.9**	SGP2004	6.5
IRL1996	5.3	NZL1993	5.7	SWE1986	5.4
ISL2003	3.7	NZL2002	4.2		
ISL2014	**5.9**	PAN1994	6.8		
ISR1986	3.1	SGP1991	12.3		
ITA1996	4.8	SGP2004	6.5		
KOR1988	3.2	SWE1986	5.4		
KOR1999	3.8	TUR2002	4.5		
LUX1997	3.4				
MEX1991	3.8				
NLD1996	3.5				
NOR1981	5.4				
NOR2004	13.7				
NOR2010	**9.6**				
NOR2018	**6.9**				
NZL1993	5.7				
NZL2002	4.2				
PAN1994	6.8				
PAN2005	3.3				
PER2004	3.0				
PHL2004	3.5				
SGP1991	12.3				
SGP2004	6.5				
SWE1986	5.4				
SWE1997	3.4				
THA1991	3.7				
TUR2002	4.5				
Average	5.0		6.3		7.0
N. Episodes	40		21		15

Notes: Cases in bold are additions from extending the data to cover 2014-21.
Source: Eichengreen and Panizza (2016, updated).

winnowing down those long lists of independent variables using the general-to-specific methodology described by Clarke (2014).

The results are similar to those in this earlier study. The most economically important and statistically significant political variable is

divided government, which reduces the likelihood of observing a sustained primary surplus, and the rate of GDP growth, which increases that likelihood. Intuitively, divided government makes agreement on sustained policy adjustments more difficult, while fast growth facilitates such adjustments.[31] Given the outlook for these variables, we are skeptical about the scope for large sustained primary surpluses.

6. Financial Repression

Another option is financial repression — using interest-rate caps and related policies to lower the r component of $r - g$.

The third quarter of the 20th century is a widely cited case in point. Advanced economies emerged from World War II heavily burdened by debt. In the subsequent period, central banks, many of which were not independent of governments, pursued policies capping Treasury bill and bond prices. Other authorities placed regulatory limits on interest rates on alternative financial vehicles, such as bank accounts, driving savings toward bonds. Together, these policies prevented interest rates on public debt securities from rising to levels commensurate with inflation. This turned r negative, allowing inflation to erode the real value of debt.

Table 3, again from Eichengreen, El-Ganainy, Esteves and Mitchener (2021), shows that the story is more complicated. It focuses large debt reductions in the advanced countries, where large debt reductions are defined as episodes when the debt/GDP ratio fell by at least 10 percentage points. In fact, a quarter to a third of debt reduction achieved in this period was attributable to primary surpluses, not financial repression. Contrary to popular presumption, the gospel of Keynesian was not yet widespread; there was only limited resort to countercyclical deficit spending in this period.[32] Recessions were few and mild compared to the preceding and succeeding periods, limiting the tendency for revenues to fall in recessions and for deficits to emerge.

Although a negative $r - g$ accounts for the lion's share of debt reduction, real interest rates were sharply negative only in 1951, when inflation rose to an average of 15 percent in this sample of countries, reflecting the monetary and fiscal imperatives of the Korean War.[33]

Table 3
Decomposition of Post-WWII Large (at least 10 ppt) Debt Reductions in Advanced Economies, (1945-75)

	Debt/GDP ratio			Decomposition		
	Starting	Ending	Decrease	Primary Balance	Growth-interest differential (r-g)	SFA
Simple Average	95.5	22.4	73.1	22.6	82.6	–32.2
Weighted average	112.0	26.2	85.8	33.3	80.2	–27.7
Weighted average (contribution to debt reduction, percent of total debt reduction)				38.8	93.6	–32.4

Notes: Sample includes 19 advanced economies. Precise period covered varies by country as peak-to trough years vary by country.
Source: Eichengreen et al. (2021).

Otherwise, real interest rates on public debt were at or only slightly below zero. The interest-rate-growth rate differential contributed importantly to debt reduction not simply because real rates were sharply negative but because economic growth was fast, averaging 4½ percent (real) across the advanced-country world.[34] Fast growth is the painless way of solving debt problems. Unfortunately, such high growth rates in the advanced countries are not in the cards today.

A repeat of other factors making for a strongly negative real interest rate similarly strikes us as unlikely. In the U.S., the authorities imposed Regulation Q interest rate ceilings on bank deposits, redirecting savings toward bonds.[35] Regulation Q ceilings, it is safe to say, are not coming back. Financial deregulation and development, and now the rise of crypto and fintech, make available a much wider range of financial instruments than existed in the 1950s and 1960s. Forcing funds out of bank accounts will no longer automatically force them into bonds.

Through March 1951 the Fed capped interest rates on Treasury bills at 3/8 percent and on Treasury bonds at 2½ percent, responding to Treasury's wartime requests. But the central bank could not simultaneously control both interest rates on Treasuries and inflation once wartime price controls were lifted. Consumer price inflation ran at 17.6 percent between mid-1946 and mid-1947 and then at 9.5 percent between mid-1947 and mid-1948. It turned negative with the

onset of recession in 1949, but then soared to 21 percent annualized in February 1951. These violent price-level oscillations led the Fed to campaign for abandonment of its commitment to cap interest rates, culminating in the Treasury-Fed Accord of 1951 (Eichengreen and Garber 1991). Some will classify any program of central bank purchases of Treasury securities, and not just explicit policies of capping Treasury yields, as a form of financial repression. But given modern-day central banks' commitment to the maintenance of low and stable inflation and our recent inflationary environment, even this more general form of financial repression is likely to be infeasible.

In sum, policies limiting interest rates on Treasury securities after World War II reflected a constellation of factors that is highly unlikely for the foreseeable future. Central bank independence is less than absolute, but it greater today than during the war and its aftermath. The Fed, Treasury, and broader investing public would not accept policies that caused inflation to oscillate from +17 percent to –2 percent to +21 percent.[36] These conclusions apply not just to the U.S. but to the advanced countries as a group.[37]

7. Inflation

Alternatively, central banks could engineer higher rates of inflation with the goal of reducing the real value of the debt. As shown in Figure 1, the inflation and growth rebound of 2020-21 reduced the debt/GDP ratio in the U.S. and worldwide by roughly 5 percentage points. When r in eq. 1 above is decomposed into the difference between the nominal interest rate and inflation, the arithmetic impact of the latter on the debt ratio in the U.S. and worldwide "accounts" for the entirety of the decline in the debt ratio in these two years.[38]

Has this strategy also worked in the past? How long before interest rates respond to inflation, eliminating any favorable impact on the debt ratio? The literature on the impact of inflation on debt reaches a consensus on several points. Moderate inflation has only a modest impact on the debt ratio; any favorable impact via the increase in seigniorage revenues and the GDP deflator tends to be offset by higher interest rates and the negative impact of inflation on economic growth. While the first (favorable) effects dominate on impact, the

second (unfavorable) effects take over after two or three years. On balance, these effects are small and by most measures statistically insignificant. Only unanticipated inflation is significant. An inflation surprise has to be large to make a serious dent in the debt ratio.

Thus, Bernardini et al. (2021) examine 30 episodes of large reductions in debt-to-GDP ratios in the advanced countries since World War II. They identify six episodes in which inflation played an important role in debt reduction (four Western European countries and Japan immediately after the war, and Israel after 1984). In all of these cases inflation averaged in the mid-double digits or even triple-digits. They also identify 10 cases in the 1950s and 1960s where inflation played a subsidiary role.[39] But in all of these episodes, interest rate caps, capital controls and other measures of financial repression were also in place, accentuating the effect of inflation.

Eichengreen and Esteves (2022) assemble an unbalanced panel of countries for which fiscal data are available back to 1800, tabulating the frequency of major debt consolidations. They do not find a uniformly positive association of inflation with debt consolidation. Countries undergoing consolidations did not experience higher inflation than their peers. In periods when inflation was relatively high and persistent, interest payments rose sufficiently to offset any positive contribution of inflation to debt reduction.

Garcia-Macia (2023) estimates the effect of inflation on the debt ratio using fixed-effects OLS regressions, local projections, and annual data for 85 advanced and emerging market economies and quarterly data for 28 advanced countries (starting in 1962 and 1992 respectively). Focusing on the post-1992 period permits the author to distinguish expected from surprise inflation, where the inflation surprise is measured as the difference between the *World Economic Outlook* inflation forecast and the actual outturn. Only surprise inflation has a significant impact on the debt ratio. A one percent surprise increase in the GDP deflator lowers the debt ratio by one percent of GDP after one year in high-debt countries (where the initial debt ratio exceeds 50 percent), and by roughly a quarter of a percent of GDP in low debt countries (where the ratio is below 50 percent). Fukunaga, Komatsuzaki and Matsuoka (2022) similarly use data

from 1997 through 2017 for 19 advanced economies to estimate impulse-responses to inflation shocks. Their results suggest that a temporary one percentage point inflation shock reduces the debt-to-GDP ratio by one percentage point on impact and that this effect persists. Again, this is the effect of unanticipated inflation, measured as the residual from an estimated Phillips Curve equation and alternatively (as in Garcia-Macia 2023) as the difference between realized inflation and *World Economic Outlook* inflation forecasts. Effects are larger for the subset of countries with relatively long debt maturities. (The analysis makes no provision for maturities to respond.)

Other studies focus on specific countries. For example, Cherif and Hasanov (2018) use time-series methods to analyze the response of the debt ratio to inflation in the post-World War II United States. They find that an inflation shock reduces the debt-to-GDP ratio on impact but that the debt ratio begins rising again after 4 quarters, as interest rates and other variables adjust. After 10 quarters the debt impulse becomes statistically insignificant, and the debt ratio returns to its pre-shock path.

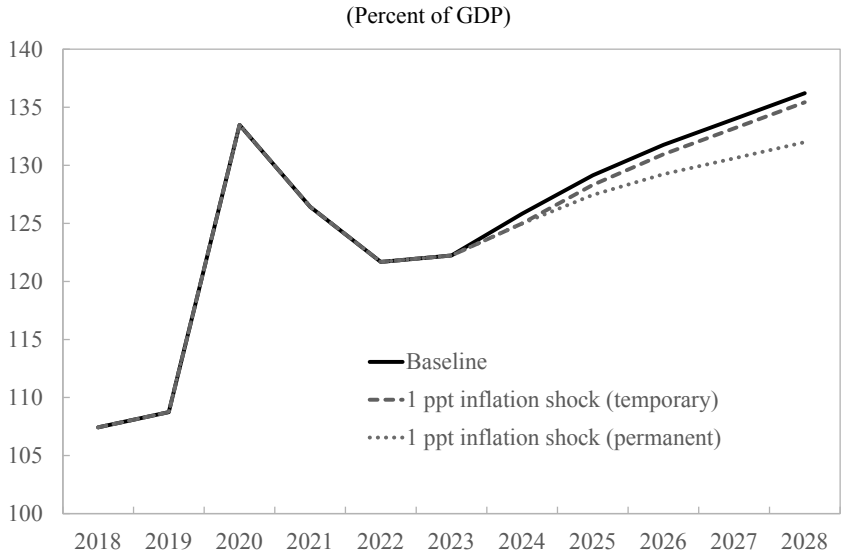
A key determinant of the impact of inflation on the debt ratio is the maturity structure of the debt. The greater the short-term share, the smaller the impact of an inflation shock. We can see this by rewriting eq. 1 above expressing the interest rate and growth rate in nominal terms:

$$\Delta b = d + ([r + \pi] - [g + \pi])\, b_{t-1} + sfa \qquad (2)$$

where π denotes inflation and separating b_{t-1} into short-term debt, preexisting long-term debt and newly-issued long-term debt. The interest rate on short-term and newly-issued long-term debt will incorporate the inflation shock, but the cost of servicing preexisting long-term debt will not. Following Fukunaga, Komatsuzaki and Matsuoka (2022), we initially assume no changes in the term structure of the debt, the primary balance or growth rate as a result of the inflation shock. These assumptions allow us to simulate the impact of the shock on the debt ratio.

Figure 7 shows the result for the United States when we adopt *World Economic Outlook* forecasts for *d*, *r* and *g*. A one-time 1 percentage

Figure 7
United States: General Government Debt



Sources: IMF World Economic Outlook (April 2023) and authors' estimates.

point inflation shock has a less than 1 percentage point impact on the debt ratio, given that short-term and newly issued debt are roughly a quarter of total debt. A permanent inflation shock has larger effects that cumulate over time, given the assumption of no changes in maturity composition. Again, however, these effects are small.[40] Table 4 summarizes analogous calculations for the G20 countries. Magnitudes vary with initial debt ratios and differences in maturity composition but tend to be small across the board.

These estimates are also upper bounds on the effect of inflation (especially those for the permanent increase inflation), since in practice higher inflation will induce a shortening of maturities.[41] We can allow for the endogenous response of maturities and other variables by estimating vector autogressions on the Eichengreen-Esteves data set and using local projections to simulate the impact on the debt ratio of a one standard deviation shock to the GDP deflator.[42] The result is a decline in the debt ratio on impact but then a rise (relative to baseline), where this rise becomes evident after three years.

Table 4
G20 Economies: Projected General Government Debt/GDP Ratio in 2028

	Baseline	With 1 ppt inflation shock	
		Temporary	Permanent
Australia	62.2	61.7	59.6
Canada	91.1	90.4	87.5
France	115.0	114.2	110.6
Germany	59.6	59.2	57.3
Italy	131.9	130.8	126.5
Japan	264.0	262.2	254.6
South Korea	58.2	57.8	56.0
United Kingdom	113.1	112.3	108.7
United States	136.2	135.4	132.0
Argentina	65.4	65.4	64.8
Brazil	96.2	95.5	92.9
China	104.9	104.3	101.4
India	83.6	83.0	80.6
Indonesia	37.3	37.0	35.8
Mexico	57.9	57.5	55.7
Russia	21.5	21.4	20.9
Saudi Arabia	19.9	19.8	19.4
South Africa	84.9	84.3	81.8
Turkey	42.3	42.2	41.8

Sources: IMF, World Economic Outlook (April 2023) and authors' estimates.

But these responses are insignificantly different from zero, consistent with the bulk of the literature just reviewed.[43]

This analysis thus points to limited scope for reducing today's high debt ratios via inflation, given the absence of restrictions on interest rates and capital flows. To exert a significant impact, inflation must be substantial. But in most countries there would be strong political opposition to substantial inflation. It would also have to be a surprise (as it was, to most, in 2020-21).[44] But once the tactic was tried, surprises would become increasingly difficult to engineer.[45]

A final point. Relying on surprise inflation to bring down public debts may have adverse financial stability implications. We saw an example in the case of Silicon Valley Bank, which was caught by surprise by inflation and associated interest rate increases and suffered large losses (some unrealized) on its Treasury bond portfolio.[46] In addition, inflation can impose losses on central banks that have engaged in quantitative easing and acquired large government bond

portfolios (again, see e.g., Hilscher, Raviv and Reis 2022). If the fiscal authority is forced to recapitalize such banks, any favorable impact of inflation on public debt will be correspondingly reduced.[47]

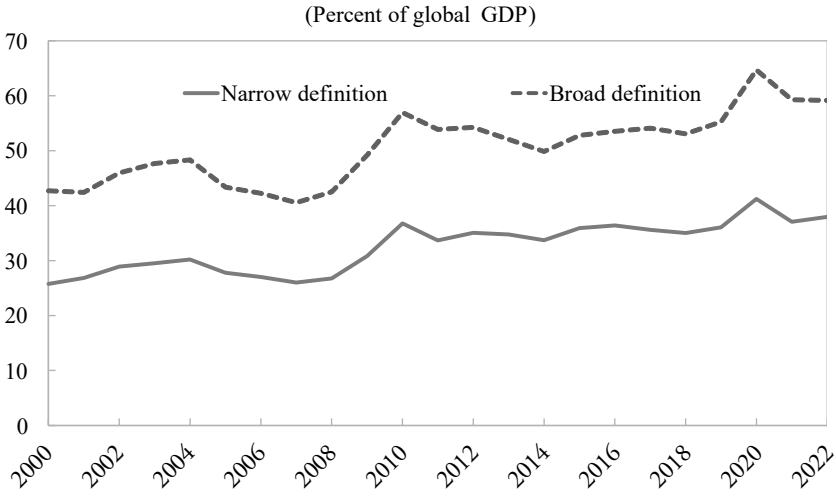
8. Safety in Numbers

A silver lining of the additional stock of government debt in the hands of the public may be to relieve the global safe-asset shortage that has contributed to high prices and low yields on advanced-country sovereign bonds in recent years (Ferreira and Shousha 2020). Additional debt issuance may attenuate this problem and also address its negative consequences, including low interest rates on safe assets, limited scope for active use of conventional monetary policy in downturns, and the danger of becoming stuck at the zero lower bound.

Safe assets are simple debt instruments that preserve their value during negative events (Caballero, Farhi and Gourinchas 2017). The ability of a country to serve as a source of safe assets depends on the fiscal capacity of its sovereign, which determines its ability to service its obligations, but also on the commitment of the government and central bank to the maintenance of price and exchange rate stability. There has been some discussion of the capacity of the private sector to produce safe assets, mainly in the 1990s when observers had reason to contemplate the possible disappearance of U.S. Treasury securities.[48] Most observers concluded then that private-label securities lack the simplicity and value-preserving qualities of public debt (see the discussion in Gorton and Ordonez 2022).[49]

There is no consensus on exactly which government debt securities are regarded as safe by central bank reserve managers and other investors. Eichengreen and Gros (2020) focus on AAA-rated government bonds, subtracting from total issuance that portion held by the issuing country's central bank. Figure 8 reports updated calculations following this convention. It shows that safe assets so defined rose following the Global Financial Crisis and again with the onset of COVID; the positive effect of additional issuance more than offset any negative effect of associated rating-agency downgrades.[50] In 2022, this ratio then fell, reflecting declining bond valuations due to higher interest rates.

Figure 8
Global Supply of Safe Assets, 2000–22



Notes: The narrow definition includes government debt of 12 countries with a AAA rating from at least one of the three major rating agencies. The broad definition also includes China, Japan, Korea, and the UK. Domestic central bank holdings of government debt are excluded. For the U.S., GSE debt securities and loans are included.
Sources: Arslanalp and Tsuda (2014, updated); Federal Reserve Flow of Funds; IMF World Economic Outlook.

We know from theory (Caballero and Farhi 2017) and history (Reinhart 2002) that the relationship between issuance and downgrades (for present purposes, between additional issuance and loss of safe-asset status) is nonlinear: high-quality issuers can continue to issue safe assets until their safe-asset status is abruptly lost. The fact that additional public debt issuance has been a positive in relieving the global safe-asset shortage up until now is no guarantee that the same will be true in the future, especially if we are entering a higher interest rate environment that poses greater challenges for prompt and reliable debt-service payments.

A complication is that some central banks also hold bonds of governments not enjoying AAA ratings. Cases in point are bonds of the UK and Japan, countries that are issuers of the third and fourth most important reserve currencies by value, which once enjoyed AAA ratings but no more.[51] Central banks are also diversifying away from traditional reserve currencies and in favor of new alternatives (Arslanalp, Eichengreen and Simpson-Bell 2022). The leading alternative, the renminbi (China currently being rated A+ by S&P and Fitch and A1

by Moody's), accounts for 2.7 percent of allocated foreign exchange reserves worldwide as of end-2022. But several other nontraditional reserve currencies, such as the Australian dollar, Canadian dollar, and Korean won, also increasingly feature in central bank portfolios. When we include as safe assets these additional currencies that are increasingly prominent in central bank reserve portfolios, the supply of the former increases even more sharply following the global financial crisis and again with the onset of COVID-19.

Whether central bank reserve managers, along with corporate treasurers and others, holding the bonds of these governments with sub-AAA ratings regard them as safe is of course an open question. It could be that they have a more positive assessment than the rating agencies of the issuers' financial prospects. Alternatively, it may be that because the investment tranche of central reserve portfolios has grown relative to the liquidity tranche, reserve managers are more comfortable allocating a portion of that investment tranche to riskier, higher-yielding securities.[52] In addition, some central banks may have been shifting the composition of their reserve portfolios toward currencies such as the renminbi in response to pressure from Beijing to appear supportive of China's renminbi-internationalization drive, or in response the risk of financial sanctions such as those imposed by the G7+ countries on Russia. In the Russian case, there is no question that sanctions have dramatically changed the definition of what assets are regarded as safe, and that this has been accompanied by a sharp shift in the composition of the Bank of Russia's portfolio from dollars to renminbi.

By how much will the increase in the supply of safe assets affect safe real interest rates? Using data for a sample of 11 advanced economies, Ferreira and Shousha (2020) find that changes in the net supply of safe assets account for a third of the variance of neutral real rates since the 1960s. According to their estimates, larger net safe asset supply between the 2008 financial crisis and the first half of 2020 (that is, before the full impact of the COVID crisis on debt issuance was felt) raised neutral real rates by nearly 1.5 percentage points. Extrapolating to COVID-era experience, their model suggests that the rise in safe

asset supply between 2019Q4 and 2022Q4 raised neutral real rates by an additional 80 basis points, holding other factors constant.[53]

Whether this increase in the supply of safe assets ends up raising equilibrium interest rates on such securities depends also, of course, on the evolution of demand. Previous analyses of the demand for safe assets focuses on demand from central banks and governments. While not neglecting this aspect, we highlight also demand from the private sector, which is equally important quantitatively.

IMF (2021) estimates that global foreign exchange reserves will have to increase by $1.1 trillion to $1.9 trillion over the next five years to remain adequate for intervention and other precautions.[54] $1.1 trillion to $1.9 trillion was 1.1 percent to 2.0 percent of world GDP in current U.S. dollars at the time of the Fund's analysis. Figure 8 shows that additional safe asset issuance since the outbreak of COVID-19 meets this five-year need several times over.[55] The conclusion that recent events in the public-debt sphere are likely to at least help to address the problem of safe asset scarcity remains intact even given that the demand for foreign exchange reserves may continue to grow.

But the price of safe assets such as U.S. Treasury bonds also depends on private demand, as noted. Financial institutions demand Treasuries as collateral for loans. Investors trade them in preference to private-label securities because they create less fear of adverse selection. They regard them as liquid because they are eligible for central banks' repo operations. Individuals hold them because they provide insurance — because they are readily sold in the event of a negative idiosyncratic shock. These are among the reasons why the quintessential safe asset, the U.S. Treasury bond, bears a convenience yield as captured by the yield differential between actual and synthetic Treasuries.[56]

Our calculations of the global private demand for safe assets (the broad definition in Figure 8) in 100 countries (countries other than those issuing the safe assets in question) puts this at $6 trillion in 2021. Regressing this private demand at the country level on country GDP and its volatility and on global policy uncertainty, we estimate

that one can expect to see another $2 trillion of demand from this source by 2026 (assuming that the explanatory variables continue to behave as in recent years).[57] Notice that this roughly matches the IMF's estimates of the increase in public-sector demand over the period. This puts the total increase in safe assets at 3.2 percent to 4.0 percent of world GDP in current U.S. dollars. On our broad definition of global safe assets in Figure 8, the increase in supply more than satisfies this demand.

Working in the other direction, Del Negro et al. (2017) argue, is the fact that the convenience yield on safe assets has risen by as much as 100 basis points since the turn of the century, given how the world has become a riskier economic, financial and political place. One can imagine the world becoming riskier still, causing investors to attach even greater importance to the insurance services of U.S. Treasuries and other safe assets, further enhancing their convenience yield. This would put downward pressure on the associated interest rate, moderating the upward pressure associated with increased public-debt supply.

This assumes of course that safe assets continue to be regarded as safe — that the factors underlying prevailing convenience yields remain intact. As Brunnermeier, Merkel and Sannikov (2022) observe, this status is not assured. The insurance value of U.S. Treasuries derives from the fact that the market is liquid — that Treasuries can be sold to other investors who value the service flows they provide in the event of an idiosyncratic shock. If some investors shun these assets, reducing the liquidity of the market, others will have incentive to do likewise. This equilibrium is fragile, in other words.

Relatedly, there is the possibility that safe assets could be re-rated as unsafe owing to the issuer's recourse to financial sanctions. This topic has been much discussed in connection with so-called weaponization of the dollar, although it is not the subject of our paper. Elsewhere we have examined the impact of financial sanctions on the composition of central bank reserve portfolios.[58] There is no evidence in the data of a significant decline in the share of foreign exchange reserves held in dollars by countries targeted by U.S. sanctions, partly because of a dearth of attractive alternatives, and partly because when imposing

sanctions the U.S. has coordinated with other reserve-issuing countries. There is some evidence of countries targeted by sanctions increasing the share of their reserves held in gold, though this effect is small. Given the shock of sanctions on the Bank of Russia (specifically, the fact that the U.S. and cooperating countries chose to disregard the 2004 United Nations Convention on Jurisdictional Immunities of States and their Property), central banks and governments could reevaluate the safety of holding their reserves in the form of, inter alia, U.S. Treasuries. Given coordination across countries and the lack of alternatives, we think that any movement away from the dollar will be minor, leaving aside countries such as Russia in extreme circumstances. Countries in Russia's circumstances are not large and important enough, relative to the international financial system, to change our conclusions.

9. Debt Restructuring

A final approach to consolidation is debt restructuring. Multiple countries with burdens of questionable sustainability have brought down their debts in this way.[59] Currently, the debts of scores of financially troubled countries are unsustainable. The economic and financial fallout from the COVID crisis was severe, and there is a long history of global shocks giving rise to debt crises affecting multiple countries simultaneously (Eichengreen 1991, Mitchener and Trebesch 2021).

Reducing those burdens, together with appropriate policy reforms, is necessary to remove debt overhangs that limit capital-market access and act as a tax on growth. The question is how to facilitate their removal. One wants to avoid making restructuring too easy, since doing so would render investors reluctant to lend and deny developing economies external finance. Equally, however, one wants to avoid making restructuring too hard, since doing so delays the restoration of market access and growth.

There is reason to think that recent changes on balance have moved the process further in the "too hard" direction. Restructuring involves a coordination problem: no creditor is prepared to offer concessions without assurance that other creditors are prepared to follow suit.

The move from bilateral to market-based lending, together with the shift from bank to securitized finance, has made such coordination more difficult. Debt of developing economies to private creditors, principally bondholders, has grown by factor of seven in the last ten years. Those creditors are more numerous and diverse. Some may be tempted to rush to the courthouse rather than the bargaining table, particularly when they hold bonds without collective action or aggregation clauses. The share of the external obligations of developing economies owed to members of the Paris Club, where intergovernmental debts are discussed and restructured, has fallen from 28 percent in 2006 to 10 percent today. China's emergence as a major bilateral creditor that is not a Paris Club member has made renegotiation of even these bilateral loans more complex.[60] Not being a member exempts China from the obligation of accepting Paris Club principles, such as information sharing and comparable treatment of creditors.[61] Lack of transparency and full accounting of outstanding public debt obligations to China and other creditors has made it more difficult for the parties to know that they are getting a square deal. Finally, the seniority and effective exemption of multilaterals from restructuring agreements has been challenged by some countries.

The G20 Common Framework for Debt Treatments agreed in November 2020 was intended to address these issues. Developing economies would be eligible for restructuring, and new official creditors would participate in a process akin to the Paris Club organized under G20 aegis. The framework stipulated further that private creditors should provide relief on terms comparable to that provided by official creditors, albeit without offering specifics on how this might be achieved. Private creditors have not exactly rushed, however, to volunteer their cooperation.

Going on three years since the Common Framework was agreed, only four countries, Chad, Zambia, Ghana and Ethiopia, have applied for relief, and only the first three have reached agreements.[62] Evidently, many candidates are deterred by fear of sending a negative signal to the markets while receiving little if anything in return.

The Common Framework thus needs to be strengthened and supplemented by other measures to facilitate restructuring. The

framework applies only to developing economies; it could be extended to emerging markets in debt distress.[63] Countries applying for relief could be expected to impose an immediate freeze on debt-service payments so that they benefit upfront and focus the minds of private creditors.[64] This is in contrast to current practice, under which applicants are expected to continue making interest payments until final agreement is reached. For a freeze to be feasible, however, governments applying for relief through the framework would have to have statutory protection from asset seizures by national courts.[65] Since a freeze would presumably also lead to a determination that the country was in default and trigger acceleration of its bonds, such legislation would also have to override those contractual provisions.

Ahmed and Brown (2022) suggest that the IMF should proactively assess the amount of relief appropriate for each country eligible under the Common Framework and present the findings to its members. Its assessments need not wait on application from the governments of the eligible countries, and their availability would apply additional pressure for creditors to come to the bargaining table. The assumptions underlying these assessments as well as the bottom line haircut should be shared with the creditors so they know not only what is being asked of them but why.[66] Some will object that blunt assessments risk precipitating the kind of crisis and loss of capital market access that the IMF seeks to avert. But the IMF already publishes debt sustainability analyses in connection with its regular Article IV reviews (for low-income countries, these are conducted jointly with the World Bank). In any case, the majority of eligible countries have already lost market access in advance of negotiations, so interrupting existing access is a non-issue.

Adequate debt sustainability and relief assessments require adequate data. External bank loans containing confidentiality clauses impeding its provision are pervasive in the foreign loans of Chinese policy banks (Horn, Reinhart and Trebesch 2021, Gelpern et al. 2022); these should be discouraged by the international community. Collateralized loans are often not reported in debt statistics when contracted by state-owned enterprises and special purpose vehicles (Di Marchi 2022). In 2021, the OECD launched a Debt Transparency

Initiative to assemble more complete information on private sector loans and investments in low-income countries (OECD 2022). Few private creditors have participated to date. Creditor-country governments could therefore make this a regulatory requirement for financial institutions. China has insisted in the past that its Big 4 banks, which are major lenders to foreign sovereigns, are commercial institutions rather than arms of government. If so, they should be subject to this transparency requirement.

To discourage free riding and a rush to the courthouse, the vast majority of newly-issued debt securities of emerging markets and developing countries include collective action clauses (CACs), which prevent minority creditors from holding up restructuring agreements in the effort to be bought out on more favorable terms.[67] Some bonds also include aggregation clauses, where voting is aggregated across bond issues. But other instruments such as syndicated loans and foreign-law-governed sub-sovereign bonds typically do not include CACs; these should be added where they are absent.[68] Additional creditor countries can adopt anti-vulture-fund legislation along the lines implemented by the United Kingdom, Belgium and France.[69] At the multilateral level, it would be possible to immunize foreign assets of eligible countries from creditor attachment by adopting a United Nations resolution, as was done for Iraq in 2003.[70] But international agreement on a UN resolution, including both terms and eligibility, would be a heavy lift. National legislation is more practical, although it leaves the danger that creditors will attempt to attach assets outside the jurisdiction of the borrower.[71]

As an incentive for investors, Lazard (2023) proposes a "Value Recovery Instrument," under which payments on restructured debt would be indexed to economic performance. Zambia's agreement under the Common Framework appears to include provisions to this effect. Ramos et al. (2023) suggest credit enhancements along the lines of the Brady Plan debt exchange. Brady Plan haircuts averaged 35 percent, but the principal of the new bonds was fully collateralized by a guarantee fund of U.S. zero-coupon Treasury bonds. Looking at a broader range of restructurings, Meyer, Reinhart and Trebesch (2022) find that historical haircuts average 39 percent. Ramos et

al. (2023) estimate that, after applying a 39 percent haircut to the debt of 61 distressed countries, an equivalent guarantee fund would require $62 billion of assets, which could be funded using Special Drawing Rights or other means.[72]

Debts to multilaterals, such as the IMF and World Bank, are de facto senior, meaning that they are exempt from restructuring. This is justified on the grounds that their loans are already extended at concessional (low) interest rates and that multilaterals lend where other lenders are fear to tread. The share of external debt owed to multilaterals is roughly half the developing economy total; for some 20 developing economies it is as much as two thirds (Zettelmeyer 2023). Exempting the multilaterals means that the same debt relief would require more drastic haircuts for other creditors.[73] China has challenged the multilaterals' preferred creditor status, asking why they should receive more favorable treatment than its policy banks. In agreements reached to date under the Common Framework, this issue has been finessed rather than addressed. Chad's agreement does not include any bilateral debt relief from China or other countries. In Zambia's case, China extended loan terms and adjusted financing costs rather than accepting haircuts on principal. In Ghana's, the World Bank contributed by extending more grants in aid.

Abolishing the preferred creditor status of the World Bank and other multilateral development banks is problematic, since losses would leave their shareholders reluctant to fund their risky loans in the future. One response is that multilaterals focusing on economic development should move further in the direction of grants rather than loans; but the same level of development finance would then require additional donor resources.[74] Another response is that the IMF already takes haircuts through its Catastrophe Containment and Relief Trust, under which interest payments by low-income countries hit by a natural or public-health disaster are effectively forgiven by a grant in aid. The trust is funded by contributions separate from the IMF's general resources, donated by advanced economies, the European Union, and others. Hence the trust is not subject to provisions in the IMF's Articles of Agreement requiring the Fund to safeguard its resources (to lend only when it is assured of being paid back).

Again, going further down this road would require more resources from shareholders, something that is easier to suggest than to secure.

10. Conclusion

Public debts have risen for reasons both good and bad, good in that governments have financed needed responses to macroeconomic, financial and public-health emergencies, bad in that they have borrowed imprudently and failed to retire debt in good times. The result has been increases in debt ratios from 40 to 60 percent of GDP since the Global Financial Crisis. In advanced countries, debt ratios have risen still higher, to nearly 85 percent of GDP. In the United States, federal government debt in the hands of the public is approaching 100 percent of GDP. In other advanced economies, debt ratios are still higher.

These trends have led concerned observers, such as Bank for International Settlements (2023) and IMF (2023b), to call for debt reduction. Our message is that debt reduction, while desirable in principle, is unlikely in practice. Primary budget surpluses achieved through a combination of tax increases and spending economies will be difficult to sustain on a scale and duration needed to significantly reduce debt ratios — to bring them back down to pre-GFC levels, for example. Historically, countries have been able to sustain large primary surpluses only when there exists political solidarity at the national level and economic growth is strong. Unfortunately, the World Bank and others project slower, not faster global growth. Political divisions are pervasive. Given the troubled outlook for these variables, we are skeptical about the scope for large sustained primary surpluses.

Real interest rates, having trended downward for an extended period, now show signs of ticking back up, not least because more public debt now must be placed with investors. One can imagine a scenario in which significantly higher interest rates drive home the urgency of consolidation and prompt ambitious adjustments. That two of our three very large, sustained fiscal adjustments in the last decade (Greece and Iceland) were in countries experiencing fiscal crises is consistent with this view. But while a large adverse $r - g$ shock may prompt additional fiscal adjustment to prevent debt ratios from

exploding, we are skeptical that such adjustment will be of a magnitude sufficient to also bring debt ratios significantly below current levels, given the political barriers to a more vigorous response. Be this as it may, our analysis points to the likelihood of only limited increases in real interest rates.

History shows that inflation at rates acceptable in most 21st-century countries has at most a temporary negative impact on debt ratios. Caps on nominal interest rates and policies of financial repression rendering the debt-reducing effects of inflation more durable are less feasible in our financial liberalized world. Debt restructuring has become more challenging with the emergence of official creditors not party to Paris Club norms and with the growing importance of market finance, making for more creditors and competing interests than in the once-upon-a-time world of official finance.[75]

Like it or not, then, governments are going to have to live with high inherited debts. Advanced countries such as the United States whose government securities are regarded as safe assets enjoy a robust demand for their liabilities, not just from central banks that hold them as international reserves but also from the foreign private sector. This gives their governments more financial room to run. This is not equally true of all advanced countries, including some whose bonds currently trade at narrow spreads relative to U.S. Treasuries. Countries where the central bank has purchased the entirety of net new debt issuance over the last decade may have less room to run; conditions could change abruptly when quantitative easing gives way to quantitative tightening. Even in the case of the U.S. and other countries in a similar position, governments must take care to avoid actions that cause their safe assets to be re-evaluated as unsafe.

For countries not in this enviable position, living with high public debts requires developing local financial markets where such markets are underdeveloped and a diverse population of local investors in debt securities is absent. It requires embracing legal and procedural changes that streamline and speed debt restructuring. It requires avoiding steps that make a bad situation worse. This means minimizing unproductive public spending, targeting social transfers, and limiting contingent liabilities by, inter alia, adequately regulating banks

and avoiding recapitalization costs.[76] It means increasing taxes where revenues are low by international standards. An influential literature based on European experience suggests that fiscal effort is more likely to stick when it focuses on cutting expenditure as opposed to raising taxes.[77] But Europe epitomizes the case where taxes are already high, but expenditures are higher. In other places where revenue shares are relatively low, additional tax effort can make an essential contribution to stabilizing the debt ratio. By creating national fiscal councils where these do not exist and strengthening their independence where they do, impartial arbitrators can inform politicians and the public of whether the problem resides mainly on the spending or revenue side, and more generally inform the debate over the sustainability of the public finances and the urgency of reform.[78]

This modest medicine does not make for a happy diagnosis. But it makes for a realistic one.

Endnotes

[1]International Monetary Fund and University of California, Berkeley, respectively. We thank numerous colleagues for helpful comments and Qin Xie for excellent research assistance. The views expressed are the authors' and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

[2]The same could be said of private debts. These, however, are not the subject of our already long paper.

[3]Institutions such as the World Bank anticipate slower, not faster, growth over the next decade.

[4]As we emphasize, this is not a blanket statement applying to all advanced countries. In addition, this conclusion is contingent on how advanced-country governments *respond* to the existence of this additional demand.

[5]We follow the country groupings in the IMF's *World Economic Outlook*, including all countries for which data are available (though not economies such as Hong Kong, SAR that are not also countries). We use general government where data are available and central government otherwise.

[6]Weighted averages would provide another perspective, one dominated by a small handful of large countries, however, and one that would raise thorny issues of choice of exchange rates etc.

[7]Those who point to the outsized role of the financial sector in the rapid growth of the pre-financial-crisis period would argue that this earlier growth was intrinsically unsustainable.

[8]This is also in contrast to behavior in the U.S. itself in the 1990s. We return to this below.

[9]This definition follows Powell and Valencia (2023). We apply the 80th percentile separately for each of the three country groupings. Defining a single 80th percentile threshold for all countries would not change the results much, since the increase in the debt ratio at the 80th percentile is in fact quite similar across groups (16 percentage points for advanced and developing economies and 15 percentage points for emerging markets).

[10]Not to mention the stark difference between the U.S. and other advanced economies and between China and other emerging markets.

[11]Chinese bank lending is counted here as foreign bank lending rather than official lending, which is arguable. While important in certain individual cases, the share of foreign bank lending to emerging market and developing economies is sufficiently small on average that this doesn't alter the essence of the story.

[12]The recent experience of Silicon Valley Bank is a reminder that this tendency is not universal.

[13]Tabova and Warnock (2022), using Treasury International Capital (TIC) data, show the share of long-term Treasuries held by the foreign official sector already peaking several years earlier.

[14]China publishes the U.S. dollar share of its reserves with a five-year lag, but independent estimates are that it reduced its holdings of U.S. Treasuries by $250 billion over the last two years, with the decline accelerating recently and the level now its lowest since 2010 (Slok 2023).

[15]Debt held by nonbank domestic investors (such as domestic bondholders) is different from marketable debt issued under domestic legislation, which can be held by foreign investors. Arslanalp and Tsuda (2014a) show that foreign investors held some 20 percent of countries' local currency bonds (unweighted average), where location of issue and currency of denomination are closely but not perfectly correlated. Powell and Valencia (2023) show that there has not been much change since this article was written.

[16]These local currency shares are higher than in Eichengreen, Hausmann and Panizza (2022), where the focus is on bonds placed in international markets. Shin, Onen and von Peter (2023) also consider securities held externally regardless of whether issued on local or international markets but do not include other forms of credit to sovereigns. Du and Schreger (2022) focus on a subsample of disproportionately larger emerging markets and find a larger shift toward domestic-currency issuance. Our findings thus highlight the importance of considering the universe of emerging markets.

[17]This was the argument in Eichengreen and Hausmann (1999).

[18]CBO projection for fiscal year 2023. For calendar year 2023 the figure is slightly higher.

[19]This is because China's share of global GDP will not be growing as rapidly as in the past, and because of life-cycle implications for China itself. The life-cycle model predicts high savings rates in fast-growing economies insofar as those currently of working age have higher incomes out of which to save compared to the incomes previously earned by the currently retired, out of which the latter now dissave.

[20]Similarly, if energy exporters in the Middle East and elsewhere face less favorable terms of trade as the world shifts toward renewables (as assumed by Kose and Ohnsorge), and if they boost their investment in non-energy-related infrastructure, the other main source of this so-called savings glut will move in the same direction. Saudi Arabia's "Vision 2030" plan, which aims to boost investment in chemicals, information technology, healthcare, life sciences, transportation, logistics, tourism and real estate, is an example of this infrastructure push.

[21]Global savings will be further affected by the evolution of U.S. household saving. This shot up as a share of personal income during the pandemic, when spending opportunities were in cold storage and households received relief checks.

Some observers speculated that, as a result of the economic uncertainties highlighted by COVID, households would permanently increase their precautionary saving. By the end of 2022, however, savings rates had fallen back to below pre-pandemic levels. How much of this reflects a venting of pandemic-era demands as opposed to a return to the pre-pandemic status quo is uncertain.

[22]One might point also to other developments, such as new materials, genetic editing, and advances in robotics, with the potential to significantly boost economic growth, but Generative AI has attracted particular attention.

[23]Felten, Raj and Seamans (2023) and Briggs, Kodnani and Pierdomenico (2023) highlight the impact on the legal profession.

[24]This renders us more pessimistic than the IMF in its April 2023 *World Economic Outlook*, where it projects *r* as falling back to pre-pandemic levels.

[25]We calculate the nominal interest rate as debt service relative to debt outstanding.

[26]There was also a positive contribution to debt reduction from Chancellor Goschen's 1888 debt conversion, which shows up as the stock-flow adjustment. This was not a restructuring; it was a debt exchange permitted by the bond covenant. It allowed the Chancellor to buy back at par securities trading above that level owing to a fall in interest rates, subject to a year's advance notice and that the transaction was at least £500,000 (Ellison and Scott 2020).

[27]Campbell (2004), p.13.

[28]This remained the case despite the reform acts of 1832, 1867 and 1884. Even after 1884, 40 percent of men, those not owning land or a home or paying at least £10 of annual rent, were still denied the vote (as were all women).

[29]The categorization allows for one-year deviations from the surplus threshold specified.

[30]There are a few slight differences from the earlier tabulation owing to subsequent revisions of the WEO database.

[31]Other significant political variables are the magnitude of electoral districts (which affects the likelihood of observing a surplus episode negatively), democracy and proportional representation (both of which affect it positively). Intuitively, policymakers are more accountable in democracies but less accountable when district magnitudes are large. Proportional representation electoral systems make for encompassing coalitions in which the burden of adjustment is shared. Other significant economic variables are high debt/GDP ratios and current account surpluses, which affect the likelihood of sustained consolidation positively. Intuitively, current account surpluses (high savings) make the maintenance of surpluses easier, while heavy debts make consolidation more urgent.

[32]Since countercyclical fiscal policy was used most actively in the United States, that the literature on macroeconomic policy in this period is disproportionately a literature on the United States may have skewed views (Eichengreen 2007, p.28 and passim).

[33]This refers to the same set of countries as in Table 2.

[34]Explanations for this rapid growth are not lacking, though authors vary in the weights attached to, inter alia, the backlog of high-return investment opportunities left over from the Great Depression and world wars, favorable demographics, and a social compact to go for growth. See Crafts (1995), Eichengreen (1996), and Temin (2002).

[35]Regulation Q was adopted in 1933 in response to the belief that competition for deposits contributed to Depression-era banking problems. It was phased out in 1981-86, although the creation of NOW Accounts in the 1960s had already eroded its effectiveness.

[36]Among other things, such policies would not be supportive of the dollar's international-currency role.

[37]There may be more scope for such policies in emerging markets and developing countries, where interest rate regulation and capital controls are more prevalent. The fact that emerging markets and developing countries have on average reduced their foreign currency exposures (as noted above) may make it easier to implement such policies. But other factors eroding their effectiveness, such as the proliferation of alternative assets, apply in these countries as well.

[38]Meaning that the impact of the rebound in growth is almost exactly offset by the increase in debt issuance. "Arithmetic impact" and "accounts" indicate that we have not yet provided for changes in interest rates and maturities.

[39]Most of these are the same as those in Table 3 above.

[40]Hilscher, Raviv and Reis (2022) emphasize a related point working in the same direction, namely that the private sector holds a disproportionate share of short-term debt and few long maturities. Consequently, inflation would have to be very high to significantly erode the real value of debt held by the private sector. Using options-market data for the U.S., the authors conclude that a decline in the debt-to-GDP ratio of more than 4 percent due to surprise inflation is perceived by investors as having a probability of less than 1 percent.

[41]Insofar as higher inflation widens the budget deficit owing to the Tanzi effect and worsens growth performance, endogenizing these other variables works in the same direction.

[42]Control variables are the primary balance, effective interest rate (interest expense/previous year's debt), and real growth. Lags of three periods are used

in estimation. The sample includes 134 economies and, where available, a time horizon spanning 1800 to 2019.

[43]This (non)result is robust: the overall response and its insignificance are unchanged when we drop small states with a population of less than 1 million, restrict the time period to post-1962, and focus on the subset of country observations with debt-to-GDP ratios above 50 percent.

[44]This point is implicit in our eq. 2, where expected inflation affects the nominal interest rate paid on debt (the first π) but realized inflation (whether expected or not) that determines nominal GDP growth and thus the denominator of the debt ratio (the second π).

[45]Garcia-Macia (2023) compares periods before and after the Great Moderation, finding that the response of debt to inflation was smaller and less persistent in the earlier period, when inflation surges were more common and investors were presumably less surprised.

[46]This is another manifestation of the "diabolic loop" linking debt problems and banking-sector problems.

[47]There is less than full agreement on the costs of low or negative central bank capital. One view is that these costs are negligible, as demonstrated by the experience of central banks that have successfully operated with negative capital. Another is that central banks without adequate capital may hesitate to raise interest rates for fearing of incurring additional losses, or be reluctant to engage in last-resort lending for fear of not being paid back.

[48]This episode harks back to our discussion of why debt consolidation is so much harder today. The answer is that the 1990s in the U.S. were characterized by faster economic growth and less political polarization.

[49]The Subprime Crisis, in which AAA-rated securitized instruments supplied by the financial industry were abruptly downgraded, then drove a stake through the heart of this private-label safe-asset story.

[50]We classify governments as AAA when they receive this rating from at least one Big 3 rating agency. 12 countries have AAA ratings from at least one of the three major rating agencies: Australia, Canada, Denmark, Germany, Luxembourg, Netherlands, New Zealand, Norway, Singapore, Sweden, Switzerland and United States. For these purposes we follow convention by adding U.S. GSE debt obligations. Though one can ask whether the extension of Federal Deposit Insurance Corporation insurance to all deposits of Silicon Valley Bank sets a precedent that renders all U.S. bank liabilities safe assets, we do not pursue this avenue here.

[51]Sterling and the yen each account for roughly 5 percent of allocated reserves.

[52]Yet another qualification to the standard view that central banks hold their reserves *in the form* of safe assets questions whether central banks hold reserves

because they *demand* safe assets (for intervention and related self-insurance purposes). Reserve accumulation may instead reflect the desire to keep exchange rates down and current account surpluses up (Aizenman and Lee 2007). In this view, real interest rates are low not because of an excess demand for save assets but because of the "global savings glut" that manifests itself in those surpluses.

[53]These calculations (by the present authors) are based on the narrower of the two definitions of safe assets above.

[54]These figures rise to $2.1 trillion and $3.1 trillion, respectively, when one looks 10 years out.

[55]These are the Fund's "lower bound" and "upper bound" estimates, respectively.

[56]This is true regardless of whether the synthetic analog is measured as a basket of foreign treasury bonds of comparable duration with currency risk hedged out (Krishnamurthy and Lustig 2019), or by a basket of high-grade dollar-denominated corporate bonds (Del Negro et al. 2017).

[57]The dependent variable and the global policy uncertainty index are both entered in logs. A representative regression is ln(Privately Held Safe Assets) = –3.69 + 1.08*lnGDP + 0.02*(volatility of GDP) + 0.20*ln(Global Economic Policy Uncertainty), where all coefficients are significantly different from zero at the 99 percent confidence level. Thus, 1 percent growth in GDP translates into a 1.08 percent increase in private demand for safe assets. The sample is annual data for 96 countries during 2000-21.

[58]See Arslanalp, Eichengreen and Simpson-Bell (2022, 2023).

[59]Critics will caution, rightly, that not all debts brought down in this way have stayed down. For low-income countries in this position, restructuring may be necessary but not sufficient for restoring debt sustainability (Arslanalp and Henry 2006).

[60]China is the leading such country (holding 52 percent of the total official claims of all Common-Framework-eligible countries), but there are other new bilateral lenders, such as India, South Africa and Saudi Arabia, that are not members of the Paris Club. Collectively they hold some 60 percent of developing economies' bilateral external debts.

[61]To address this issue, the IMF, World Bank and Indian G20 Presidency organized a Global Sovereign Debt Roundtable as a more encompassing venue for discussing restructuring standards and processes.

[62]Ethiopia is the remaining case. In Ghana and Zambia, negotiations with private creditors have not been finalized at the time of writing, which again points up the lengthy nature of the process.

[63]Sri Lanka springs to mind as an example.

[64]Ramos et al. (2023) suggest a coordinated freeze on a portion of the payments of the 60-some countries in debt distress, up to prescribed limits. A more modest approach would apply such a freeze on a country-by-country basis as individual governments apply to the Common Framework.

[65]Suggestions to this effect have been made by the IMF and World Bank, but no action has been taken.

[66]In response to requests by creditors, the Fund and Bank have moved to share the information and assumptions of their debt sustainability analyses more widely.

[67]There is, however, a stock of older sovereign bonds still in the market that lack such contractual provisions. IMF (2020) reported that this legacy share amounted to roughly 50 percent of the outstanding stock as of three years ago.

[68]More ambitiously, one can also imagine clauses that aggregate bonds, bank loans and other instruments.

[69]See Iversen (2019). Bills to this effect have been submitted to the Assembly and Senate of New York State, under whose governing law most dollar bonds are issued. One can further imagine contractual clauses requiring creditors to acknowledge comparability of treatment, or court decisions to this effect (Buchheit and Gulati 2023).

[70]The U.S. and UK operationalized this resolution by adopting domestic measures implementing it.

[71]It also raises the possibility that the new issue market will migrate at the behest of investors. But there is no evidence of this effect from the earlier experience of the UK and other Europeans.

[72]This calculation assumes that the facility would guarantee 80 percent of principal, that $1 of capital could guarantee $4 of principal, and that the multilaterals would take equivalent haircuts, limiting the haircuts required of private creditors to achieve 39 percent debt reduction.

[73]Much of this debt is on concessional terms, so the change in the interest burden associated with excluding it is less than proportional.

[74]There is precedent: additional resources provided through special trust funds endowed by bilateral contributions from advanced economies helped to finance their contributions to the HIPC Initiative and MDRI.

[75]In advanced countries, where substantial sums of public debt are held by institutional investors (banks, insurance companies etc.), restructuring would be financially destabilizing, and any such thoughts would be quickly walked back. Hence our discussion of restructuring in the preceding section focused on developing countries. Greece's restructuring is the exception that proves the rule: it was extensively supported by deep-pocketed external actors.

[76]A detailed analysis of contingent liabilities is beyond the scope of this paper. For a start, see Bova et al. (2019). These authors confirm that spikes in the realization of contingent liabilities coincide with major financial sector bailouts, consistent with our emphasis in the text.

[77]A definitive summary of this body of work is Alesina, Favero and Giavazzi (2019).

[78]A recent update of evidence on the effects of fiscal councils is Davoodi et al. (2022). Balasundharam et al. (2023) is a broader survey of the role of fiscal institutions and fiscal transparency in the maintenance of fiscal discipline.

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Country Groupings

Advanced economies:

Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States

Major emerging markets:

Argentina, Brazil, Bulgaria, Chile, China, Colombia, Egypt, Hungary, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, Ukraine, Uruguay

Other emerging markets:

Albania, Algeria, Angola, Antigua and Barbuda, Armenia, Azerbaijan, Bahamas, Bahrain, Barbados, Belarus, Belize, Bolivia, Bosnia and Herzegovina, Botswana, Costa Rica, Croatia, Dominican Republic, Ecuador, El Salvador, Eswatini, Fiji, Gabon, Georgia, Guatemala, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kosovo, Kuwait, Lebanon, Mauritius, Mongolia, Montenegro, Morocco, Namibia, Nauru, Nigeria, North Macedonia, Oman, Pakistan, Palau, Panama, Paraguay, Qatar, Saudi Arabia, Serbia, Seychelles, Sri Lanka, St. Kitts and Nevis, St. Lucia, Suriname, Syria, Trinidad and Tobago, Tunisia, Turkmenistan, United Arab Emirates, Vietnam

Developing economies:

Afghanistan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Cameroon, Cabo Verde, Central African Republic, Chad, Comoros, Congo Rep., Congo Dem. Rep., Côte d'Ivoire, Djibouti, Dominica, Eritrea, Ethiopia, Gambia, Ghana, Grenada, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Kenya, Kiribati, Kyrgyz Republic, Lao PDR, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Marshall Islands, Mauritania, Micronesia, Moldova, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Papua New Guinea, Rwanda, Samoa, São Tomé and Príncipe, Senegal, Sierra Leone, Solomon Islands, Somalia, St. Vincent and the Grenadines, Sudan, Tajikistan, Tanzania, Timor-Leste, Togo, Tonga, Tuvalu, Uganda, Uzbekistan, Vanuatu, Yemen, Zambia

Commentary: Living with High Public Debt

Carmen Reinhart

Good morning, everyone. It's a pleasure to be back here in Jackson Hole once more. For clarification, I thought I was going to be discussing a paper on global financial flows, but I am discussing a paper on living with high public debt, an issue which, as you know, is also close to my work.

First, let me lay out the plan of my remarks. I am going to start out by summarizing the main takeaways of the paper (perhaps even more succinctly than Barry did). Then, I'm going to briefly highlight what more I'd like to see in the paper. Lastly, I will discuss the policy menu.

Let me start with the main message of the paper: public debt levels are very high; have risen markedly in recent years; and this phenomenon is global. This point is very carefully treated in the paper. The authors point out that what is considered high for advanced economies differs from what is considered high for emerging markets or low-income countries, but that (whatever the relevant metric is) debt is high by historic standards. This is the key message of the paper on the measurement side.

The second message of the paper is that the menu of policy options available to reduce public debt are either politically unfeasible, economically undesirable, or a combination of the two. And, for that

reason, we're likely to be living with debt for a long time. I am in full agreement with those two messages.

On the topic of the measurement of public debt, the issue of contingent liabilities is not addressed in the paper. The International Monetary Fund (IMF) has been highlighting this risk (see various papers by Moreno and others at the IMF, who have created a global database on private debt). Historically, we know that often what are private debts before a crisis become public debt after the crisis. This is not me becoming philosophical about what constitutes public debt, but rather a discussion of public debt has to consider that some of the largest spikes in public debt have been due to the transfer of private liabilities to the public sector balance sheet. Take Ireland, Spain, and Iceland, for instance, during the Global Financial Crisis (GFC). These countries had public debt levels below 40% of GDP before the crisis and ended up with very significant and rapid increases (to over 100% in a single year). We need a discussion of current contingent liability risks in the paper, but I will come back to that.

Then there is the main conclusion of the paper (reflected in the title, "Living with High Public Debt") that debt is going to remain high for a long time. In a 2012 paper with Ken Rogoff and Vincent Reinhart, where we focused on public debt overhangs in advanced economies, we documented that, on average it took more than two decades to reverse the surge. That is, indeed, a long time from a policy standpoint.

So why do we care if public debt is high and likely to remain high for a long time? I think the answer to this question is importantly missing from paper. Why do we care that we have high public debt? Is it perhaps that high public debt may stifle growth? Is it perhaps the case that public debt may tilt the probability of financial crises into a different range, with a higher likelihood of financial crises? The paper touches on this important issue in the context of emerging markets, but it is silent when it comes to the advanced economies. I will come back to two of the issues I have raised (contingent liabilities and the "so what" if we have high public debt).

Let me say a few words about the policy mix to "deal with debt". I will mostly supplement what Barry discussed except in the case of financial repression in which I will offer a different interpretation. First, on the prospects of significant fiscal consolidation, I agree with Barry that the political obstacles are daunting. I would highlight that in the menu of debt reduction, in the end--it's all about taxes. If you look at the composition of government spending at the end of World War II, it is clear that a significant share of spending was discretionary. At present the composition of public expenditure in the advanced economies is markedly different, with expenditures being dominated by non-discretionary spending and transfers. So when we talk about fiscal consolidation, we are going to tackle taxes.

It is worth highlighting that prospects for fiscal consolidation paint a very different picture from the debt reduction that we saw in the United States at the end of World War II. This point is evident graphically from the time series on debt to GDP. Previously, there is the wartime spike in public debt and then it comes down very, very rapidly. We had the spike during the GFC but subsequently debt plateaus at a much higher level. Then came the even greater COVID spike. A debt reversal has proven elusive. In a paper called "Dealing With Debt" (also with Vincent Reinhart and Ken Rogoff) we studied the very same fiscal consolidation menu that Barry talked about, and we call this the *Orthodox* approach to debt reduction. In the Unorthodox menu to reduce debt we considered inflation, financial repression, and debt restructuring (which was still part of the menu for advanced economies through the 1950s.) Indeed, we document that about a quarter of the debt reversal episodes involved some sort of debt restructuring in advanced economies. Debt restructuring is not limited to emerging markets and developing countries. I think perhaps something important to remember and not addressed in the paper.

I turn now to the inflation tax. Inflation does indeed reduce nominal public debt, especially surprise inflation. We had an illustration of this point during the most recent inflation spike, as debt ratios fell globally. I noted earlier, it is all about taxes and inflation is another tax. There's an old literature highlighting that it is a very regressive tax. Working at the World Bank reminded me of how regressive it

really is, as it is common for inflation spikes to be accompanied by sharp relative price increases in necessities, such as food and energy. These basics have a much larger share in low-income households and in low-income countries. In stressing inflation's regressive nature, I am supplementing some of the discussion in the paper.

Debt restructuring is also a tax; it is a tax on creditors. The paper's discussion on restructuring is entirely about developing countries and I fully agree with the author's prognosis that this is going to take a long time. At the moment, approximately two thirds of the 73 low-income countries that were eligible for the Debt Service Suspension Initiative (DSSI) or subsequently eligible for the Common Framework are in debt distress or high risk of debt distress. So a low-income debt crisis is not a hypothetical. Do I think this is going to be resolved quickly? No. Part of the reason of why it is likely to take tie is already discussed in the paper, but also there's a very basic and fundamental reason. Creditors want to be repaid and they want to be repaid in full. Whether they were London creditors in the 19th century, American banks in the 1980s, or Chinese official creditors today, they want to be repaid. They don't want haircuts. It takes a long time for creditors to accept losses. In my 2009 book with Ken, we looked at the duration of default spells and these in the seven-to nine-year range. They're shorter than they used to be before World War II, but they usually are still very long and difficult to resolve.

Finally, on financial repression, which is also a tax via negative ex-post interest rates. The message in the paper, as Barry pointed out, is that financial repression is not very likely, not in the cards (at least in the advanced economies). I think we have been living through many important features of financial repression in the advanced economies since the GFC. In my 2011 paper with Sbrancia, we discuss and document that financial repression is importantly defined by the size of the official sector in financial markets. And the official sector played an enormously bigger role after the GFC through increased regulation and through the much larger footprint of the central bank in public debt markets. Real interest rates have been negative on a sustained basis during this period. The post-GFC era is only the fourth episode of sustained negative real interest rates in

about 100 years. The earlier episodes of sustained negative real rates were around World War I, World War II, and the 1970s.

To conclude, let me return to what I'd like to see included in the paper.So what will living with high debt look like, Barry? Will it tilt central banks to even larger balance sheets? Will it limit central bank independence if debt servicing costs start weighing in more heavily in the budget? Will it impact growth? Will it make financial crises in the advanced economies more likely? So, I would like to see more of that discussion in a paper that concluded that high public debt will be around for a while. Related to that point, the authors need to say something about contingent liabilities and how to deal with them. Even though we may not be able to do much to reduce public debt, we can at least have better guidelines to how to limit spikes and sudden increases in public debt that are the byproduct of the public sector taking on previously private debt. These episodes often arise in the context of a panic reaction (often understandably) during periods of financial stress. But government guarantees go beyond financial stress and financial institutions. During the 1997 Asian financial crisis, which has been overshadowed by the GFC, the Korean government came out and guaranteed the debts of the chaebols as well. Guarantees of firms perceived as economic champions or subnational governments are nothing new.

According to the IMF's Fiscal Monitor and associated databases and research, private debts in advanced economies and in emerging markets are also at record levels. This means that when we do historical comparisons, the present situation is in uncharted territory in terms of indebtedness. This fact merits mention because during the prior episode of high public debt in many advanced economies at the end of World War II, public debt was the only game in town. As the Historical Statistics of the United States documents, private debt had been pretty much wiped out during the Great Depression years and the subsequent World War.

I am cognizant that do not have time left to delve into the broader issue of hidden debt, but contingent liabilities are just one form of "hidden debts". We have a lot of other varieties hidden debts as well, particularly in many emerging markets and developing countries

where consolidated public sector accounts are incomplete to non-existent that merit mention in a paper on global public debt.

I will conclude with the observation that there are other ways of reneging on debt that do not involve an explicit default. To illustrate, let us follow the potato chip story. You go to the store and you purchase a bag of potato chips. To you, it looks the same as before, maybe the price is about the same. When you open it, however, you find that the bag has much fewer potato chips inside. I wonder whether when it comes to dealing with Social Security and other benefits in the aging advanced economies (now a significant part of the government's contingent liabilities), one way of reneging without the drama of open default is through an erosion of what is actually delivered. We can't lose sight of that approach to dealing with high debt.

General Discussion: Global Financial Flows

Chair: Christina D. Romer

Christina Romer: Thank you. All right, so many questions. I'm going to actually start with Amir Yaron.

Amir Yaron: Thank you, Barry. I obviously agree that the high and rising debt levels pose very significant political-economy challenges. However, I do want to remind ourselves that in the 1990s a common perception was that fiscal consolidations are politically challenging and are not likely to happen. Then in 1992, political reality set in and policymakers adopted a tighter fiscal stance. A change in public views allowed and even supported a process of consolidation, in the advanced economies, that lasted over time, beyond unique circumstances. Specifically in Europe, I think we do have a challenge that both the ECB and maybe certain EU states are functioning as safety nets, particularly for nations that are Too Big to Fail. That may create a moral hazard risk and delay fiscal adjustments. The perception is that in Europe, debt can be offloaded to a communal pool. Therefore, the situation in Europe is likely to require some kind of a fiscal adjustment.

Finally, a comment to your last part about developing economies, I think that in terms of the suggestions of incorporating collective action clauses and aggregation clauses in debt issuances, there are obviously ex-post benefits, but ex-ante disadvantages in pricing.

There are additional questions, for example, are you going to take 85% of all the debt of the country or just of a specific bond? But, I don't think these technical issues are the core issues for the developing countries. It's really not about the technical financial issues, but rather what is important are the political structural arrangements.

Christina Romer: Actually, I'll just let you pass it right back to Karen Dynan.

Karen Dynan: Great paper, Barry. It's really wonderful. It's going to be such a great resource. I want to say I'm a little concerned about how much the paper seems to let the advanced economies off the hook. You were guarded with your language when you discussed it. But, I think there's a real problem with political will and without more discussion of the potential harms of the path that countries like the United States are on, I'm worried we're not going to get anywhere. But anyway, my question is about whether your exploration of cross-country patterns in fiscal situations has yielded insights about what sort of within-country political structures are useful for achieving fiscal sustainability — even in a situation of divided government and or weak economic growth. So not so much the spending and tax levers that I think economists are focused on, but rather on institutions like rules, commitments, nonpartisan or bipartisan commissions and so on. I think you referred to these things as legal and procedural processes, but I was interested in hearing your thoughts.

Julia Coronado: I want to just kind of put into the conversation that the debt that was issued was in a response to something, a crisis, and that the latest tranche of U.S. debt that was issued was also in response to a crisis, which is climate change. And that in a sense, you're buying resiliency. So far the recovery is much more resilient than anybody expected. Inflation is coming down. We've had the shock higher in interest rates that you might expect with the increased fiscal issuance, but we've absorbed it. So I mean, I just think it's interesting and conversation I've been having in Texas, the subsidies for renewable energy are absolutely taking off. And we would absolutely be in a crisis this summer if it weren't for the fact that we had enormous exponential growth in generation capacity from renewable.

Fiscal action is in response to something. And what is the counterfactual had we not done that? We've gotten a more resilient global recovery and a potentially more resiliency down the road. Not to say that we've got much worse fiscal trade-offs as a result. But I also want to ask the question for both Barry Eichengreen and Carmen Reinhart. Right now, I mean, Barry, you talked about it in your paper about the slower growth in China and less excess savings and that's been sort of a dominant theme in recent decades. What are your thoughts about, we're seeing some signs that maybe the transition to slower growth could be bumpy in China, maybe a debt de-leveraging cycle. Carmen, I would love your thoughts on that. And what are the implications for the fiscal trade-offs for the advanced and emerging economies?

Phil Swagel: I have two questions. The first one is what might lead to action? The paper is not super hopeful on this, but I have some thoughts for the United States. The end-2025 date for tax policy is the obvious one. The personal income side of our tax system is expiring and so something will be done then. Through that time, we have sharply rising interest payments. Those payments are set to rise very substantially even from last year to this year. And then it doesn't get better as you look ahead.

And then not much beyond that is that the Social Security trust fund is exhausted in 2032. The trust fund for Medicare Part A is exhausted the next year. I can see some drivers of action in the near-term horizon.

And then question two, I honestly don't know the answer. This is truly a question. In an economic crisis, policy makers look to the central bank. Everyone here knows that. So should central banks around the world be more vocal about fiscal policy, about the fiscal trajectory, about the problems being pointed out in this paper? And, I'm not just talking about the United States, I'm talking about all the central banks around the world.

Christina Romer: All right, let me take one more.

Chad Jones: Thanks. The paper focused on the current situation and living with our debt to GDP ratio of a hundred percent in the

United States. But I wanted to kind of follow up on what Phil Swagel was saying – asking you to look forward 10 or 20 years. And the CBO has been writing these reports for at least the last couple of decades, looking at entitlement spending rising partly Social Security. But to my read, much more health spending is a share of GDP publicly financed health spending. And that this is going to drive debt to GDP ratios as high as you want them to go until we do something. And this is a problem of advanced economies more generally. And so do you see us being able to live with that and if not, how do you see it?

Christina Romer: All right, Barry, why don't I give you a little time.

Barry Eichengreen: Okay. I'll work more or less backwards, coming to Carmen last. Amir Yaron mentioned that we have done fiscal consolidation in the past. We did it in the United States in the 1990s. The message of the paper is we're not in Kansas anymore. There was a degree of political consensus then that no longer exists, and there was a higher growth rate that no longer prevails.

And you asked about collective action clauses. My paper in the *American Economic Review,* comparing bonds with them and without them suggests there's no price penalty. So I disagree with that point.

Karen Dynan asked about within-country structures that are conducive to fiscal adjustment. The one that we find in our empirical work in the paper is proportional representation electoral systems. If you have an encompassing coalition government, with all the parties at the table, they may be able to agree on a package of reforms and share the costs. That's not a very reassuring observation for the United States. But that's what we find. And in other work I've done in the past, I've shown that independent fiscal councils have an important role to play here.

On China and slower growth, yes, slower Chinese growth will mean less global savings, but increasing global longevity will mean more global savings. We think those two things cancel out to a first approximation.

Chad Jones, knowing what's going to happen to the relative cost of healthcare 20 or 30 years out is above my pay grade.

On Carmen Reinhart, I too thought I was going to write a paper on global financial flows, but the Kansas City Fed gives its authors a title, and then a paragraph describing what they want. And the paragraph was all about public debt. So, I ran with it.

Section four of the paper looks at realized contingent liabilities. Does the standard debt arithmetic interacting the inherited stock of debt with the real interest rate minus the real growth rate and what's left over, that is not explained. Those are things like debt restructurings and realized contingent liabilities. We look at them in the 19th century and after World War II. And yes, they have important implications for the evolution of public debt.

Does high public debt stifle growth? Clearly, there's a point at which heavy public debt becomes a drag on growth. But this is a Pandora's box as everybody in this room knows, that we hesitated to open, because we didn't feel we could offer much beyond that generalization. Clearly, heavy public debt creates additional financial fragility. There becomes a point where safe assets become unsafe, but exactly where that point is in different countries, we didn't feel we could do more than offer the observation. I agree with what Carmen Reinhart said about taxes versus spending. There is famous work by European teams led by the late great Alberto Alesina that says fiscal adjustments are sustainable when they occur on the spending side. And that's true for Europe, where spending is too high. But it's not necessarily true in the United States, where taxes are too low. So it depends on the circumstances of the country.

Financial repression, I don't think that central banks will be able to expand their balance sheets further to support the debt situation under current circumstances, or be able to force-feed bonds to the banks for financial stability reasons. And finally, implications for the central banks, I'll hold that one until later.

Carmen Reinhart: To Julia Coronado's point on China. Domestic and external. On the external, we track and work with Horn and Trebesch, the global financial flows. China slowed down and the fact

that so many emerging market debts have gone sour meant they had a classic Guillermo Calo sudden stop in 2019, where large inflows are now net repayments. Okay? But, it's the second-largest economy. So, one word on the domestic, they have a big debt overhang. It is not at this conjuncture with central government, but it's corporate, and it is also related to the property cycle and provincial debts. So, the issue of contingent liabilities and what China does, I think, will produce a lot of back and forth, because they are reluctant to simply transfer them into their own balance sheet at this stage.

Arvind Krishnamurthy: Barry, do you see an asymmetry between the U.S., with the dollar and Treasurys as a reserve currency and reserve asset of the world and other non-reserve economies? Theory suggests that there's a nowhere else to go effect that must play out in U.S. Treasurys. And as Darrell Duffie emphasized yesterday, there's a safe-haven premium in the pricing of Treasurys. That means that the U.S. probably has more room, more fiscal space, and can delay adjustment longer than other economies. Now, what I'm really interested in is, would that same thing be true of Britain 100 years ago? And, Britain ends up, as you've written, losing its reserve currency status to the U.S. sometime either between the wars or maybe after the wars. How did the fiscal adjustment in Britain play out? Was it slow or fast, and what can we learn from that experience to understand the U.S. in the present?

Eswar Prasad: Barry, you have told us persuasively that things are bad and not getting better. Carmen has told us that things are worse and getting worser. And Phil Swagel has confirmed that for the U.S. This brings up two questions. One is, from the point of view of inflation, you've pointed out that it's not a viable strategy for reducing debt, but are we in an era already where — given that none of this is a secret to market participants — that fiscal dominance may already be kicking it in some fashion. Especially with the interest rate-growth rate differential turning adverse, does it affect central banks' ability to conduct monetary policy, particularly in the future, in an environment of even greater fiscal dominance?

And second, going to the point about global financial flows, this puts us in a very bleak situation if you think about global growth,

with rising debt sucking out money from private investment in the advanced economies. But then, if you think about the parts of the world that are labor rich but capital poor, it suggests that even those parts of the world where we could generate some growth, because the demographics are favorable, are not going to get capital, because you're going to get much of global savings getting sucked out. So it suggests that, in terms of long-term growth as well, there are some bleak aspects from a global perspective.

Christina Romer: We're going to go to Maya MacGuineas.

Maya MacGuineas: This is not a happy paper. It's an excellent paper. I thought it was excellent, compelling, and downright depressing. I will apologize because I had four questions and they were all asked. So, I'm just going to make a quick comment. But, I felt like you really effectively systemically shot down every cause there was for hope, both on the economic and political front, and you just nod like, "Yep, that's right. That's right. That's right." And I do worry that it's more likely worse than better in the U.S. for a couple of reasons. One, when you think about the R versus G situation which caused so much like, "Okay, don't worry. We'll be fine" for a while there. What it missed in the U.S. was that we've never been close to having primary balance. We've always had very large structural deficits looking forward. The risk in the U.S. is, how much we've pre-committed to spending and borrowing, I think, is at $19 trillion over the next decade.

The second is on the political polarization. I mean, I think, if you think about where we are right now, if the U.S. has some crisis, it's more likely we will respond in the wrong way than the right way. The only deficit reduction we've had in the past 10 years. Bipartisan deficit reduction, I'm not sure if inflation reduction ended up being deficit reduction or not, but was at the threat of defaulting, right? And we will still not stick to the changes that we put in place. I don't think we have the ability to stick to our fiscal consolidation when we do it. The lesson learned by both parties is that you can curry more favor by giving things away than doing fiscal consolidation. And, as Phil Swagel's looking out at the action forcing moments, another one that we have is another debt ceiling in 2025. And, while I didn't

think we were going to default this last time, I think it's very likely we could next time. And so I think there's huge cause for concern.

And just the third, in the Karen Dynan's comment from yesterday on AI, in all the economic conferences I've been at this summer, everybody knocks on wood and says, "Okay, AI, I think maybe there's going to be a big productivity boost, and we can all be hopeful, and optimistic." And I am, but I also think we have to spread out beyond just the economic effects and look at what's about to be a world of massive disinformation, a loss of political trust much worse than we have now, which will make anything in terms of repairing our political or economic system so much more challenging. So, I just thought, in light of an excellent paper, I wanted to find a few more places to be depressed. If I could toss in one question, I would love to hear if there's anything about the fiscal councils you think would work particularly well in the U.S., because I think that is one of the big hopes.

Christina Romer: All right. Diane Swonk?

Diane Swonk: Thank you for the uplifting news. I have just a couple of questions there related to things that I learned from our own tax people on the Hill. One of the things, and this is a little bit counterintuitive, is that they're arguing that there's enormous shift within both parties, which is now against-large businesses; they're more than happy to tax large businesses on both political spectrums, and especially in the extremes of the political spectrums. That could be a place where we see a boost in tax revenues.

The other issue is that anything international, as we mentioned in the previous panel, is considered fair game for taxation, and regardless of what the economic consequences may be, they see it as low hanging fruit. Wanted to get your thoughts on that in terms of revenue sources. The third issue, I've been watching and thinking about. Maya MacGuineas mentioned the chance of an actual debt default, which is very hard to get your head around, but certainly share her fears. I think also that the role that private investors are now playing versus large countries in holding our debt, is important. That shift could make investors perhaps more fickle, more apt to move more

rapidly and susceptible to panics. That could cause a more dramatic move in interest rates going forward.

Christina Romer: All right, let me move over to Nela Richardson.

Nela Richardson: Thank you for the great discussion. I probably will be watching comedies for the rest of the weekend just to reverse some of the discussion. But, really, really great discussion. I have just a quick question. So, the fiscal response to global shocks we've seen this last two cycles was first the financial recession, which was austerity in the U.S. and in Europe. And then, we've seen the complete opposite with the pandemic response, where advanced economies really stepped up their spending to spend through the downturn, making it very deep but very short. And I wonder, what is the playbook for the next global shock? If you think that geopolitical shocks are going to be more frequent, how hamstrung are governments around the world now? And, wouldn't they like to spend more money, this is a different version of Julia's question, to get out of it? Or are we going back to austerity again? Or are we going to pinging pong between the two? If you could project or hypothesize what's now the government's go-to strategy for a geopolitical shock, I'd love to hear your thoughts.

Christina Romer: All right, so I'm going to take two more questions. So, Peter Henry and then Debbie Lucas.

Peter Henry: Thank you for an excellent paper, Barry. Excellent summary of the issues. So, just a couple of comments on middle income countries and low income countries. First on the middle income countries, the one very significant data point that I think wasn't captured by your analysis on running large fiscal surpluses over a sustained period of time is Jamaica, circa 2012-2017. Christine Lagarde was actually in Jamaica in 2017 to celebrate the first successful IMF program completion in Jamaica after 12 failed programs over the course of about 20 plus years. So it can be done, and Jamaica's not a particularly undivided country if I can put it that way.

Moving from the middle income countries to the low income countries, I think, Carmen Reinhart is absolutely right, in that, creditors want to be paid. And even when there have been initiatives like the Heavily Indebted Poor Countries Initiative, or the more recent

debt relief initiatives, what you see typically is that when the left hand gives the right hand takes, so usually, there's debt relief. And then, there are reductions in bilateral aid. And so, there's no increase in the net resource transfer. So I think, holding any hope of any significant action by rich countries to actually generate more official flows to poor countries is just really a non-starter.

But I think, there is hope, because if we can actually generate more efficient public spending, right, that is the way to deal with the Chads, the Zambias, and the Ghanas of the world. And the challenge is that the World Bank for the last umpteen years has been talking about more efficient public spending, hasn't done anything to actually make that happen. And simply, producing data on the rate of return on public spending in poor countries, and actually, using that as a means of guiding investment decisions would go a long way, and be far more productive than the repeated discussions about debt relief in poor countries.

Christina Romer: Thank you. All right, Debbie Lucas.

Debbie Lucas: I wanted to pick up on the contingent liabilities that Carmen Reinhart mentioned, and maybe this is a bit more optimistic, because it's a plea to the people in this room for what we could do which was affirmatively useful. So, the IMF has done good work. I've tried to participate in how can we better measure contingent liabilities. Carmen suggested it's everything, which is true, but really, what we need is a way in our official accounts and a more uniform way across countries of understanding the magnitude. So, just for instance, it didn't come up, but in COVID, even the rough calculations by the IMF said that the credit interventions, which were basically contingent liabilities, were as large as the traditional fiscal liabilities. Yet, in our official accounts, we don't have a way of measuring that. Certainly, with climate, we have new contingent liabilities.

Relevant to central banking, what happened during the global financial crisis and what happened again during COVID is central banks instituted more and more emergency facilities. A lot of them were backstopped by treasuries, and in that sense, it gets into the official accounts. But, in fact, central banks are taking on more

contingent liabilities, which I would argue are not being transparently measured in the way the central banks are accounting for them. So, I guess, I'm interested in what everyone who's speaking has to say about, as a profession, I think, we could do a lot more for measuring contingent liabilities, and then we could even have that conversation, and it would be productive, because this whole issue of how much dry powder do we have, I don't think we can answer that by just looking at traditional debt measures. I don't have any more questions.

Christina Romer: Thank you. Barry, final words?

Barry Eichengreen: Arvind Krishnamurthy asked about the interesting case of the UK and how sterling lost its safe asset status. There's a really interesting comparison between the aftermath of World War I, where Britain was saddled with a debt to GDP ratio of 100%, but restored sterling's international currency status at the cost of considerable domestic sacrifice in terms of unemployment and output foregone. Versus the aftermath of World War II, where this was not the case. But even then there was no collapse of the currency, because sterling balances held abroad were blocked. They could not be converted into merchandise or other currencies for a decade and more, without the permission of the British government. So, while those are interesting thought-provoking cases, I'm not sure they really speak to the prospects of the dollar.

Diane Swonk asked about the implications of the switch to private investors and whether they are more footloose or fickle than governments and central banks. That brings us back to the issue of global financial flows. I didn't go there, but I think it's Deborah Lucas who has a paper that looks at how volatile flows associated with different investors are. And, her results, she can correct me, are consistent with your intuition. Peter Henry, on Jamaica. The thesis might be, if you have three failed consolidations, then you can do a successful one. Argentina, of course, contradicts the point, so it would be nice to know more about what made consolidation possible in Jamaica in the end.

Finally, I want to touch on implications for central banks. I see three. Number one, expect in many countries less active use of fiscal

policy in response to the next crisis or downturn, because more governments will be constrained and that may have implications for what the central bank has to do. Make provision for those exceptional interventions that Darrell Duffie was talking about yesterday, because there is more strain on treasury markets. And number three, I basically agree with what Phil Swagel was hinting at, that central banks are going to have to engage in "open mouth operations." They're going to have to weigh in on the implications of high public debt, insofar as public debts have direct implications for the conduct of monetary policy. They will need to talk about that.

Carmen Reinhart: So, I want to follow on Nela Richardson's question. So what's in store for the next policy response? Let me say that the U.S. policy response was really, really out there. In the World Development Report in 2022, what you find is a real drop-off even within the wealthy economies, but certainly when you go to emerging markets, let alone when you go to low-income countries. In the policy response, the fiscal policy stimulus in response to COVID, and much of it had to do with initial conditions, how much fiscal space there was, whether they were close to prior peaks in debt played a role. So, initial conditions on debt on fiscal space played an important role. This, as I say, I refer you to the World Development Report 2022 on how countries were able to deal with COVID, which also, is one of the issues I was asking for, in terms of can high debt constraint growth. And it certainly can constrain the policy response to adverse shocks.

Panel: The Economic Costs of Restricting Trade — The Experience of the UK

Ben Broadbent

Introduction and summary

Good morning. I haven't been to this conference for a number of years and it's a great pleasure to be back.

Quite a bit has happened in the interim. We have been through a terrible pandemic. Just as the world was overcoming the worst of Covid-19, Russia invaded Ukraine. We are now witnessing the most serious armed conflict on the European continent since the Second World War.

These events have taken a terrible human toll. They've also had significant impacts on the world economy.

Despite their differing origins, the economic consequences of these shocks have quite a bit in common. The pandemic disrupted the supply of traded goods, much of it from Asia. This contributed to a material rise in their relative price and a reduction in the real incomes of goods importers.

Ben Broadbent discusses the economic costs of restricting trade. The pandemic and the war in Ukraine provide a stark illustration of the impact of a sudden contraction in the supply of imported goods for an open economy like the UK. He argues that in 2021 and 2022 these shocks reduced real national income significantly and contributed to the rise in domestic inflation. He explains that although import costs have been declining in recent months, it is likely that monetary policy will have to remain in restrictive territory for some time.

Similarly, Russia's invasion of Ukraine was accompanied by a sharp reduction in the supplies of energy and food from that region and a further hit to the wellbeing of those reliant on them.

The resulting real-income squeeze has led to rapid inflation in domestic wages and prices in these importing countries, through the normal mechanism of "real income resistance". In both cases it's also led to calls for policymakers actively to reduce dependence on these imports — whether goods from parts of East Asia or gas from Russia — in order to "de-risk" trade.

However, one should be careful not to over-generalise. The fact that they've both involved significant interruptions to the supply of traded goods doesn't mean these two episodes have the same implications for trade policy. Nor should we imagine that, just because they're global, the economic consequences of these shocks — for either real income or inflation — have been identical in every country.

The argument that trade has been over-concentrated — and that governments have a role to play in addressing the problem — is surely reasonable when it comes to Europe's (pre-war) reliance on Russian gas. Arguably, the security of energy supply is something for which governments should and do take some responsibility. (There are significant increasing returns in the physical infrastructure and therefore an economic case for the involvement of public policy. It's also an area in which political risk is ubiquitous: this isn't the first time a monopolistic producer has restricted the supply of energy for political ends.[1]) And although this reliance was considerable — and clearly not costless to replace — there's nothing intrinsically special (or "non-substitutable") about Russian gas in particular: one molecule of methane is much like another.

It's not clear the same is true of supplies of goods affected by the pandemic. The extensive global value chains (GVCs) built up during the 1990s and 2000s have almost certainly increased economic inter-dependence[2]. There's little doubt either that, at least in the face of this very particular and very severe shock, the dispersed and specialised nature of production worsened the hit to the supply of goods during the pandemic. But the shortages and price rises weren't just because of supply problems. Covid-19 also led to a material rise in the global

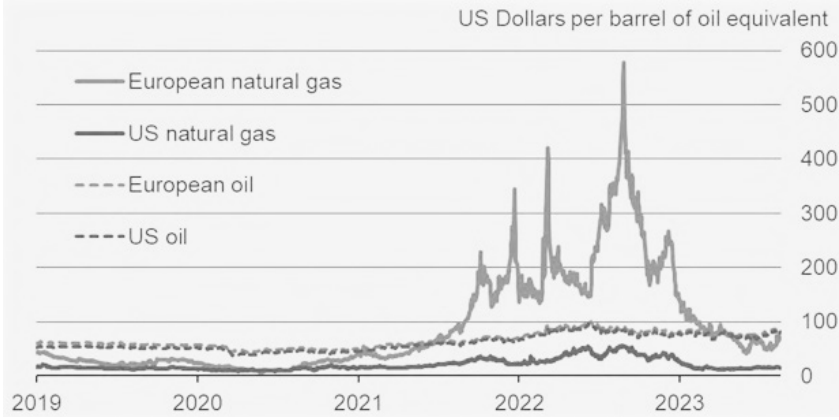
demand for goods, as consumers in many countries shifted spending away from services. Even a closed economy would have had trouble adapting to a switch in demand on this scale.

Nor was the pandemic a typical shock. Some warn they could become more common in future. But over the past, at least, there's little evidence that greater openness has led to greater volatility in economic growth — or, therefore, that there's some "risk-return" trade-off to be struck when it comes to international trade. If anything, the correlation seems to have gone the other way. And whatever the particular shocks to which they might be exposed in the future it's not obvious that private-sector firms involved in these GVCs should somehow be unaware of, or fail to internalise, the risks involved (or, therefore, that there's a prima facie case for government intervention). Finally, many of the goods prices affected by the pandemic have since subsided, or at least decelerated. This suggests that, even without a significant degree of "re-shoring", these supply chains may be more adaptable, and more robust, than sometimes imagined.

I don't want to pretend that the difficulties caused by the pandemic are the only (or even the primary) argument made in favour of curtailing international trade. There are also geopolitical factors at play. But when policymakers suggest the "fragility" of supply chains is another reason to push in the same direction I'm not sure I agree. In fact, perhaps the lesson of the past three years is not that there was too much international trade before the pandemic but that there was too little of it immediately afterwards (or, at least, that it was closed down too readily in response). After all, it also heavily disrupted economic activity within countries, not just between them, yet no-one ever makes the case for lasting intra-national restrictions on the flows of goods, services or people.

Turning to the consequences of these shocks for real incomes and inflation, one thing I want to stress today is how different these have been, even among developed economies in the west. I think it's well understood that the economic costs of Russia's actions have been greater for Europe. Unlike oil, gas is not easily tradable between continents and the cost of energy rose to a much greater extent than elsewhere. But the scale of the difference is nevertheless under-appreciated at times. At its peak last August, the wholesale price of gas was

Chart 1
European Gas Prices Rose Very Steeply Last Year



Sources: Bloomberg Finance L.P. and Bank calculations. U.S. gas is Henry Hub natural gas. European gas is Dutch TTF natural gas. U.S. oil is West Texas Intermediate (WTI) crude. European oil is Brent crude.

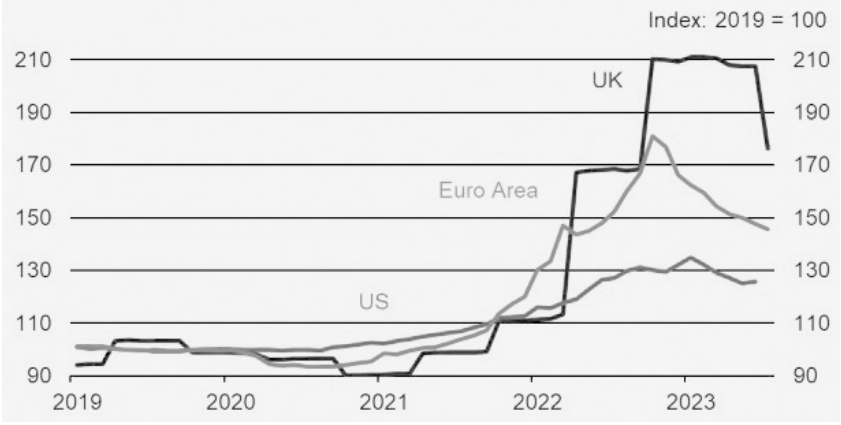
over ten times higher than in North America and the equivalent of nearly $600 for a barrel of oil (Chart 1).

Thanks to the particular way in which retail energy bills are calculated in the UK, the direct impact on the CPI and on real household income has been both larger and more drawn out even than in the rest of Europe (Chart 2)[3].

If the hit to household income has been greater in the UK even than in other countries in Europe the same is true for the country's aggregate real income. As a relatively large consumer of imported energy and goods, and against the backdrop of the UK's withdrawal from the European single market and customs union, which raised its costs of trade, the UK's aggregate real national income was hit particularly hard both by the war and the pandemic.

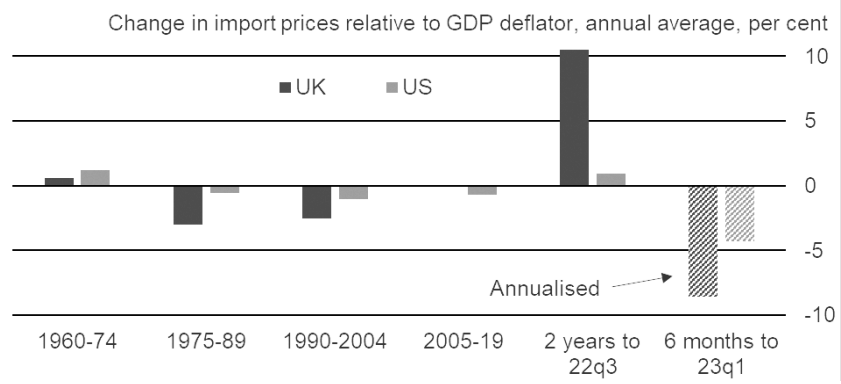
Chart 3 plots average rates of growth of import prices, relative to the GDP deflator, over longer periods in the past and then the early part of the current decade. Having for many years benefitted from the scale and nature of globalisation — the UK's comparative advantage has long been more in tradable services than in goods — the turnaround in the two-year period to 2022Q3 was particularly dramatic. The cost of imports rose by around 20%, relative to domestic

Chart 2
Utility Bills Rose Further in the UK than in the Rest of Europe and the U.S.



Sources: ONS, Eurostat, U.S. Bureau of Economic Analysis and Bank calculations. Chart shows price of household energy utilities in UK's CPI, Euro area's HICP and U.S.'s PCE.

Chart 3
In Contrast to Pre-GFC Trend UK Import Prices Rose Dramatically at the Start of the 2020s



Sources: ONS, FRED and Bank calculations. U.S. bars weighted by ratio of U.S. import share of output to UK import share of output in volume terms, for comparability with UK bars. Euro area not included in chart due to limited back run of data and limited external trade data.

prices. Because they account for around 30% of domestic expenditure this knocked close to 6% off real national income.

By contrast, the U.S. — even the non-energy U.S. economy — saw little deterioration in its terms of trade following the pandemic and

is in any case a less open economy. So these external events caused barely a ripple in its national income (relative to GDP).

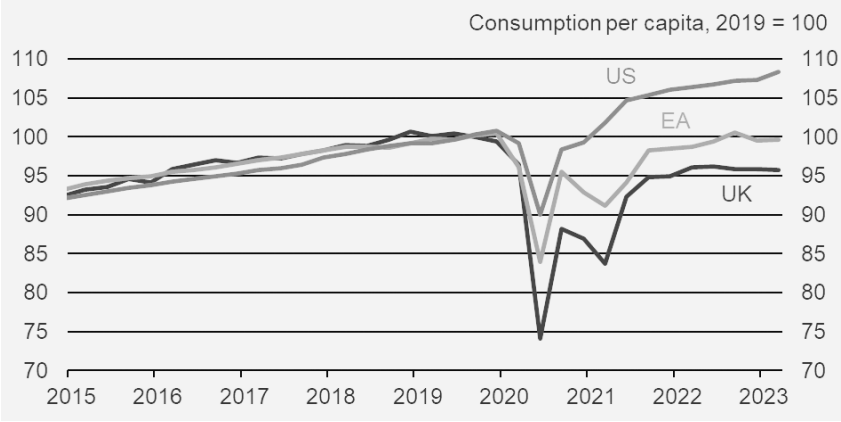
This difference in the scale of the real-income squeeze has been reflected in a sharply lower path for consumer spending in the UK (Chart 4). It's also likely to have contributed to significantly worse "second-round effects" on domestic wage and price growth[4].

The big jumps in import prices don't just affect their counterparts in the CPI. They will also have raised the cost of imported intermediates, including those used to meet domestic spending. If there's any degree of "real income resistance" in the economy, hits to real income from a worsening terms of trade can add further to domestic inflation. Employees seek to defend real pay by bidding for higher nominal wages; firms protect the real (consumption) value of profits by raising their own prices. Collectively this cannot succeed: the hit to real national income is what it is. But, in the meantime, the process fuels higher domestic and overall inflation. I won't claim this proves the point but there is some evidence that, in countries where import price inflation has been higher, wage growth has also been stronger (Chart 5).

The good news is that these import prices have now been subsiding (or at least decelerating) for a while. Wholesale European gas prices peaked almost a year ago and have fallen back a long way since. In many countries manufacturing output prices have also been declining in recent months.[5]

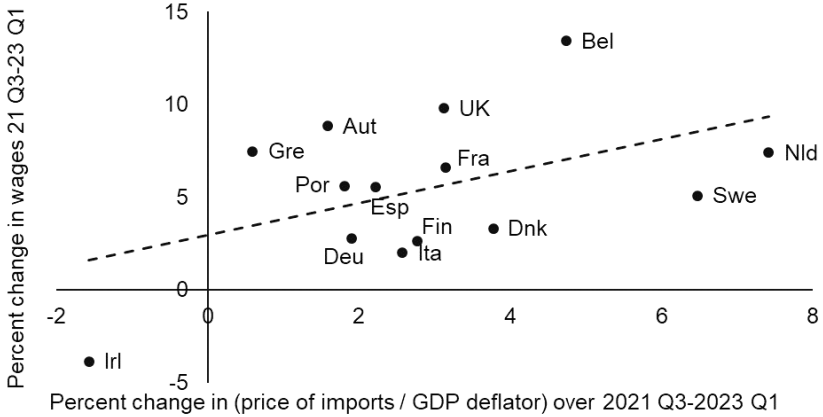
We can expect this to feed through to retail goods inflation over the next few months. In time, and even for given levels of unemployment and wider spare capacity in the economy, it's also likely to relieve pressure on real incomes and, for that reason, on domestic rates of inflation. A crucial question for monetary policy is whether this unwinding of "second-round effects" will be as rapid or as marked as their emergence over the past two years. The judgement of the Monetary Policy Committee (MPC) is that this is unlikely — we think the process will take longer — and, therefore, that policy will probably have to remain in restrictive territory for quite some time yet.

Chart 4
Marked Divergence in Consumer Spending



Sources: Refinitiv Eikon Datastream and Bank calculations. Population of Euro area and UK available on annual basis and interpolated linearly to quarterly frequency.

Chart 5
Wage Growth has Been Higher in Countries Where Import Prices Rose More



Sources: Eurostat, OECD, ONS and Bank calculations. Percent change in (import deflator / GDP deflator) is adjusted by country's import share of output. UK wages are AWE total pay, Euro area countries' wages are total wages and salaries. For Greece, wage data for 2023 Q1 not available so wage growth calculated over 2021Q3–2022Q4.

Anyhow, having picked off some of the main points in this introduction I'll now fill in some of the details. I'll begin with some remarks about trade. The second main section is about the effects of the real-income squeeze on domestic inflation and the prospects for a reversal of these "second-round effects" now that the real price of

imported goods and energy prices has started to decline. I close with some remarks about the behaviour of monetary policy in the presence of these sorts of shocks.

The Global Supply of Traded Goods and UK Income

It's now common knowledge that the huge expansion in world trade, during the latter part of the last century and the first years of this one, then petered out around the time of the global financial crisis (GFC). Globalisation gave way to "slowbalisation". The share of trade accounted for by GVCs, whose growth had been the main engine of the long expansion, levelled out around the same time (Chart 6). Unsurprisingly, the same pattern can be observed for many individual countries. In the UK, during the fifteen years from the early 1990s until the GFC, the share of imports in domestic spending almost doubled.

Some have blamed the subsequent flattening out in trade shares on more restrictive policy[6]. That may be true to some extent. But the more accurate description is that the rate of liberalisation slowed down, not that policy turned significantly more restrictive. Thanks to a succession of regional agreements, progress on multilateral rules and, in 2001, China's accession to the WTO, average tariff rates declined significantly in the years ahead of the GFC. In Europe, the EU's expansion, and the creation of the single market, removed many non-tariff barriers *(Dhingra et al, 2022).* Perhaps it was always going to be difficult to maintain that rate of progress.

And, as *Antras (2020)* argues, many other factors contributed to the expansion of trade and they too were always likely to run out of steam, or at least to decelerate, at some point. By dramatically reducing the costs of information exchange and improving the efficiency of supply chains, the ICT revolution also made it easier to disperse manufacturing across different countries. Political developments brought significant numbers of people — from Eastern Europe and above all China — into the global economy. The growth of air freight and improvements in shipping reduced the physical costs of trade.

As we know, the gains from this earlier period weren't evenly distributed, either across countries or within them. Much has been

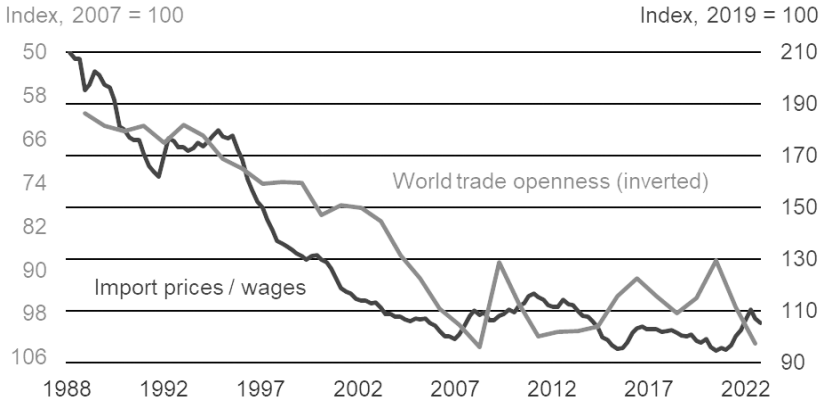
Chart 6
Trade Levelled Off After the Global Financial Crisis

Sources: ONS, World Bank Development Indicators, *Borin and Mancini (2019)* as reported in *World Development Report (2020)* and *Antras (2020),* and Bank calculations. World trade is defined as the sum of world exports and imports of goods and services as a share of world GDP in value terms, divided by two as a country's import is another country's export.

written about the effects of China's rise on competing sectors in the developed world, and in particular on the wages of the less skilled *(Autor et al, 2013).* As *Samuelson (2004)* pointed out, greater openness needn't be beneficial even at a national level if it lowers relative prices in a sector in which the country happens to enjoy an initial comparative advantage (thereby reducing its terms of trade).

The effects and benefits of openness don't hinge solely on the terms of trade. But at least as far as these aggregates are concerned[7], this was not the experience of the developed economies: the terms of trade of most large OECD countries were broadly constant or rising during that period. And for small open economies — particularly ones like the UK, whose comparative advantage had long been more in tradable services than goods — the relative-price benefits look to have been sizeable. Chart 3, in the introduction, plotted the average rates of change of import prices relative to the output deflator. Chart 7 gives an alternative presentation — it's the level of UK import prices relative to domestic wages — but conveys the same message. National and household income benefited significantly from declines in real import prices during the "hyper-globalisation" years.

Chart 7
UK Import Prices Fell Steeply During the Phase of Rapid Globalisation, Relative to Domestic Wages, but then Stabilised



Sources: ONS, World Bank Development Indicators and Bank calculations. Wages are AWE private sector regular pay.

Some of this reflects rapid gains in productivity in tradable goods production, at home as well as abroad. But a good part will also have been caused by declines in the costs of trade and the opening up to China in particular[8].

Conversely, as both UK and world trade growth slowed, over the subsequent decade, the gap between income and output growth also narrowed. And if this was disappointing — compared, at least, with what had come before — the huge dislocations of the pandemic and the war in Ukraine, against the backdrop of the UK's departure from the EU's single market and customs union, proved much worse. As we saw in the introduction, the jump in import prices between mid-2020 and mid-2022 reduced the consumption value of UK output by over 5%.

As much as UK incomes had gained from the increased supply of tradable goods over the preceding decades — and particularly during the "hyper-globalisation" period before the GFC — so they suffered (and dramatically so) when those supplies were curtailed.

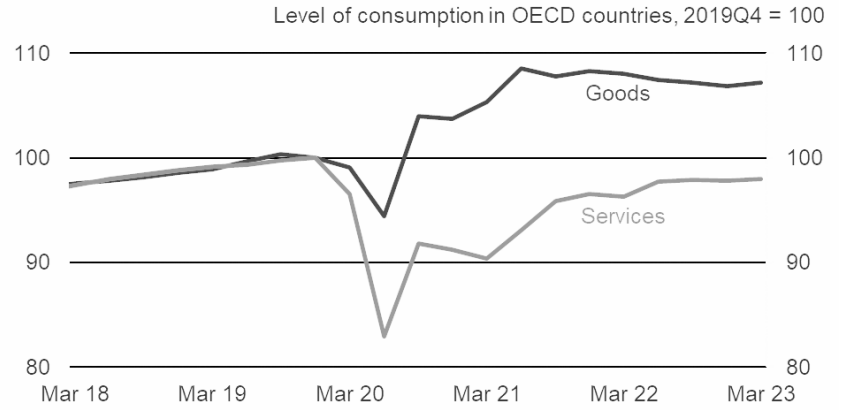
Is There a Trade-Off Between Openness and the Stability of Output Growth?

For some, these experiences have raised questions about the wisdom of unfettered openness, and in particular the rapid growth of GVCs in the 1990s and 2000s. Accepting that trade has brought gains on average, across the population and over time, does it not also result in greater volatility in output and income? The risk — well identified long before the growth of GVCs (by *Newbery and Stiglitz (1984)* for example) — is that, by encouraging specialisation, international trade also makes production more vulnerable to local and sector-specific shocks. If one part of a car is built in country A, another in country B and the two assembled in country C, there would seem to be three potential points of failure instead of one. The widespread effects of the Tohoku earthquake, on manufacturing sectors well beyond Japan's borders, are well known *(Carvalho et al, 2020).* More recently, the war has disrupted production of cars in Western Europe because manufacturers had relied for a particular electrical component on factories in Ukraine. More materially, the argument is made that the shortages and price rises following the pandemic, for a wide range of goods, represented a failure of "fragile" supply chains. The suggestion is that these problems wouldn't have arisen had production been less dispersed.

I think this is overdone and I want to make some points in mitigation. Two are particular to the pandemic, the third more general.

The first thing to point out is that the shortages and price rises in the wake of the pandemic cannot be blamed on global supply disruptions alone. Big increases in the demand for goods, as consumers worldwide switched their spending away from services, were also important (Chart 8). This shift was probably amplified by the nature and scale of the U.S. fiscal easing in 2021, as one-off transfers are more likely to be spent on durables than non-durables like services. (Remarkably, U.S. consumer spending on durables was over 30% higher in the second quarter of 2021 — in volume terms — than it had been immediately before the pandemic.)

Chart 8
Pandemic Not Just About Supply of Goods: It also Boosted Demand

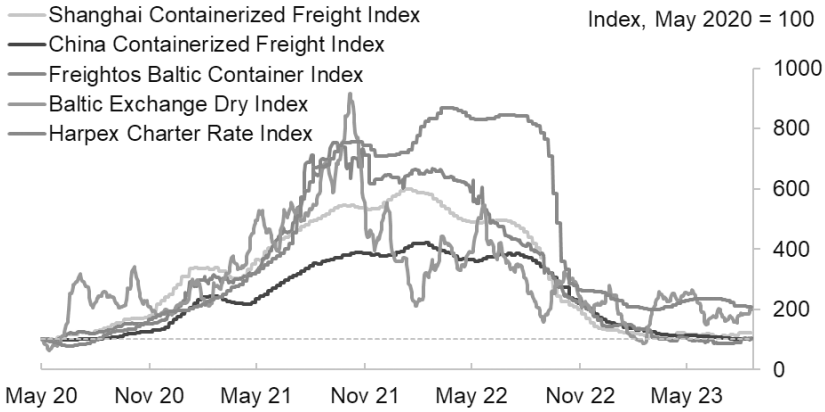


Sources: OECD Quarterly National Accounts, IMF World Economic Outlook and Bank calculations.

Nor is it right to imagine that production itself would have been unaffected had it only been less dispersed across different regions. Lockdowns severely restricted transport within countries, not just between them. The decentralised nature of GVCs certainly mattered, as did the problems with shipping. The big rise in container shipping costs is enough to tell you that. But one suspects that, even without these constraints, or this dispersed pattern of production, the global economy would have found it difficult to adjust to a shift in demand on this scale.

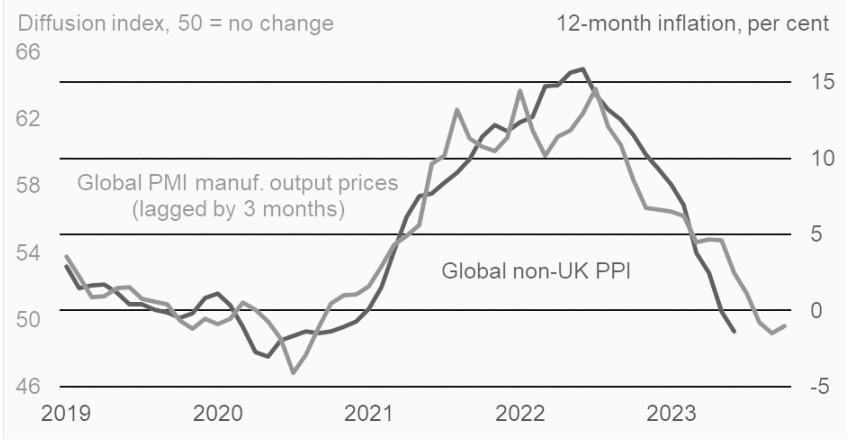
Second, judging by the behaviour of wholesale prices, quite a bit of this supply has now come back. Shipping costs peaked in early 2022 and have since declined markedly (Chart 9). And global producer price inflation has recently turned negative after over a year in double digits (Chart 10). Some of this reflects a moderate rebalancing of consumer demand: as the pandemic retreated so too, to some degree, did the skew towards goods. But the volume of global manufacturing output is still higher than in 2019, indicating that a revival of supply is at least part of the explanation for the decline in price pressures. Nor has "reshoring" been a significant part of this recovery. If anything, the evidence suggests that GVCs have played a critical role in the revival of supply *(Goldberg and Reed, 2023).*

Chart 9
Shipping Costs Rose Very Sharply in 2021 but Declined Again in 2022



Sources: Refinitiv Eikon Datastream, Baltic Exchange, Freightos Baltic Index, Harper Petersen, Shanghai Shipping Exchange and Bank calculations.

Chart 10
Inflation in Tradable Goods Prices has been Declining for Some Time



Source: Refinitiv Eikon Datastream, JPM Global PMI index and Bank calculations.'Global non-UK PPI' is the average of PPIs from the Euro area (manufacturing PPI), U.S., China, Switzerland, India, Poland, Japan, Hong Kong, Sweden, Canada, South Africa, Denmark, South Korea and Singapore, weighted by their shares of UK imports. These economies account for over 90% of UK imports.

Third, as a more general matter, the evidence that greater openness means more economic volatility is at best patchy. If anything, there's more that suggests the opposite. Certainly, a very simple and crude

comparison of the two in the UK time series indicates that, during periods of greater openness, UK output growth has generally been less, not more, volatile. In Chart 11, the white line is the share of imports in demand, the gray line the standard deviation of GDP growth (measured over rolling ten-year windows and plotted on an upside-down scale).

The negative correlation between the two isn't that tight (the period after the Second World War, when trade was still heavily restricted but output growth relatively stable, is one clear exception). Nor can we really claim this tells us anything about causation. There could well be third factors that have independently affected both trade and economic volatility.

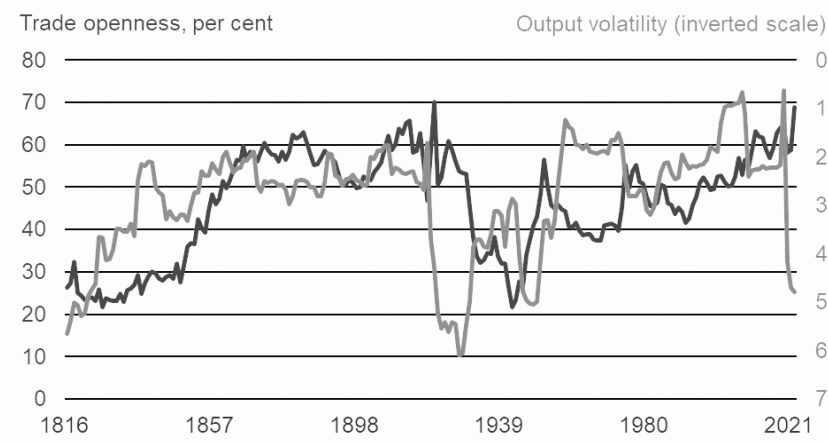
But, for what it's worth, you get the same (albeit smaller) negative correlation with the variability of output growth if you look not at openness itself but the fitted values from a simple regression of openness on trade costs (a sort of "instrumentation", to use the econometric term).

More significantly, a couple of recent studies point out that, although there are clearly mechanisms through which greater openness raises an economy's exposure to foreign supply shocks, it can also help defray the effects of domestic shocks.

A 2021 report by economists at the Bank of England *(D'Aguanno et al. 2021)* makes this point by focusing on the role of GVCs. When there is trade in intermediate inputs, a decline in productivity at home raises the relative price of a country's own output and encourages the production of substitutes abroad. This dampens the domestic impact of the shock: it's effectively shared with its trading partners. The authors demonstrate that, when this effect is sufficiently strong[9], and in the face of variable productivity in both countries, greater openness can actually reduce the variance of their output.

In a similar vein, *Caselli et al. (2020)* develop a model in which greater openness can have two opposing effects on the stability of output. By encouraging greater specialisation it exposes economies to sector-specific shocks (a la Newbery and Stiglitz). But, rather like well-functioning international capital markets, greater openness

Chart 11
In the UK Time Series Openness and Volatility of Growth Have Been Negatively Correlated (if only weakly so)



Sources: ONS, *Thomas and Dimsdale's Millennium of UK data (2017)* and Bank calculations. UK trade openness is defined as the share of (exports + imports) in GDP in value terms. Output volatility is the standard deviation of real UK GDP growth over the previous 10 years.

also allows countries to dampen the effects of domestic shocks on their own output.

In both these models the net effect of openness on output volatility is ambiguous. And previous empirical studies had also failed to come down clearly on one side or the other: some found a positive relationship, some a negative one[10]. Caselli et al. claim that their model-based estimates allow for a better identification of the pure effect of lower trade costs — and that, for most of the twenty-five countries in their sample, greater openness has actually lowered the variability of output growth. This is essentially because country-level disturbances, which trade can dampen, have tended to be more important than sector-specific shocks (whose effects are enhanced by trade-induced specialisation).

The Inflationary Consequences of Real Shocks

In the introduction we saw that countries whose import prices rose more after the pandemic have since tended to experience faster rates of domestic inflation. The UK certainly qualifies as one of them.

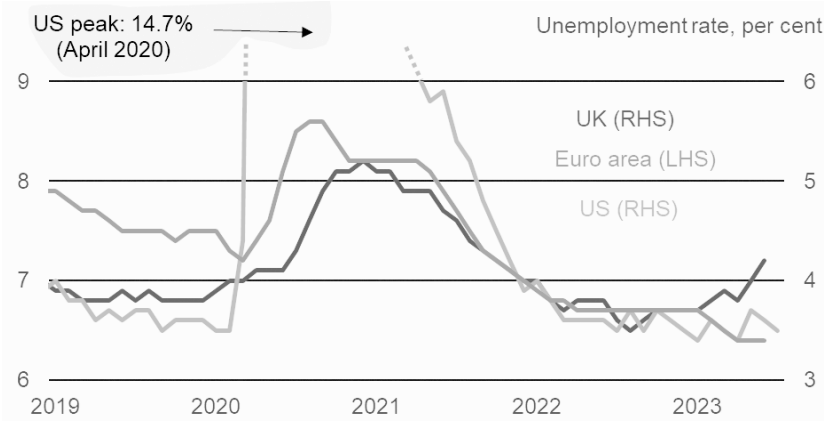
Other things have clearly contributed to UK inflation. Thanks in part to a sharp drop in labour-market participation the rate of unemployment declined steadily after the economy re-opened in early 2021, falling to 3½% last summer. Despite relatively weak cumulative growth of output over the preceding two and a half years this was a touch below where it had been just before the pandemic (indeed the lowest for forty years), lower than estimates of the UK's long-run natural rate of unemployment and close to levels in the United States (Chart 12[11]). Alongside this decline, measures of labour market tightness — vacancies, surveys of firms and the rate of job-to-job moves — all rose sharply. Only in the past few months has tightness in the labour market begun to subside.

Furthermore, even allowing for the scale of the rises in import prices, their "second-round" effects on domestic inflation have been significant and, to all appearances, stronger than past relationships (at least over the inflation targeting period) would have led one to expect.

Controlling for the impact of changes in unemployment, productivity and a measure of inflation expectations, Chart 13 plots a rolling estimate of the sensitivity of wage growth to the change in the wedge between consumer and producer prices. This is a measure of real-income resistance. Back in the 1970s and 80s, according to these estimates, a 1% hit to real incomes would on average have raised domestic inflation by around half a percentage point, with the effect persisting over several quarters. Observationally, the effect resembles a rise in the so-called NAIRU — the rate of unemployment consistent, at any point in time, with stable inflation.

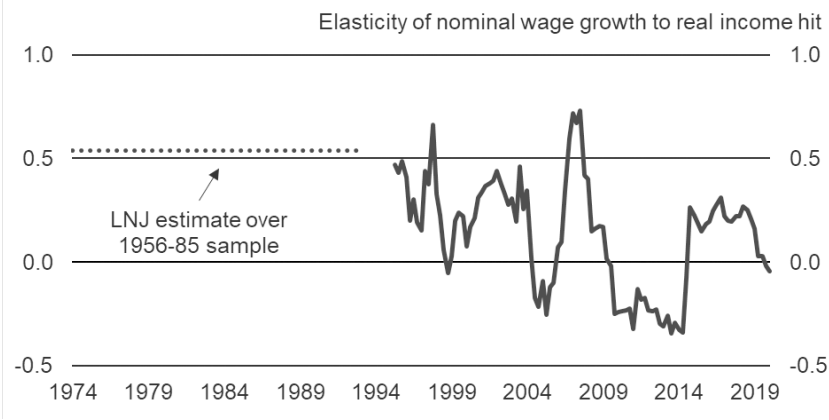
Over the years, and in particular after inflation targeting was introduced in the early 1990s, this sensitivity appeared to decline. The sizeable benefits of falling import prices during the pre-GFC "hyper-globalisation" were less disinflationary than those earlier estimates would have implied. The sharp decline in trend productivity growth, around the time of the GFC, seemed to be accommodated by nominal growth rates without any need for higher unemployment (in Chart 14, the wage Phillips curve shifted down in line with the drop in trend productivity). Similarly, the big depreciations in sterling

Chart 12
UK Unemployment Fell as Far as in the U.S. and has Only Recently Begun to Rise



Sources: ONS, Refinitiv Eikon Datastream and Bank calculations. The unemployment rate did not increase materially in the Euro area and the UK during the pandemic thanks to government-provided employment support.

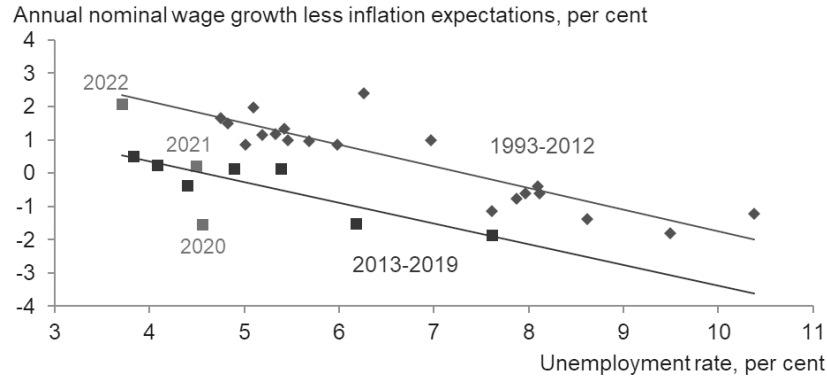
Chart 13
Estimated Degree of Real Income Resistance Declined After the 1980s



Source: *Layard, Nickell and Jackman (1991),* ONS and Bank calculations. Rolling coefficient on wedge between consumer and output prices using 18-year regressions. Dotted line shows coefficient estimated by Layard, Nickell and Jackman (LNJ) on 1956-85 sample.

after the GFC and the EU referendum, both of which squeezed real household income relative to GDP, had almost no perceptible effect on wages or domestic price inflation.

Chart 14
Domestic Prices, Including Wage Costs, Have Accelerated Significantly Over the Past Two Years



Sources: ONS, Bank of England and Bank calculations. Wage growth is AEI until 2010 and AWE since. Inflation expectations are implied by the indexed gilt market. The unemployment rate did not increase materially during the pandemic thanks to government support.

But if this muted response was the new rule, compared with earlier decades, the experience of the past eighteen months has proved the newer exception to it. Over the past year UK wages have risen by almost 8%, as much as twice the rate consistent with the 2% inflation target. There've been similar rates of inflation in services prices and the GDP deflator. Given the estimated slope of the labour market Phillips curve, and if one assumes a stable "NAIRU", one can explain at best one percentage point of this (roughly) 3½ percentage point overshoot in nominal wage growth.

Some of these "second-round" effects can be represented as the usual response to higher-short-term inflation expectations — which, in their turn, track actual, spot inflation quite closely. To this extent it's not that surprising that wage growth has been stronger than the path of unemployment alone can explain.

But even controlling for the rise in near-term inflation expectations, recent growth in average wages (and in domestic output prices) has been higher than conventional models would have predicted.

It's not clear why this has happened. One plausible possibility is that the labour market has actually been tighter than even the low

rate of unemployment would suggest: the assumption of a stable NAIRU is wrong. Certainly many other indicators of labour-market tightness suggest as much. The presence of the furlough scheme makes it hard to follow what happened to the Beveridge curve — the inverse relationship between unemployment and vacancies — during late 2020 and early 2021. But even then there were other indications that, for a number of possible reasons — the shifts in demand caused by the pandemic, early retirement and restrictions on movements of people (including across borders) — the degree of "mismatch" in the labour market had risen[12]. And during the second half of 2021, when the economy was re-opening and the number of furloughed jobs beginning to decline, these earlier indications of labour-market frictions were corroborated by a marked rightwards shift in the Beveridge curve (i.e. large numbers of vacancies, even relative to the low rate of unemployment — see Chart 15. Note that, in recent months, the V/U ratio has declined significantly — on this evidence, at least, these acute frictions may now have begun to recede.)

It's also possible that there are non-linearities in these relationships. Perhaps the wage Phillips curve is convex — falls in unemployment from low levels have more powerful effects on inflation than those from higher levels. Or maybe these two underlying drivers — the worsening terms of trade and the tight labour market — have interacted in some way, each amplifying the effect of the other (i.e. there's a multiplicative term in the Phillips curve — see Pill, 2023).

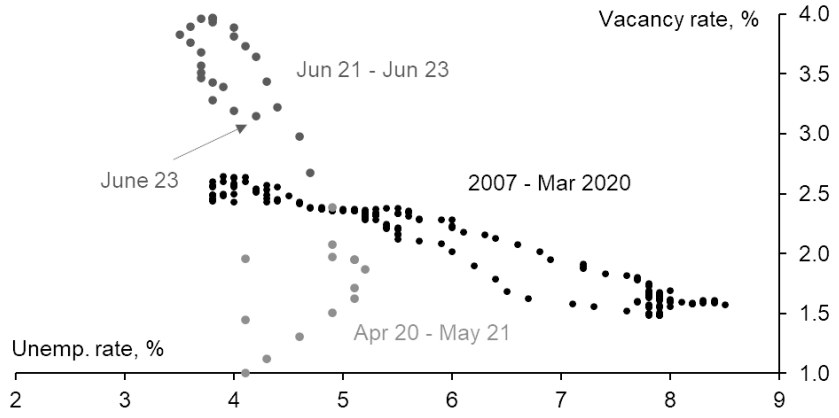
Unfortunately, I don't think we have the evidence to say with much precision how important these factors have been. But to the extent they've contributed to wage growth, this would obviously lessen any estimate of the genuine degree of real-income resistance over this period.

Monetary Policy and Uncertainty about the NAIRU

What we can say is that, in the face of these uncertainties, setting monetary policy becomes a good deal more complicated.

When I first came to this conference, in 2014, I sought to explain that, when one's uncertain about underlying productivity growth, it

Chart 15
Labour Market may now be Re-Normalising



Sources: ONS and Bank calculations. Vacancy rate calculated as number of vacancies divided by employment level (both 3-month averages). The unemployment rate did not increase materially during the pandemic thanks to government support.

makes sense to put weight not just on the behaviour of output but on unemployment as well.

Judging by its rate-setting behaviour, the pre-GFC Monetary Policy Committee in the UK lived (or at least believed it lived) in a blessed world in which supply disturbances either didn't exist or were too short-lived to have any enduring effect on inflation. The "divine coincidence" effectively prevailed and the policy that stabilised demand was also the policy that stabilised inflation.

Subsequently, however, when supply disturbances seemed to become more common, this was no longer the case. When it's less clear whether a given move in output growth has been driven purely by demand, or instead has some supply component, it makes sense to pay attention to more direct indicators of spare capacity in the economy. As long as the NAIRU is judged to be reasonably stable — and that's what the estimated Phillips curve in Chart 14 seemed to suggest — the most obvious was the rate of unemployment.

However, when the NAIRU is itself (highly) uncertain, even this isn't enough. You need to respond to wage and price growth too. This

is effectively why, at the start of this year (and ever since) the MPC in the UK said it would pay attention not just to the rate of unemployment but other measures of labour market tightness and also nominal variables — growth in services prices and wages — that tell us something about the persistence of inflation. One way of understanding this is that these things are informing us about an uncertain NAIRU and wider spare capacity in the economy.

Given the lags involved we are learning not about where things are right now but where they were some months ago. In behaving this way, policy is responding in part to things that the pre-GFC MPC would almost certainly have regarded as "late cycle" indicators — variables that lie right towards the end of the chain of transmission of monetary policy. This is real "whites-of-inflation's eyes" territory. But the circumstances have forced us there: we are, in some sense, having to trade off a degree of timeliness in our response to the economy for the sake of more knowledge about it.

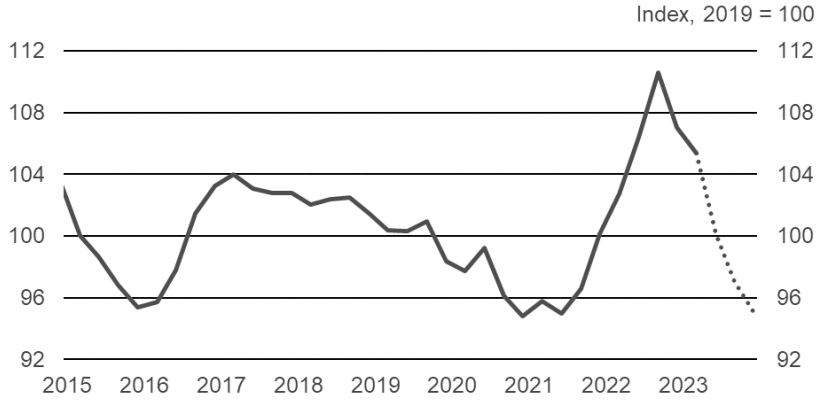
Recent Developments: Goods and Energy Inflation to Decline but MPC More Cautious About Domestic Inflation

Maybe this is slightly too downbeat an assessment of what we know — what leading indicators of inflationary pressure are available to us. Let me make a few points about the outlook.

The first thing to say is that the primary cause of this inflation — the huge rise in real import prices, following the war and the pandemic — has begun to subside, and with it the squeeze on real incomes. Chart 16 has the same series as the earlier Chart 7 — the price of UK imports relative to domestic wages — but looks only at the past five years, so as to get a better picture of the more recent moves. You can see clearly the steep increases in 2021 and the first three-quarters of last year. You can also see the steep declines since, a trend that the MPC expects to continue for a while yet (the dotted extension is drawn from the Committee's latest set of economic projections).

Arithmetically, this partly reflects the acceleration in nominal UK wages in the past few months, the denominator of this ratio. Mostly it reflects declines in the numerator. European gas prices have fallen

Chart 16
Ratio of Import Prices to Wages has Begun to Decline



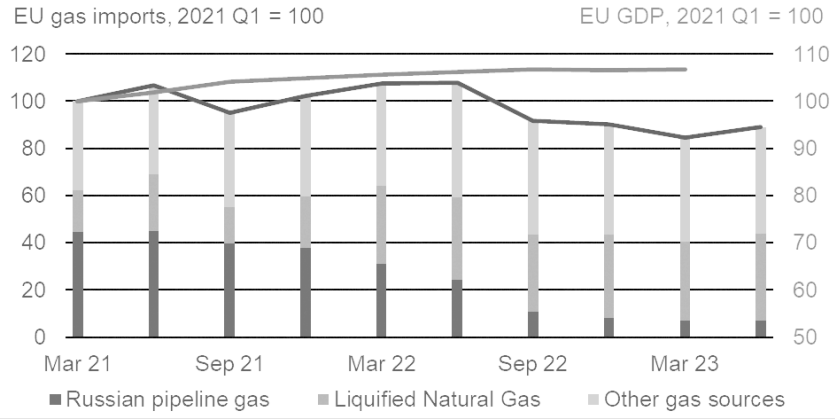
Sources: ONS and Bank calculations. Wages are AWE private sector regular pay, excluding pandemic-related compositional effects. Dotted line is a projection to the end of 2023 consistent with the August 2023 Monetary Policy Report forecast.

back sharply. Energy efficiency — how much the economy consumes per unit of GDP — improved through the winter (Chart 17). More importantly, there has been an impressively rapid substitution away from Russian gas and towards imports from other countries in the Middle East and in North America. Europe's still having to pay up for this: wholesale gas prices are twice as high as in the U.S., for example. But a year ago, at its peak, that ratio was over ten-to-one.

Nor is it just energy. We've also seen declines in many of the goods prices affected by the pandemic. Globally — in the UK and many other countries — manufacturing output prices have fallen slightly since last summer (Chart 10 plotted producer prices for the UK's main trading partners; the gray line in Chart 18 is the series for the UK itself).

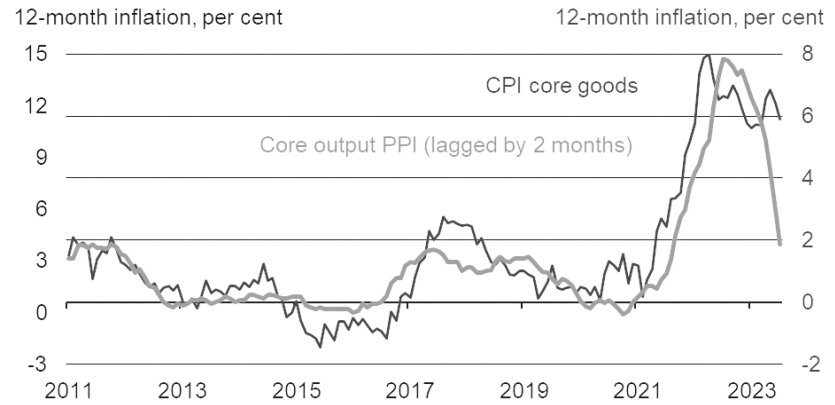
As we saw in the introduction, the UK's pricing mechanism means it will take some time for the drop in wholesale gas prices fully to feed through to household utility bills. Empirically, the same seems to be true for wholesale tradable goods prices. But I think it's reasonable to expect a decline in both components of CPI inflation — not just energy but "core" goods as well — over the next few months.

Chart 17
Significant Substitution Away from Russian Gas



Sources: *Bruegel dataset of European natural gas imports,* Eurostat and Bank calculations.

Chart 18
Deceleration in Wholesale Core Goods Prices Likely to be Reflected in Retail Goods Inflation in Coming Months



Sources: ONS and Bank calculations. Core output PPI is for manufactured products excluding non-core items.

These direct effects are all very well, however, what matters more for inflation over the medium term, as the MPC has said, are the deeper and more persistent trends in domestic inflation. In this respect there are several important judgements to make:

- To what extent will the drop in real import prices be followed by a reversal of "second-round" effects on domestic wage and price inflation?
- Will the decline in vacancies and other indicators of labour market tightness also take the edge off wage growth — is the NAIRU now declining (Chart 15 might suggest that the Beveridge curve has started to shift back to the left)?
- Improvements in real income, while they may help to blunt second-round effects, will also support demand in the economy; taking this into account, and the usual lags involved in monetary policy, will the prevailing level of interest rates be enough to ensure further rises in spare capacity in the economy, including the rate of unemployment?

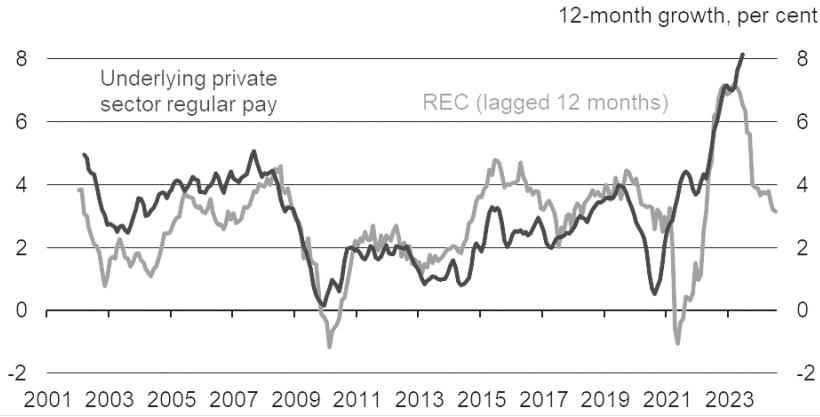
None of these questions is straightforward and individual Committee members have differing views about them.

Collectively, the MPC has been relatively cautious about the first. Partly because real import prices have not yet returned to pre-pandemic levels, we suspect any unwinding of the second-round effects on domestic inflation will be more gradual than their emergence over the past eighteen months.

On the second, it's hard to tell whether some of these other labour-market indicators have predictive power for wages for a given rate of unemployment. There hasn't been enough differentiation in their behaviour, prior to this episode, to tell the difference. There are some straws in the wind. Chart 19 plots private-sector wage growth against a relatively longstanding survey measure, an index produced by a body representing recruitment agencies. This suggests that, at least for new employees, wage growth has declined. But as you can see, in the past few months official estimates have been significantly stronger than this survey measure would have suggested, so one can only be cautious in this respect[13].

As for the third, the MPC's latest forecast implies that policy is tight enough to offset the positive influence on demand from improving real income and that spare capacity will widen. But here too the proof

Chart 19
Surveys Suggest Wage Growth Will Weaken



Sources: ONS, Recruitment and Employment Confederation (REC) and Bank calculations. Wages are AWE private sector regular pay; 'underlying' measure removes pandemic-related compositional effects. REC indicator of staff permanent staff salaries is mean-variance adjusted to match wage growth over 2002-19. REC indicator 12-month lag gives best correlation with 12-month wage growth over 2002-19.

of the pudding will be in the eating of it: policy will respond to the evidence on spare capacity, and to indicators of domestic inflation, as and when it comes through.

Summary and Conclusion

It's sometimes presumed that the economic gains from trade come at the price of greater economic volatility. At least as far as aggregate output is concerned it's not clear this is the case. In the longer-run UK history, periods of greater openness have generally coincided with lower variance of output growth. A more careful recent study finds the same for many countries over the past half-century. It's possible that, while it might encourage greater specialisation, and therefore a country's exposure to sectoral disturbances, openness to trade also dampens the impact of those on domestic demand and productivity.

In an open economy national income depends not just on GDP but what that output can buy on global markets. In the UK's more recent history there have been significant shifts in these relative prices. In the years leading up to the 2008 financial crisis, a period of rapid globalisation, import costs fell markedly (relative to wages and the price of domestic output), boosting real incomes. Over the

following few years they then levelled out, mirroring the wider pattern in global trade. The early part of this decade, from mid-2020 to mid-2022, saw dramatic rises in import prices. The pandemic boosted the demand for tradable goods and impaired their supply; Russia's export cuts led to a ten-fold rise in the price of European gas. Against the backdrop of its departure from the European single market and customs union, which itself has raised the costs of trade, these shocks knocked close to 6% from the consumption value of UK output during that two-year period.

One possible conclusion from experiences is that it's wrong to be so reliant on imported goods — particularly from a single source — to begin with. When it comes to Europe's pre-war reliance on Russian energy this makes sense. Certainly the fragility of Russia's energy supply, if it wasn't apparent before the war, is clear enough today. Thankfully, Europe's energy prices have fallen back sharply since last summer's highs. In large part this reflects concerted efforts, including by governments, to replace imports from Russia with liquefied gas from other countries.

The "fragility" of global supply chains, said to have been exposed by the pandemic, is less obvious. The pandemic was as much a story of higher demand for goods as it was one of lower supply. The restrictions in the flow of goods were widespread — they existed not just between but within countries — and would have impaired that supply even if production had been less dispersed. Judging by the retreat in many of their prices over the past year, global value chains have actually proved relatively robust. There may be good political reasons — political imperatives, even — to repatriate production in some strategic areas. But it's not clear the experience of the pandemic provides an additional reason for doing so.

Either way, the experience of an open economy like the UK provides a stark illustration of the cost of a sudden contraction in the supply of traded goods. Together with a tight labour market, the resulting squeeze on income is likely to have contributed to the sharp rise in domestic inflation and the consequent tightening of monetary policy. Over time, the more recent decline in import prices will alleviate some of this pressure. But it's unlikely that these

"second-round" effects will unwind as rapidly as they emerged. As such, monetary policy may well have to remain in restrictive territory for some time yet.

I've received helpful comments from colleagues at the Bank of England. I'd like to thank Shaheen Bhikhu, Aydan Dogan, John Lewis, Ellen Kockum, Doug Rendle, Nickie Shadbolt, Roger Vicquery, Teresa Wukovits-Votzi, and especially Fabrizio Cadamagnani, Simon Lloyd and Rana Sajedi for their help in preparing the speech. I'd also like to thank Pol Antras, Solomos Solomou and Alan Taylor for help with data. The views expressed are my own and do not necessarily reflect those of the Bank of England.

Endnotes

[1]The big rise in oil prices in 1973 was the result of an embargo by OPEC targeted at countries that had supported Israel in the Yom Kippur war.

[2] Chapter 4 of *World Bank (2020)* has more on the effects of global value chains on cross-country correlations in economic growth and inflation.

[3]Domestic gas and electricity prices in the UK are set by the regulator (OFGEM) using a formula that depends on the lagged, forward price of gas in wholesale markets. This is the case even for suppliers who generate electricity using other sources of energy. Retail prices have been capped by government subsidies in recent months. But this was no more generous than in other European countries. So the greater sensitivity to gas prices has still been apparent and, because of the lags involved in the regulatory formula, the response of retail to wholesale prices has also been more drawn out in the UK. In the first quarter of this year, domestic energy utility inflation was 89%yoy in the UK, compared with 16% in the Euro area and 13% in the U.S.

[4]See for example *Broadbent (2022), Dhingra (2023)* and *Pill (2023).*

[5]The last, hatched bar in Chart 3 exaggerates the scale of this effect as it's calculated on an annualised basis and covers only half a year (2022Q4 and 2023Q1). But more recent data indicate that this trend has continued since the first quarter. I discuss this point further in the body of the talk.

[6]See *The Economist (2019).*

[7]My focus today is on aggregate measures rather than distributional questions. But, as an aside, we should not imagine that rising income inequality during the 1990s and 2000s, in much of the developed world, was caused primarily by globalisation: most studies attribute more to technological developments. In this respect it's notable that the Gini coefficient in the United States has risen by more in the "slowbalisation" years, since the 2008 financial crisis, than in the decade or so beforehand (for what it's worth, the Gini coefficient for household income in the UK has been broadly flat throughout the past thirty years). Nor should we ignore the more favourable distributional consequences of falling import prices. As it happens, these declines, during the hyper-globalisation years, were concentrated in things that were a bigger share of spending of the less well off *(Fajgelbaum and Khandelwal, 2016).*

[8]The strength of productivity growth may itself have been the result of greater openness, to a degree. There are many studies that find a positive link between the two (see, for example, *Grossman and Rossi-Hansberg (2008), Bustos (2011)* and *Halpern et al. (2015)*).

[9]The strength of the effect depends on the degree of substitutability, in production, between home and foreign intermediate goods.

[10] For example, *Rodrik (1998), Easterly et al. (2001), Kose et al. (2003)* and *di Giovanni and Levchenko (2009)* found that trade increases output volatility. *Bejan (2006), Cavallo et al. (2008), Buch et al. (2009), Haddad et al. (2010), Parinduri (2011)* and *Burgess and Donaldson (2012)* found that trade reduces volatility.

[11] Unemployment was supressed in Europe by furlough schemes, designed in keep people from losing jobs. The U.S. chose instead to allow layoffs but to raise unemployment benefits. Chart 12 cuts off the full rise in U.S. unemployment — it reached a peak of almost 15% in April 2020 — in order to make the more recent movements visually clearer.

[12] See *Broadbent (2021)*

[13] Many firms made explicit "cost-of-living" adjustments to their pay awards for 2023. As these are more likely to have been paid to existing rather than new employees this may help to explain the apparent discrepancy in Chart 19.

Panel: Structural Shifts in the Global Economy

Ngozi Okonjo-Iweala

Globalization at an inflection point?

Excellencies, ladies and gentlemen,

I'm really delighted to be here — thank you to Joe Gruber and the Federal Reserve Bank of Kansas City for the invitation.

The past three years have reminded us how much trade, on both the supply and demand sides, matters for macroeconomic stability. I'm convinced it's important for central bankers and the trade community to work together. That's why I left the G20 trade ministers' meeting in India at the halfway point and flew straight here to join you. Jaipur to Jackson Hole was a new itinerary for me.

The COVID-19 pandemic and the war in Ukraine exposed vulnerabilities in global supply chains, with disruptions and delays leading to product shortages and price spikes.

Sustained inflation has made a comeback across the rich world. And even as the picture improves within many advanced economies, spurring hopes of soft landings, monetary tightening has exacerbated debt distress and financial instability for dozens of developing economies.

Some policymakers have looked at these shocks, alongside rising geopolitical tensions, and concluded that globalization needs to be rolled back.

Over the next fifteen minutes or so, I will make the case that we should not wish globalization away. But I will argue that we can — indeed we must — improve it, and that doing so offers opportunities to advance growth, resilience, sustainability, and price stability.

I will make three main points.

- First, predictable trade is a source of disinflationary pressure, reduced macro volatility, and increased economic resilience. It has also been a major contributor to global growth and poverty reduction. Economic fragmentation would be painful.
- Second, falling trade costs for goods and especially for services mean that globalization can still be an engine for increased growth, efficiency, and economic opportunities, while also contributing to price moderation.
- Third, supply chains are already shifting in response to changing risks, costs, and technologies. These shifts create opportunities to bring in more countries into globalized production networks. This process, what we at the World Trade Organization (WTO) are calling "re-globalization", offers potential to boost productivity, growth, development, and long-term price stability.

Seizing these opportunities requires open and predictable international markets, anchored in a strong and effective rules-based multilateral trading system.

Our credibility at the WTO — that is, the extent to which people believe that governments will maintain market conditions broadly in line with multilateral rules and commitments — will help central banks with their credibility. The converse holds as well: a less predictable world for trade will make life more complicated for central bankers.

So let's start by looking back at how trade has performed.

By expanding the international division of labour, international trade has fostered the productivity improvements that come with increased specialization, scale, and competition. For developing economies in particular, access to external demand has enabled rapid export-led growth.

Predictably open international markets, anchored in the GATT/WTO system, were critical in making trade an engine for global prosperity: market actors could scale up investment and orders, and be reasonably confident that they would not be unexpectedly cut off from export markets or imports.

Since the beginning of the 1990s, when the Uruguay Round of multilateral liberalization was complemented by market-oriented reforms in China, Eastern Europe, India, and other emerging markets, international trade has grown seven-fold in value terms, and quadrupled in volume.

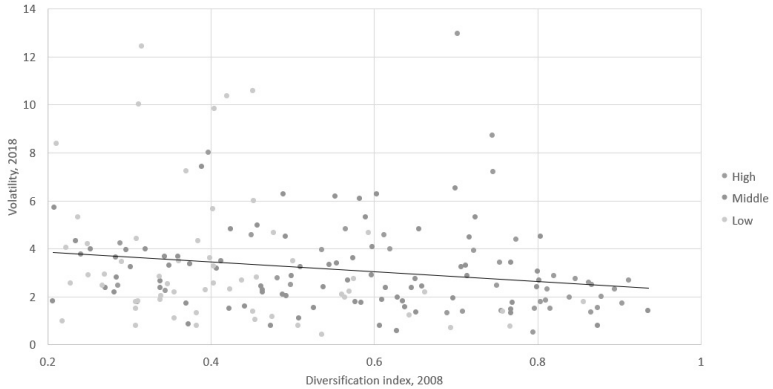
Open markets combined with better communications to allow manufacturing production and processing to be unbundled into multi-country supply chains. This lowered the bar for entry into global markets — and for accessing the knowhow and productivity gains that come with participation in those production networks.

The boom in trade was a pivotal factor in the sharp reduction in extreme poverty, from nearly 38% of the global population in 1990 to just over 8% in 2019, according to World Bank data.

With regard to prices, there is considerable evidence that trade liberalization and the rise of modern supply chains were disinflationary

Research shows that openness to international trade lowers macro-volatility more than specialization increases it. By allowing countries to diversify sources of both demand and supply, trade integration reduces exposure to domestic shocks, whether they are caused by economic downturns, disease outbreaks or extreme weather (Figure 1). Our 2021 World Trade Report showed that greater trade diversification in 2008 was correlated with lower GDP growth volatility over

Figure 1
Trade Diversification Tends to Reduce Macroeconomic Volatility by Expanding Sources of Supply and Demand



Note: The diversification index is based on the Herfindahl-Hirschman index of geographical export concentration and ranges from zero (no diversification) to one (complete diversification). Volatility is computed as the standard deviation of the nearly ten yearly GDP growth rates.
Source: WTO World Trade Report 2021.

the subsequent decade. This relationship will become increasingly salient as climate-related shocks become more widespread.

Turning now to the past three years, an under-appreciated fact is that trade has been an important shock absorber.

At the macro level, global goods trade rebounded strongly from the lockdowns and was setting new records by early 2021, helping drive economic recovery. Last year, global goods and services trade was 7% higher in real terms than its pre-pandemic peak.

During the pandemic, trade and multi-country supply chains quickly became vital mechanisms for ramping up the production and distribution of medical supplies. Billions of COVID-19 vaccine doses were manufactured in supply chains cutting across as many as 19 countries. The volume of food traded around the world held steady. Absent trade, COVID-19 would have been harder, not easier, to cope with.

Over the past year and a half, deep and diversified global markets have helped countries mitigate disruptions arising from the war in

Ukraine: for instance, Ethiopia sourced wheat from the United States and Argentina after its imports from the Black Sea region were cut off. Europe could make up the loss of piped Russian gas by importing liquefied natural gas from elsewhere.

A retreat from open global trade would undermine this supply "flexicurity" that comes when firms and households have more outside options from which to purchase goods and services. It would contribute to increasing price pressures and macro volatility, and make it harder to scale up and diffuse the green technologies we need to get to net zero emissions. Furthermore, fragmentation would be very costly: WTO economists estimate that if the world economy decouples into two self-contained trading blocs, it would lower the long-run level of real global GDP by at least 5%, with some developing economies facing double-digit welfare losses.

Meanwhile, the data increasingly shows that the recent supply chain problems were rooted in the pandemic. Locked-down consumers pivoted massively from services to more heavily traded goods. Producers and ports, often constrained by pandemic restrictions, struggled to keep up. But supply chain pressures are now back to or even below pre-pandemic levels, as illustrated by the New York Fed's Global Supply Chain Pressure Index. Current clouds on the trade horizon have more to do with insufficient demand than too much of it. Eurozone output has been flat, and recent data for China in particular point to slowing growth, declining exports and imports, and falling producer and possibly consumer prices.

But it would be wrong to conclude from all this that nothing needs to change in the way global trade operates. The past three years exposed genuine vulnerabilities in a handful of products and trading relationships where excessive concentration prevents the kind of supply flexicurity I was just describing. Re-globalization would tackle these concentration problems by bringing more countries and communities into deeper, more diversified international production networks. It would also make commercial relationships harder for any single country to weaponize.

My remaining remarks will look at how re-globalization and trade can continue to drive growth, development and price stability.

One intriguing new finding by WTO economists is that despite all the tensions and scepticism around trade, overall trade costs for agricultural products, manufactured goods, and services have fallen by 12% over the past twenty years.

In other words, despite some higher policy costs like tit-for-tat tariffs among major trading nations and rising non-tariff barriers, trading goods and services across borders has in aggregate become cheaper, once we account for improvements in transport, communications, regulatory, transaction, and information-related costs, alongside governance factors. This is significant because trade cost reductions have historically been a major driver of trade growth.

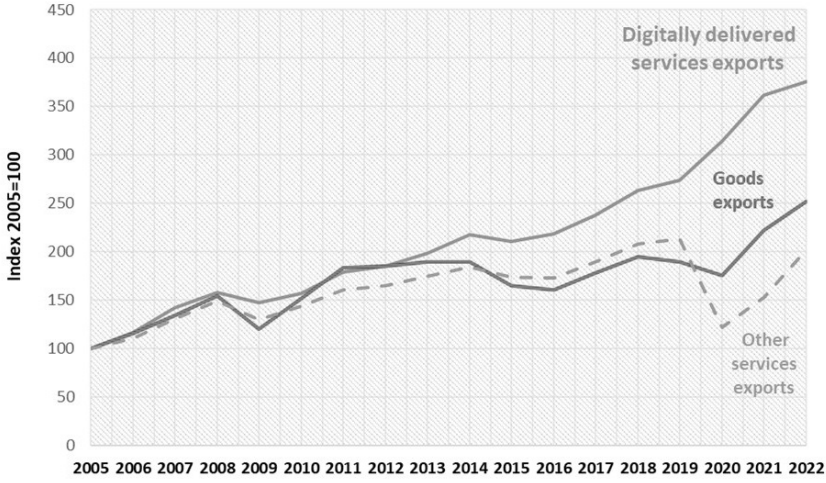
Between 1996 and 2018, trade costs fell by more than a quarter in countries like Vietnam, Poland, and India. There is still room to improve: trade costs in developing economies remain almost 30% higher than in high-income economies — and are 50% higher in Africa.

Trade policy and the WTO have played an important role in these reductions. The WTO Trade Facilitation Agreement lowered non-tariff trade costs by simplifying and harmonizing rules around border procedures. Average tariffs have fallen to about half their level in 1995 through unilateral reforms as well as WTO accession, plurilateral arrangements like the WTO's agreement on high tech goods, and regional agreements.

Another potential driver for trade and re-globalization is services, which are becoming increasingly tradeable.

Global exports of services delivered via computer networks — things like streaming entertainment, remote learning, software services and cloud computing — have more than tripled since 2005, growing far faster than exports of goods and other services (Figure 2). At $3.82 trillion in value, digitally delivered services accounted for 12% of total global trade in 2022, compared to only 8% a decade before. They also emerged as increasingly important inputs into the production of other services.

Figure 2
Global Exports of Services Delivered via Computer Networks



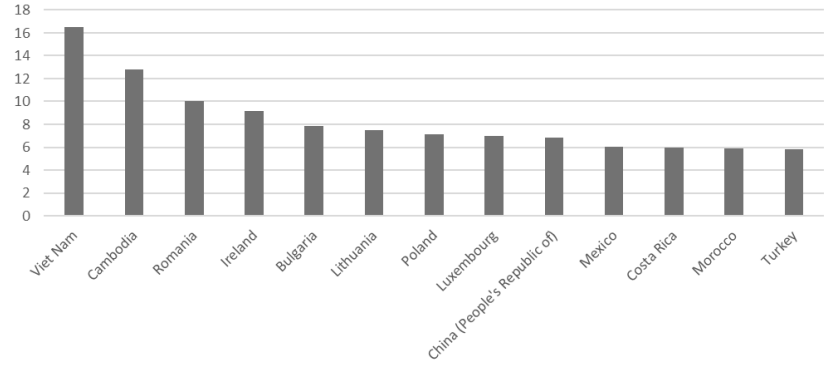
In fact, Richard Baldwin at the Graduate Institute in Geneva predicts that services is due for an "unbundling" analogous to what we saw with goods a generation ago. This time, it will be white-collar offices instead of factories that stretch across borders, as services firms in rich countries offshore intermediate tasks to lower wage countries and use remote-work tools to ensure coordination and quality.

Increased digitalization and trade in services could become a powerful disinflationary force, with implications for monetary policy — and for social policy.

Too many governments dropped the ball on supporting dislocated workers during the goods supply chain boom. We cannot afford to repeat that mistake with services, whether it's about trade or the widescale adoption of AI.

At the WTO, we have an ongoing agenda to reduce services-related trade costs. About 70 of our members, together accounting for over 90% of global services trade, have signed on to an agreement on Services Domestic Regulation that cuts red tape, sets out best practices, and make rules more transparent. And a group of 90 members including the U.S., the EU and China, are currently negotiating a set of basic global rules for digital trade.

Figure 3
Main Evolution of Total GVC Participation, Selected Economies
2010–2018 Annual Percentage Change



Source: WTO calculations based on the OECD TiVA database.

Some evidence of re-globalization was visible even before the recent crises, with countries like Vietnam, Cambodia, Romania, Morocco, and Turkey sharply increasing their participation in value chains across a range of goods and services (Figure 3).

WTO analysis suggests that China's position in bottleneck products, defined as heavily traded goods with few suppliers, has declined by 8.5 percentage points from its 2015 peak of 40%. However, the share of bottleneck products in total global trade remains high, at around 20%.

Today, as businesses recalibrate how they think about scale efficiencies versus concentration risks, they have an opportunity to bolster supply chain resilience by taking this diversification process further, to encompass more places in Africa, Asia and Latin America that have good macroeconomic fundamentals but remain stuck on the margins of the global division of labour. These regions offer younger workforces and reserves of potential productivity increases. A more deconcentrated, shock-resistant global supply base would help return trade to its familiar role as a force for price moderation.

In sum, there is a strong case for diverting some of the energy behind reshoring to re-globalizing production instead.

Re-globalization requires a supportive trade policy environment, including action at the WTO and elsewhere to keep lowering trade costs, narrowing the digital divide, and making trade finance more available.

Let me now conclude. The traditional objective of the trade policy community has been predictability. This focus has served the central banking community's goal of price stability.

A world that turns its back on open and predictable trade will be one marked by diminished competitive pressures and greater price volatility. It would be a world of weaker growth and development prospects, a slower low-carbon transition, and increased supply vulnerability in the face of unexpected shocks.

Re-globalization is a far better alternative. I ask all of you to speak up for open trade, multilateral cooperation, and the WTO. Doing so might even end up making your jobs a bit easier.

Panel: Globalization at an Inflection Point

Kazuo Ueda

I would like to thank the organizers for inviting me to this symposium. It is my great pleasure to participate on this panel. The topic is a very broad and difficult one: addressing structural changes in the global economy caused by the possible trend of de-globalization and discussing their macroeconomic implications. Being no expert in trade theory, I would like to confine myself to sharing with you the picture we are seeing from Japan on these key questions.

To provide a preview of my main points, trade and foreign direct investment (FDI) patterns in Asia are changing partially in response to rising geopolitical tensions. As far as Japan-related trade and FDI flows are concerned, there has been some diversification of production from China into the rest of Asia, to some extent into North America, and also back to Japan. Some of this has been going on for a while, and thus can be more appropriately viewed as continued attempts at globalization, while some more recent diversification seems to reflect a response to geopolitical risks. The net effect of the latter flows on Japan and the world economy remains very much uncertain, but skewed to the downside. The uncertainty poses a difficult challenge for monetary policy making.

I. Japanese Experience in the 1990s

Let me begin with the Japanese experience some three or four decades ago with respect to trade policy and its effect on the pattern

of trade involving Japan, the U.S., and Asia, although the nature of trade conflict back then was very different and less threatening than what is happening now. As a result of sharp increases in Japanese exports to the U.S. in the 1970s and 1980s, the U.S.-Japan trade relationship deteriorated significantly — culminating in the adoption of trade restrictive measures such as tariffs, voluntary export restraints, etc. The trade tensions resulted in a permanent change in the structure of foreign trade involving the U.S. and Asia. By sometime in the 1990s, as shown in Chart 1, a significant portion of Japanese exports to the U.S. had taken a detour by way of the rest of Asia. I hasten to add that a more important cause of the change in the trade structure was the rise in Japanese wages relative to the rest of Asia. But I suspect that it is possible to carry out a statistical analysis that finds the U.S.-Japan trade relationship had some role. Needless to say, I also would add that a changing pattern of regional business investment — increases in inward FDI into the rest of Asia and stagnant domestic investment in Japan — was a major driver of such a relocation of production.

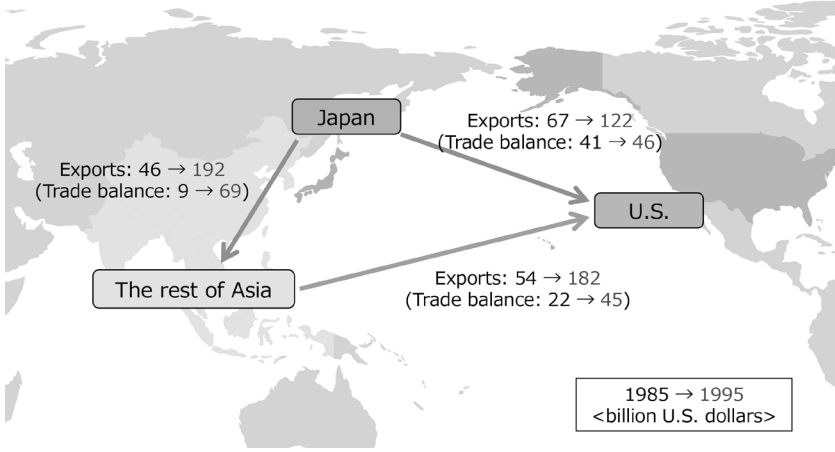
Another consequence of the trade friction was the tendency for Japanese firms to produce in the U.S. by setting up plants there (horizontal FDI). As pointed out by *Alfaro and Chor (2023),* total sales of goods of Japanese origin in the U.S. are much larger than U.S. imports from Japan.

II. Trade and FDI in Asia

Coming back to the main theme of the panel — possible fragmentation of the world economy due to geopolitics — I think that the basic reference is the IMF's *World Economic Outlook* released this April *(IMF (2023)*), especially the analysis in Chapter 4. One of the most important conclusions of the analysis is that the emergence of permanent barriers to FDI between the U.S. and China blocs, according to their baseline hypothetical scenario, would cause a large decline in world GDP. The negative effect on GDP would be much more serious in Southeast Asia, as a result of the area's geoeconomic proximity to China and its heavy reliance on inward FDI (Chart 2).[1]

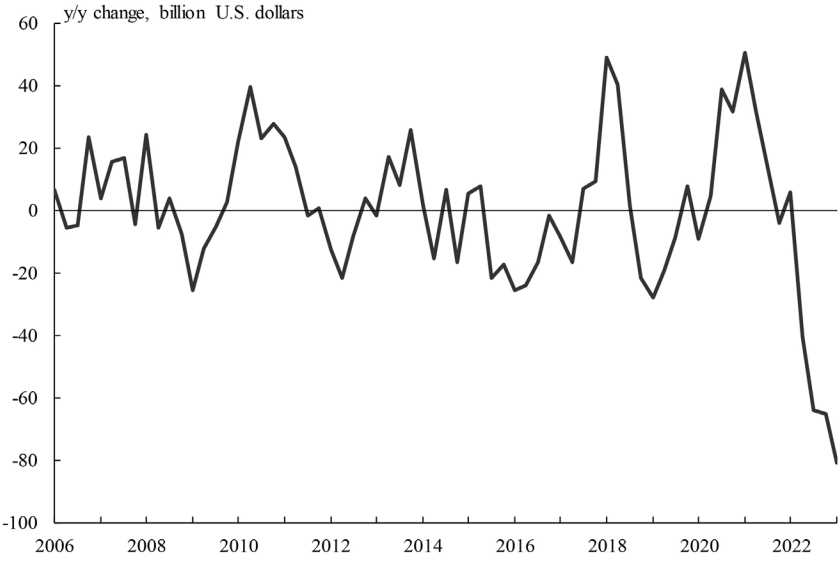
Chart 1
Production Relocation in the 1990s

Trade Structure among Japan, the Rest of Asia, and the U.S. (1985 to 1995)



Sources: IMF, "Direction of Trade Statistics"; Ministry of Finance, R.O.C.

Chart 2
Inward FDI into China



Source: IMF, "Balance of Payments."

How does such a picture fit with recent trade and FDI flows around Asia? Chart 3 shows movements in Japanese exports. The left half shows that the share of Japan's exports to China rose during the pandemic but has declined somewhat since then, while those to the U.S. and the rest of Asia have held up. For individual countries, there is a noteworthy trend, shown in the right half of the same chart, that exports to Vietnam have risen consistently and those to India have risen more sharply for a few years.[2]

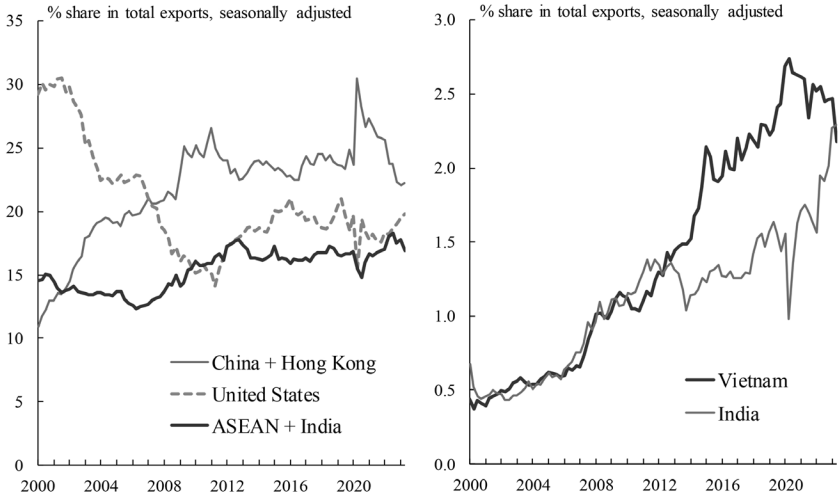
Turning to Japan's outward FDI, Chart 4 shows that FDI to China has been stagnant for some time, FDI to North America has rebounded since 2019, and FDI to the rest of Asia has been steady, with some strength in FDI to Vietnam and India.

Chart 5 shows FDI plans for 2023 and beyond among large Japanese firms based on a survey carried out by the Development Bank of Japan (DBJ). North America stands out as the most important destination for Japan's FDI, followed by China and the rest of Asia, where four countries — Vietnam, Thailand, India, and Indonesia — appear to be more important than others.

These charts as well as some anecdotal evidence that we obtain from our contacts may be summarized as follows. There is some diversification of production bases from China into ASEAN, India, and North America. Flows to ASEAN and India are motivated not only by geopolitical considerations but also by demand increases in the host countries. Flows into the U.S. are also demand-driven but may be affected by U.S. industrial policies such as the IRA and the CHIPS and Science Act as well.[3]

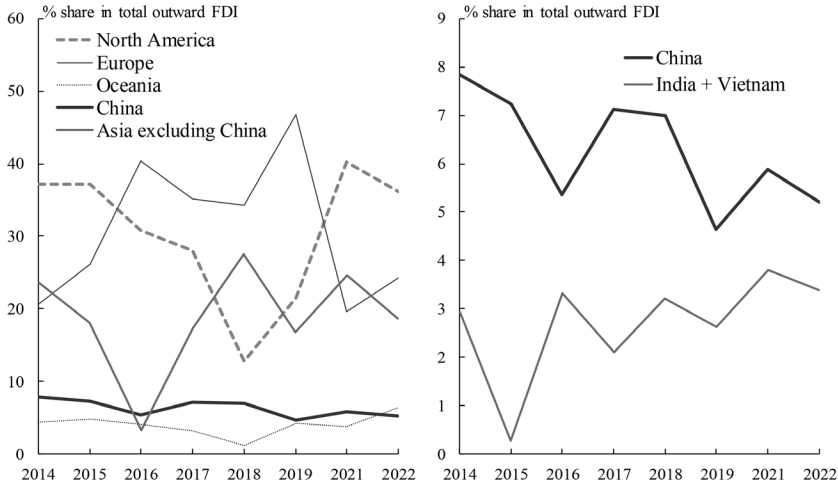
Regarding reshoring back to Japan, Chart 6 shows that an increasing number of Japanese firms have plans to expand domestic production capacity, but not entirely at the expense of foreign production capacity. At the sectoral level, firms in the auto, general machinery, and chemical industries still plan to increase capacity in Asia, while there is a clearer tendency in semiconductors and related industries to increase domestic capacity with support measures by the government.

Chart 3
Japan's Exports by Destination



Source: Japan's Ministry of Finance.

Chart 4
Japan's Outward FDI by Destination



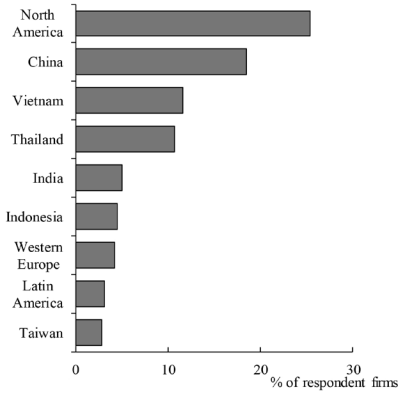
Note: Figures for 2020 are not shown.
Source: Japan's Ministry of Finance and Bank of Japan.

Chart 5
Japanese Firms' Foreign Investment

Foreign Business Fixed Investment by Large Japanese Firms

	FY 2022 Actual % change	FY 2022 Actual % share	FY 2023 Plan % change
Total	35.9		21.0
North America	34.5	35.6	16.6
Europe	25.2	15.2	19.8
China	4.8	13.3	23.7
Rest of Asia	48.8	24.2	23.6
Rest of World	63.3	11.7	26.1

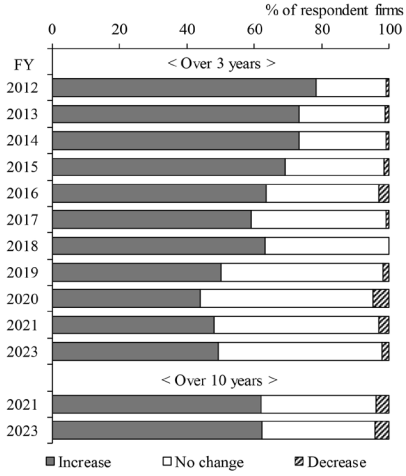
Most Prioritized Destination for Future FDI



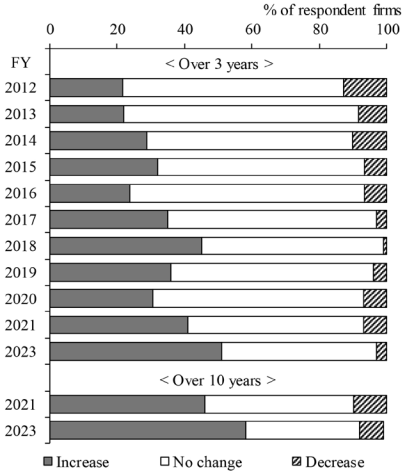
Notes: 1. In the left-hand chart, figures are based on responses from 510 firms for FY 2022 and 611 firms for FY 2023. Figures show investment expenditure mainly by foreign subsidiaries of Japanese firms, which is not the same as FDI.
2. In the right-hand chart, figures are based on the 2023 survey.
Source: Development Bank of Japan (DBJ), "Survey on Planned Capital Spending."

Chart 6
Outlook for Production Capacity

Foreign Production Capacity



Domestic Production Capacity



Note: Figures are based on the DBJ survey for large Japanese manufacturing firms. Data for FY 2022 were not collected.
Source: Development Bank of Japan (DBJ), "Survey on Planned Capital Spending."

III. Course of Fragmentation and Globalization

Such a picture seems to be somewhat at odds with the IMF simulation analysis I described earlier. If emerging Asia were to be adversely affected by fragmentation, businesses would try to move out of the area. Asian countries, even including China, however, continue to be hosts to Japanese FDIs. In fact, one of the charts presented in IMF (2023) on global FDI flows in strategic sectors (their Figure 4.4.) also shows that, although flows into China have been declining since 2019, flows into Asia excluding China have been fairly resilient.

Interpretation of the resilience of Asian production sites is not straightforward. Perhaps many firms assume that fragmentation risks would be contained to a small number of specific sectors. Or they may just keep doing the same as before until the geopolitical picture becomes clearer. Yet another possibility is that, as the title of the panel suggests, we are slowly approaching an inflection point beyond which many things will change drastically. It appears fair to say that, at least in the semiconductor sector, friend-shoring and reshoring activities are taking place on a non-negligible scale.

Meanwhile, regional economic integration in developing Asia has become even deeper. Chart 7 shows that intraregional shares in developing Asia have risen not just for total trade and FDI, but also for intermediate goods and ICT goods trade — evidence of deeper vertical integration within the region. Such an increase in regional economic dependence, of course, is partly a reflection of China's attempts to de-route production by way of the rest of Asia, as pointed out by *Alfaro and Chor (2023),* akin to what happened to Japan and Asia 40 years ago. As was the case with Japan then, rising wages in China must be a major factor behind such relocation, in addition to geopolitical forces. Anyway, globalization forces are still alive in the region. Should the region's economic integration go into reverse, the world would lose not just some of the gains from free trade, but also the efficiency gains from Marshallian externalities arising from an agglomeration of manufacturing plants in the region.

Another non-linearity-related story regarding the region is about the medium of exchange. China's attempt to relocate production or

Chart 7
Regional Economic Integration in Developing Asia

Intraregional Shares of Developing Asia (Including China)

Indicators	2006	% of total 2022	
Trade in goods (exports plus imports)	43%	47%	↑
FDI inflows	40%	61%	↑
Intermediate goods exports	63%	70%	↑
ICT goods trade (exports plus imports)	54%	58%	↑
Outward portfolio equity investment	31%	29%	
Outward portfolio debt investment	13%	27%	↑

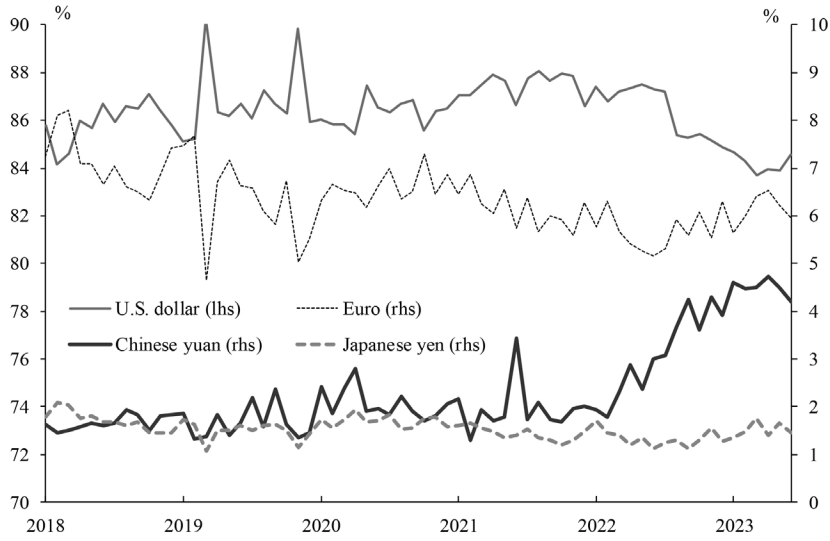
Notes: 1. Figures are estimates for 46 Asian developing economies.
2. Figures for FDI inflows, intermediate goods exports, and ICT goods trade are as of 2021.
Source: Asian Development Bank.

cultivate trade relationships has extended well beyond Asia to now encompass regions such as South America and Africa. Along with such efforts on the trade front, China has strategically encouraged the use of the renminbi in trade finance. The currency's role remains rather small compared with that of the U.S. dollar as the world's vehicle currency, but it has been growing in some areas according to SWIFT data, for example (Chart 8). The choice of the medium of exchange is essentially a multiple-equilibrium story. Thus, even a temporary change in the structure of trade flows could result in a persistent change in the choice of currency supporting trade flows.

IV. Implications for the Outlook for Japan's Economy and Monetary Policy

Let me now turn to the question of how all this affects Japan's economic outlook. The Japanese economy started the year with an expansion led by consumption and investment — 3.7% (SAAR) growth in real GDP in Q1. The strength of the economy was to a certain extent a response to the relaxation of pandemic-related restrictions, including a resurgence in inbound tourism. Growth in Q2 was also high, at 6%, but this was largely due to declines in imports while strength

Chart 8
Currency Shares in the Trade Finance Market



Source: Swift.

in tourism continued. Private consumption declined in Q2, partly due to bad weather, but we think that domestic demand is still on a healthy trend — although this is something that needs to be checked with Q3 data. Business fixed investment is supported by record-high profits as well as structural factors, such as labor shortages, digitalization, climate changes, and the tendency toward expanding domestic, relative to foreign, capacity.

On the inflation front, the rise in import prices in 2021-2022 has spilled over to domestic prices. The CPI inflation rate (all items less fresh food) was 3.1% in July, but it is expected to decline toward the end of this year. We think that underlying inflation is still below our target of 2%. This is why we are sticking with our current monetary easing framework.

As pointed out earlier, the tendency toward reshoring of manufacturing activities has been a positive for the economy. New investment projects in the semiconductor industry are providing stimulus to the local areas in terms of rising sales in related industries and employment.

Offsetting this is the slowdown in some parts of the world. In particular, the pace of economic activity in China has been a disappointment. Monthly data for July — such as for retail sales, fixed asset investment, and industrial production — were on the weak side. The underlying problem appears to be the adjustment in the property sector and its spillover to the rest of the economy. It is very difficult at this point to detect the contribution of the geopolitical factors to the slowdown in the economy. For the Japanese economy, some offset is provided by the relative strength in the U.S.

Longer-run effects of geopolitical factors on the Japanese economy are unsurprisingly very uncertain. In addition to the factors described earlier, the tit-for-tat war, mainly in the semiconductor sector, between major advanced economies and China is a risk. The enthusiasm about reshoring in key industries that is partly motivated by government subsidies is expected to lead to industrial clusters and accumulation of human capital, thereby raising potential growth. However, there may not be adequate infrastructure to support growth of the projects that are starting. Japan may lose out in the global race to attract top firms. The widespread use of industrial policies globally could just lead to inefficient factories.

Central banks will have a hard time factoring in these forces when making policy decisions. As described, the economic outlook is clouded by a number of effects that geopolitics/de-globalization could generate, many of which will affect the supply side of the economies, as well as the demand side. It will take time to determine how long-lasting these effects will be. As production location shifts over time, researchers will find it difficult to obtain stable statistical results involving regional variables.

Such an environment shares some similarities with the one central banks faced over the last few years. There were a series of pandemic-related supply shocks, the durability of which was very uncertain in real time. Some affected the aggregate demand side of the economies as well. Hopefully, we will learn to cope with such an environment appropriately.

Endnotes

[1]The data on inward FDI into China, based on the Balance of Payments statistics, indicate sharp declines recently (Chart 2). This does not quite match trends in Japanese/U.S. data and needs to be analyzed further.

[2]July trade data were published on August 17. They show strong Japanese nominal export growth to North America and Europe and declines to Asia, except to India and Indonesia.

[3]South Korean and Taiwanese exports of high-tech goods are usually a good indicator of global trends in the sector. Since around 2022, exports of high-tech goods from these areas to China have been declining, while those to the U.S. remain steady. It is, however, still difficult to determine whether this is a result of geopolitical factors or just a reflection of the macroeconomic strength of the U.S. and Chinese economies.

References:

Alfaro, Laura, and Davin Chor. 2023. "Global Supply Chains: The Looming 'Great Reallocation,'" paper presented at the Federal Reserve Bank of Kansas City's Economic Symposium, August 24–26, 2023.

International Monetary Fund. 2023. *World Economic Outlook,* April.

General Discussion: Globalization at an Inflection Point

Chair: Christina D. Romer

Christina Romer: Thank you. All right, let me open it up to questions. We'll give the three panelists a chance to talk among themselves, but also answer some of your questions.

Hyun Song Shin: Some of the facts that Governor Ueda put on the table were really interesting and I wanted to link those to the session that we had this morning on the change in trade patterns. What we saw this morning is that there are important open questions that can really only be answered with firm level data, especially firm level network data. Let me just give you a couple of nuggets from some work that we've been doing at the Bank for International Settlements (BIS).

Firm to firm trade data is difficult to come by, but we can instead look at the imprint that trade leaves on the financial accounts of the firm. If there is a shipment, there will be accounts receivable against the buyer. What we did was to take a very large set of companies around the world and mapped the network, where the edges are simply the receivables connections. And then we asked what's happened to the average distance between firms across the world? One fact that we found was that the average distance between firms has actually increased. This alone doesn't quite address the resilience question that Markus Brunnermeier asked, because we want to know whether has the network has become denser even as average distance

has increased. And there, the answer is no, it hasn't got denser. We have longer chains, but a less dense network. This doesn't look like a more resilient network.

We need to be careful in drawing firm conclusions. The findings could simply be the overhang from the pandemic, and we're still digging into that. But this does, I think, raise a very interesting question with regard to the resilience issue. And I think Figure 7 in the presentation from Governor Ueda on intra Asian integration is a very interesting fact in this debate. This is because if we simply lengthen chains, but actually it's simply a rerouting of trade, then we may simply end up with longer and perhaps more fragile chains.

Mingzhi Liu: My question is for Madame Director-General Okonjo-Iweala of the World Trade Organization. I would like to give thanks for your very kind presentation and your strong support to globalization. My question is: how do you think about the relationship between the concept of reglobalization you mentioned just now and the concepts of nearshoring and friendshoring given and used by American politicians and economists?

Christina Romer: All right, let me take one more question. Yuriy Gorodnichenko?

Yuriy Gorodnichenko: I have a question for the panel. We often talk about the very costly decoupling or fragmentation of trade out there, but one lesson we have from the disconnection of Europe from Russian gas was that we didn't have mass unemployment. It turned out to be relatively inexpensive. I was wondering if you can comment on this.

Christina Romer: All right. Let me turn it back to the panel for a minute and let's just go in order. Deputy Governor Broadbent?

Ben Broadbent: I'm really sorry. I just couldn't catch the last bit of your question. You were asking about...

Yuriy Gorodnichenko: How costly is decoupling?

Ben Broadbent: In Europe? I mean, we've seen the main effect for Western Europe, which was, trade has dominated. There's a general

pattern in trade, actually. There were one or two super products in bilateral relationships which dominate everything else. In the case of Western Europe and Russia, it was oil and gas. So the main cost of the decoupling was experienced for that reason, because of the reductions in gas supplies. And it hasn't lasted long. I didn't have time to get onto the fact that a lot of these things have gone away now.

So those very, very steep rises in import prices for UK, for example, have retreated relative to domestic prices. In the last year, the substitution of LNG from other places for Russian gas has been pretty impressive. It wasn't the only reason the price came down. There was a relatively warm winter and various other things, but it's been a pretty impressive effort within the space of a year to substitute for it. Beyond that, I'm not sure that the effects are that big, quite honestly, because that dominated bilateral trade between Russia and Western Europe. That was by far the most important thing, was energy.

Christina Romer: Madam Director-General?

Ngozi Okonjo-Iweala: The question was the relationship between the concept of reglobalization and nearshoring and friendshoring. What we're actually trying to say is that the concept of reglobalization is one that we feel helps manage risk much better and builds resilience much better than the concept of nearshoring and friendshoring. We accept some of that will happen inevitably. I think if you look at semiconductors and other concentrated sectors, even pharmaceuticals, the vulnerabilities exposed in supply chains mean that we're going to see some reshoring and some nearshoring in some of those. But what we are trying to say is that using this as a policy concept does not build the kind of resilience we are looking for in the world, that it still exposes the world to vulnerabilities.

Let me take friendshoring for example. I always say this, I think I said it during one of the IMFC sessions at the World Bank, who is a friend? Who is a friend? Your friendshoring today, I think some people who have found friends in the United States or Europe may have said, "We have friends," may find that all of a sudden there may be policy changes or governance changes that mean that's not so much of a friend anymore, right? So when we talk of friendshoring, let's be

careful, because we can't define who a friend is. That does not build you resilience. Next thing is the nearshoring, and some of that can help, but we also need to be careful.

We are dealing with changes now that we cannot control with respect to the existential threat of climate change. When we reshore, friendshore and nearshore and all these things that don't really deconcentrate supply chains, we're also building in vulnerabilities we may not be able to deal with. When we have climate events like we had in Thailand that have affected the automobile industry when there were the floods, what happened? So we are saying that this reglobalization, we now have many more options for countries and regions where the macroeconomic environment and the business environment is appropriate to think of decentralizing and deconcentrating and diversifying supply chains to these places. And we should do more of it. We are seeing Romania, Morocco, others coming. Let's do more of that, because we think this is how you build resilience.

Christina Romer: Governor Ueda?

Kazuo Ueda: First I'd like to thank Mr. Shin for sharing with us your recent result. Now, just remember the story that came up in the press a few days ago, which went like, the U.S. government has decided to postpone the implementation of the ban of exports of high-end semiconductors or semiconductor related products to China by Korean and Taiwanese companies, because otherwise there would be serious bottlenecks in the supply chain of a wide range of electronic goods globally. Any case, we are talking about a possible trade-off between economic efficiency and resiliency. In this case, resilience to possible geopolitical events. I must say that the shape of the trade-off curve is very, very uncertain and we need a lot more analysis, including that on the shape of the supply chains, in order just to stay on the frontier of the trade-off.

Christina Romer: All right. Kristin Forbes?

Kristin Forbes: I had two questions to link this panel to the last presentations. First, a question for the central bankers. Barry Eichengreen presented this very nice paper showing the increase in

government debt, but what he didn't talk about was that the increase in government debt is at partially balanced by stronger balance sheets in other sectors of the economy. For example, the increase in public debt around 2008/2009, some of that was balanced by improved balance sheets in the financial sector. The financial sector was bailed out. More recently during the pandemic, increased borrowing by governments helped strengthen the balance sheets of consumers and companies. In some cases, like the U.S., consumer balance sheets actually came out better after the pandemic than worse.

So how do you think about that composition of debt, as a central banker? You could argue that since consumers have come out of the pandemic with stronger balance sheets, that might affect the transmission of monetary policy. Today higher interest rates impose more of a cost on the government, but governments seem insensitive to higher deficits in many countries. Since consumer balance sheets are much stronger, higher interest rates are not passing through to consumers the same way as occurred historically. Is that part of why our economies have been more resilient than expected?

Second question, more for Ben Broadbent. You rushed through at the end, unfortunately, what I thought was a very interesting part of your comments, on how the structural changes in the global economy that we're talking about are affecting how you set interest rates. No longer can you count on our models and structural parameters that may have moved. You have to instead look more closely at late frequency indicators, such as wage growth, to know if you're done raising interest rates and what's next for inflation. That obviously presents some major risks. I was hoping you could expand on this change in approach, since you ran out of time at the end of your talk.

Christina Romer: Why don't you take that right now?

Ben Broadbent: Okay, I'll mention something about debt. I think it does, but I think it's, as I said, unavoidable. Back in the pre-crisis days, occasionally I think it would have been nice to be in the MPC then rather than now, that committee seemed to believe with good reason that they lived in a world of divine coincidence. The best policy for stabilizing inflation was also the one that stabilized growth

and trend supply growth was just this fixed number. And you needed one thing as an outside observer, as I was at the time, to empirically to explain official interest rates, which was just economic growth. That's all you needed. Nothing else mattered.

And then, as I say, when post crisis, when you are less certain about underlying productivity, you have to look at other more direct measures of changes in spare capacity instead, or as well, at least. And if an area is stable, you can just take unemployment, and that's what happened, I think. When you're on the committee, we look more closely at that than we had done, than the MPC had done before the crisis. And now we're in this just very different place where we don't even trust that. And we've had to do it, given the forces at work. We've had these very powerful, as I say, I think these second round effects, which seemingly have gone away under inflation targeting but have been operating again through this episode is an interesting question about why they have.

The result, together with all this turmoil that is normalizing again in the UK and the U.S. and the labor market, so all the shifts in the beverage curve is a more uncertain narrow, and that means you have to start looking at wage growth. But as I say, that pre-crisis MPC would have looked at us and said, "What are you doing responding to things that are right at the end of the supply chain?" I don't know who coined "whites of inflation's eyes", but I think that certainly we and a few other central bankers are having to do that, and to extract information, whether it's core inflation or services or, as Madam Lagarde said yesterday, the other components that you think are persistent, you're looking at things that in the easier days would've come right at the end.

So that's pretty challenging. And I had some slides at the end that say, look, there's a risk that we've underdone this, we have to go further. The persistence is just bigger than we thought. There's also a risk that we've already done not just enough, but too much. I mean, that is clearly there, and there are some indicators that... I mean, you just have to read these differing speeches from MPC members. We've not had a unanimous vote for, I don't know, forever, it feels like. And

people pick and choose these things, and these disagreements are understandable I think, because the times are very uncertain.

And I do get concerned that the outside world, certainly financial markets, is always looking for some unconditional promise about interest rates. That's never been possible, and it's so difficult now to say that, and we are in the position where we're just responding to this news and, as I say, responding to things that traditionally would have come at the end of the chain.

Christina Romer: All right. Governor Ueda.

Kazuo Ueda: It's always very risky for us to make comments on government debt and government budget. So let me just say, during the last few years, the Japanese government, including other governments, has taken large risks to support the economy. Now, we always say that the government should take care or take actions in the medium run to sustain or maintain the sustainability of government budget in order to win the confidence of the market and the public. Whatever the government does, we'll take it as given and set monetary policy in an optimal way.

Christina Romer: Beth Anne Wilson?

Beth Anne Wilson: First, I wanted to thank all the presenters. This was terrific. We're in the heart of the American West. I think we can all agree that we're pretty remote, far from the coast, far from big cities. And I wanted to bring it back to the topic of this session, which was globalization at an inflection point. If that inflection point happens, if there is a turn in globalization, I'd like to get your views sort of distilled on what that would mean for monetary policy and how should policy makers communicate that and communicate the costs of this inflection point to people in the heartland, to people who, Laura talked about today, are highly skeptical of the benefits of free trade.

George Alessandria: I think these discussions of supply chains and resiliency are really interesting. I want to point out a couple dimensions where global supply chains worked really, really well in this event. When you have long supply chains, firms have two margins

of adjustment that you don't have with domestic supply chains. One is, they end up holding larger buffers of inventory. It's just the nature of moving things around the world. And that proved to be a really important margin of adjustment early in the crisis.

And the second thing that they do is they have a margin of adjustment, which is to speed up trade. So when you look at personal protective equipment in the early crisis, that was a product that you would never put on an airplane. It's just not feasible to do that. But there was lots of PPE that was on boats, that you then put on airplanes. And so you could basically double the consumption of PPE in a minute, whereas you couldn't scale up production with domestic home production or something in Mexico. Those two things are just not there. And so those are important margins. They're probably just as important as having diversified supply bases and closer supply chains. Just a comment. Thank you.

Christina Romer: All right. I want to go to Justin Wolfers.

Justin Wolfers: I hope the folks from the Kansas City Fed are really pleased with the coherence of the day. There's a clear straight line from Laura Alfaro this morning through to this, and it's these big questions of causes and consequences of what is going on with globalization, and so on. I just wanted to put forward a plea for just a very simple diagnostic, which is anytime we draw graphs of what's going on with international trade to then follow up with a graph of what's going on with intranational trade.

The data's a little harder to get, but I think it's really important, for two reasons. One, it tells you a lot about what's going on. If international trade and intranational trade track each other, you have a hint that this is not global political institutions doing their work and you can rule a whole bunch of stuff out, and the welfare consequences are also really different. David Ricardo says, first best is when we have a car, it'd be great if we assembled it in Detroit using parts from Japan and Korea and all sorts of countries. Second best would be we build a car in Detroit using parts from Alabama and California and so on. And autarky is when we do none of the above. Which of these scenarios is it when we see trade flows declining?

Joachim Nagel: I am still a little bit struck about the discussion between globalization and friend shoring. We all know that deglobalization is not good for economic growth, but we all learned in a very harmful and painful way over the past 18 months how it was a mistake not to think about countries that are not friendly to us. And there are some countries out there in that world, and this is a catastrophe for all of us, they are definitely not friendly. And to avoid concentration risks from time to time is also a difficult task. It sounds easy to say, "Well we should avoid concentration risk," but we all know that there are some countries that are in a better position when it comes to certain resources.

So I believe at the end the concept of friend shoring is a very relevant concept in these days. We do not like this, but the world is difficult and at the end I believe it's not a matter of a question for a central banker, it's a question that I believe it's in the political arena. They have to decide in these days what is good for my country and what is not good. And this is far away from, I believe, economic concern. So as I said, we are living in a political world that are giving us more or less some good arguments that friend shoring makes a lot of sense.

Christina Romer: Let me turn it to the Director-General. And I just want to add on a question of my own, which is as you think about re-globalization, what's the way to not end up where we got with the first globalization — with parts of society feeling left behind? How do you make it more durable and less politically divisive?

Ngozi Okonjo-Iweala: I'll address the re-globalization friend sharing question first. I think from a political point of view, you can understand how attractive it is to say, "Look, we see the vulnerabilities. We're just going to try to do business with those who have the same values as we have with those who look at the world the same way we do." But I think that the world has changed considerably in a way that means we also have to go beyond that. What I'm trying to say is that even if you want to trade or invest only with those who have the same values and who think the way you do, there are

some risks that we don't have any control over that need to be managed that dictate we think differently. And what I'm talking about is climate change.

We really need to think about that. So if you say, "Let us just deconcentrate or diversify, I don't know, pharmaceutical, because we have a concentrated pharmaceutical industry at the moment, to just those we know, or let us do semiconductors only with those we know," what if you have these climate events that wipe things out in those countries, what do you do about that? So what we are saying is in addition to thinking about your friends, maybe you need to go a little bit further and that there are many more options and that we should be active in trying to encourage firms to take those options and relocate and diversify into those areas. If they're going to diversify anyway, why shouldn't we spread it to those who have been at the margins of the global system and also help include those at the same time. So you said how do we avoid doing what we did last time?

First, firms are sometimes making the right decision and I think we shouldn't interfere in their decision-making process too much by offering them subsidies to locate in places where they don't want to locate, which is what some of this is amounting to. This time we're offering incentives to concentrate in certain areas when firms may be deciding to make other decisions. So that's one thing we can do positively right off the bat. I think the second thing we can do is in our advocacy to these firms, we can also point out those areas where the environment is good for investment. I'm not saying that we should diversify where the business environment is not appropriate. No. And if you speak to firms, there's some willingness to look at this, but what is happening is that the rhetoric on the geopolitical tensions, the implied threats on what might happen to them if they don't do certain things, it's making them take decisions that may be different from what they would've done and decisions that we believe would've built more resilience for the world.

Christina Romer: Mr. Broadbent?

Ben Broadbent: I'll make a couple of points here. First, I do remember a time, maybe a more naive time when we believe the

effect would go in the other direction, that more trade would create friends. That was a view a long time ago and maybe that's no longer the case. I also think there's a material difference qualitatively, by the way, as regards to the government's role for the supply of energy. It's a big increasing returns infrastructure as a role for public policy. It's an area where there's long been political risk, as I say in 1973 was very similar, the sort of revenge against those who supported Israel and the Yom Kippur war, it's exactly the same thing. So I view that very differently. It's not clear to me with these supply chains, what is the externality here? Why do firms not understand the risks or why is a government meant to know better?

That's just not clear at all to me. Whatever the resilience fragility, why is the state meant to understand these things better and intervene? I just don't see the grounds for it. And as regards Justin's point, I was trying to say precisely that during the pandemic, intranational trade collapsed as well because of these restrictions. But no one then says, "Oh well clearly we need to clamp down on intranational trade because it was very fragile during the pandemic." I just find the reaction to the thing pretty weird to be honest. And it's basically a cover for protectionism. There may well be strong political reasons, political imperatives even to do this, but don't use the cover of the experience of the pandemic to justify it to say, "Well, there's some additional economic reason." I don't really see what it is to be honest.

Christina Romer: Let's see. Nina Pavcnik?

Nina Pavcnik: This is a question for the Director-General. So all three of you have highlighted the economic costs of greater uncertainty. One thing that really stood out during great recession is that WTO rules-based approach to trade policy worked. Despite recession in many countries, trade barriers didn't go up. So that showed the strength of World Trade Organization. Now, as you mentioned, countries are trying to conduct power-based trade rather than rules-based trade. At the same time, they're also using industrial policy and there's just much more uncertainty about trade policy. Trade policy uncertainty has increased. What do you see as the role of the World Trade Organization in reducing this trade policy uncertainty?

Christina Romer: Let's take a couple more questions and then we're going to wrap it up.

Dambisa Moyo: I would like to throw the cat among the pigeons here. We were promised a debate around globalization and I think a couple of the key pillars have certainly been addressed. We've talked about trade, we've talked about capital flows. I think Barry Eichengreen's, not withstanding the focus on debt, I think that debate was covered also. I'm quite surprised that we haven't really talked about immigration and I'm just wondering whether it's no longer considered a pillar of globalization or we've just decided to seed it as a political economy issue and that it's so fraught that the issues around knock on effects of supply of labor, concerns around the cost of labor, wage inflation, all the stuff that we've talked about here today, and obviously the debate around rate hikes because of the wage pressures that are being seen across the world.

I'm just trying to get a calibration here of how the panel generally sees the role of monetary policy in a world where we are now. I think the IRC says we've got about 80 million people displaced and obviously the immigration issue continues to persist. Thank you.

Christina Romer: I think that's actually a great question. Let me turn it back to the panel for sort of answering those questions in the final remarks. Governor Ueda?

Kazuo Ueda: Okay, I thought there was a fairly abstract question about what central banks should do if we hit an inflection point. I don't have an interesting answer, but all I can say is it'll depend on what form the explosion will take. Surely we will adjust our economic outlook to the explosion, whatever form it will take. And if appropriate, we'll change monetary policy. Of course, if there's financial stress as a result of this explosion, we will immediately do something along the lines we have done during the last two, three decades.

There was a question about inventory holdings and information we had or we did not have about inventories and its effect on our inflation forecast. I was not the governor last year or two years ago, so I didn't know exactly what was going on, but I'm sure researchers

in our bank took great care in looking at the data on inventories and still they made errors in inflation forecast. Maybe they had to go beyond what was published in the public domain.

Now on this question of migration, I don't think it's appropriate for us central banks to ask the question what monetary policy can do to affect the flow of immigration. But in this age of labor shortage, we will watch carefully what's happening on the front of immigration to look at future wage developments.

Christina Romer: Director-General?

Ngozi Okonjo-Iweala: Speaking directly to the issue of the WTO role in reducing trade uncertainty and dealing with the various unilateral policies that have emerged that are feeding into this uncertainty, it's a very difficult time and a very delicate time and I'd be lying through my teeth if I said that there was some neat answer about how we handle this. But what I'd like to say is first we've been focusing very hard on pointing out the benefits of the system that has been created over time. I've gone so far as calling it a global public good that has delivered, I know it's not exactly the right term to use in economic terms, but what I'm trying to say is this. You've created a system over 75 years that has largely delivered. Retreating into protectionism and unilateral measures so severely undermines this system that the costs of going power-based will be high, not just for those who have the power, but multiple times over for those who don't.

And what we're trying to show at the organization are the costs of this. So we're trying to do some analytical work on what does it really mean if we all start taking these measures and we start fragmenting? Because that's what it means. If you take your unilateral measures and I take mine to counter that and another person, then we have a world of fragmentation and the cost of that is very high. So we've been able to do some modeling and some work which has shown that, and there's been some listening to what this might imply. So that's the first thing. I think the second thing is providing a forum where others who are hurt by these measures can put their complaints on the table. There's no other place in the world where members can come to on trade issues and be able to talk to each other.

We provide that forum in various committees and it actually helps. It might sound like a lot of jaw-jaw, but being able to talk to, being able to put your complaints somewhere and have it heard makes a difference. Third, the monitoring mechanism also helps. When these measures are done and they are reported or we go to the member and say, "Look, this is what we've seen and we put it out transparency that shows that members are not doing the right things is also a bit of a stick. So do we have a magic bullet at the WTO to help us? The answer is no. We're trying to use several measures from the analytical to the deliberative to try to deal with these problems and to remind everyone that 75% of world trade still takes place on MFN WTO terms today. Notwithstanding what we say that's the case. So numbers matter.

Christina Romer: Deputy Governor, final thoughts?

Ben Broadbent: Very good. I never got round to Beth Anne Wilson's question, which I'm going to have to talk about afterwards to her. Although the only thing I'd say is that people around the world always find it incredibly difficult to understand the benefits of trade. They're perfectly happy to accept the benefits of trade within a country. They can understand that. But you draw a border, you will know, I think you're at MIT, famous story about Paul Samuelson who was asked by a mathematician colleague who was very snobbish about economics and saw it as a minor branch of applied math, for anything, any result in economics that was both true and counterintuitive. And Samuelson said, "The law of comparative advantage is the best example." So it's always hard for people to understand a lot of politicians who are not... Well, I don't have those ideas.

Just on immigration quickly, the position of the MPC has generally been the first order. It's not having effect on inflation. So the production is constant returns. I add 1% to the population and they're identical to the indigenous population in terms of participation skills and so forth. They spend as well as produce. It's not going to have a first order effect on wages or prices. And it's an irony that last year, immigration to the UK, given that the motives, at least some of those who voted for Brexit, was higher than ever. It was like 1% of the

population, 600,000 people, absolutely enormous. But it may well be that because immigrants are not the same as the indigenous population and where they work and what they do, that it can have an inflationary effect. We've heard from firms, the EU workers were much more concentrated in some sectors than in others. And so Brexit I think probably added to difficulties in the labor market and that new immigration hasn't overcome those because they haven't necessarily gone into the same sector. So I think the mix matters quite a lot.

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