

Overview

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During the past two days, this symposium has addressed an extraordinary array of issues pertaining to the information economy. As the concluding speaker, I will try to summarize the main themes and highlight some policy lessons, emphasizing those that are particularly relevant to central banks.

The first major lesson and point of general agreement is that economic policy matters to productivity growth. Chuck Freedman asked yesterday why the United States enjoyed an especially large IT-related boost to productivity during the 1990s. Was it good luck, good policy, or both? He noted that information technologies and the equipment that embodies them are available in world markets. But American firms invested especially heavily. And the United States reaped greater productivity gains from ICT than most OECD countries, not just in the IT sector but throughout the economy. I agree with Martin Baily's answer: Globalization, coupled with deregulation of key industries like telecom and finance, exposed American firms to brutal competitive pressures. And monetary and fiscal policy created an environment conducive to investment. Low barriers to entry and exit were important spurs to the Schumpeterian process. John Haltiwanger stressed, and his research reveals, that the entry of new firms and the reorganization of existing businesses is critical to productivity growth. So, a regulatory framework that made it easy to start new businesses, to reorganize existing firms via mergers and hostile

takeovers, and to close failing businesses surely facilitated productivity growth. There has been general endorsement of Martin Baily's conclusion that flexible labor market institutions are necessary for firms to reap productivity gains from IT. Unfortunately, these gains don't just fall like manna from heaven, painlessly augmenting output. They require businesses in the old economy to undertake painful restructuring, a point Alice Rivlin stressed yesterday. Firms altered relationships with suppliers and customers. They changed production methods. Most important, they re-engineered jobs, hierarchies, and organizations. They redesigned compensation systems. They also vastly increased outsourcing both at home and abroad. Financial markets rewarded such changes and American firms were not prohibited from shedding workers and reorganizing work. So, the basic policy lesson is familiar: A regulatory environment and institutions that facilitate the reallocation of labor and capital are likely to improve both static efficiency and also the dynamic gains from innovation. But there are some provisos, and these were emphasized in yesterday's discussion. The requirements for static and dynamic efficiency sometimes conflict, particularly in IT industries. Antitrust and intellectual property are two important areas where difficult trade-offs exist and case-specific judgments must be made.

A second policy issue for the information economy concerns income inequality. The dark side of IT innovations is that they tend to raise wage inequality—not just among countries but also within them. It seems clear from case studies and from firm and industry hiring patterns, that the adoption of computer-based technologies has shifted demand in favor of skilled workers. Firms sought workers knowledgeable in the use of computers; but beyond that, as they reorganized work, they sought workers capable of exercising judgment, solving problems, and able to work in teams. So, the return to skill—which is related to wage inequality—has increased in many OECD countries. Where such widening has been thwarted, the shift in demand is seen instead in increased unemployment among low-skilled workers. In some countries, such as Canada, expanded education has more successfully countered these shifts than in the U.S. This suggests that there is a role for policy—to expand access to education and training.

Brad DeLong and Larry Summers argued that IT has more important implications for microeconomic than macroeconomic policy. I am sympathetic to this view, but I think there are at least a few linkages between IT and the macro environment that are policy-relevant and I'll try to enumerate them. For example, an important lesson from the U.S. experience is that faster productivity growth may make an economy less inflation prone. Productivity growth apparently affects NAIRU. As recently as four or five years ago, this proposition surely would have aroused controversy. But at this symposium, it commanded broad consensus. It probably explains why the United States enjoyed such low inflation after 1995, as unemployment declined to thirty-year lows. Faster productivity growth was not the *only* factor that contributed to lower inflation: The containment of costs for health insurance and other employee benefits, the strong dollar, lower energy costs after 1996, and measurement changes courtesy of BLS mattered too. But Alan Blinder and I estimated that the improvement in productivity was the single most important supply shock working to keep inflation low.¹ By 1999, after the favorable influence of all other factors had ebbed or reversed, it single-handedly held inflation down. During the second half of the 1990s, American workers enjoyed more rapid real and nominal wage gains. But nominal wages escalated less than surging productivity would have allowed. The growth of unit labor costs consequently declined, reducing inflationary pressure. Most likely, a decade or more of stagnant real wages depressed workers' aspirations for real wage gains. Another possibility is that nominal wages simply take a long time to escalate in the face of low unemployment. Either way, faster productivity growth lowers short-run NAIRU, at least *for a time*. The proviso—*for a time*—is important, though, because we don't know how long such reductions in NAIRU will last. As Alan Blinder pointed out, it is possible, but not certain, that the effects will be long lasting. And we don't know if a similar mechanism applies in other industrial countries, or if this hypothesis is mainly relevant to the U.S. experience.

A number of papers alluded to the possibility that IT innovations may affect macroeconomic volatility. I would like to highlight several channels through which this might occur. The first relates to inventories.

Inventories obviously play a central role in business cycle dynamics. In almost all industrial countries, inventories fluctuate more than production. There's no doubt that, by improving supply chain management, new information technologies have caused inventory/sales ratios to decline. Better monitoring and control of inventories reduces the chances of stockouts, thereby lowering desired inventory levels. Also, modern supply management systems permit rapid responses by firms to unanticipated changes in sales. The interesting question is whether lower inventory/sales ratios and more rapid responses to imbalances translate into a reduction in the volatility of GDP, which is the conventional wisdom. This issue deserves careful investigation. I doubt that the conventional wisdom is actually correct. In simple accelerator-type models, where the purpose of inventories is to facilitate sales, it is relatively easy to show that faster responses by firms to eliminate deviations between actual and target inventories exacerbates volatility. On the other hand, lower inventory/sales targets tend to reduce volatility. For reasonable parameter values, the first effect dominates, so, on balance, volatility rises. If firms use inventories to *smooth* production, improved information and more rapid response translate into a less volatile output path. Unfortunately, the production-smoothing theory of inventories does not perform well empirically; accelerator models fare somewhat better.

IT could also affect output volatility through trade channels. For example, IT innovations have facilitated a vast expansion in global trade. And the size of a country's marginal propensity to import affects the volatility of GDP. Since imports are a "leakage" from the circular flow of spending, they serve as an automatic stabilizer, reducing the sensitivity of GDP to spending shocks. On the other hand, larger trade linkages increase spillovers across borders, raising the sensitivity of GDP to foreign shocks and making business cycles more synchronous. With extensive global outsourcing, the decline in U.S. investment is shrinking order books around the world. Increased interdependence arguably raises the need for policy coordination.

Beyond inventories and trade, there are also linkages between IT and macro volatility that involve financial markets. These linkages are

especially important for central banks. My fear is that IT innovations could work to increase systemic risk. The issues are, of course, complex. Yesterday, Andrei Shleifer and Roger Ferguson emphasized that IT innovations are responsible for an explosion of new financial products. Improved risk management technologies facilitate hedging, the reallocation of risks toward agents most able and willing to bear them, and more accurate pricing of financial assets. So, perhaps IT innovations diminish both financial and real volatility.

On the other hand, I worry that the sophisticated risk management strategies that are now commonly used by banks and other financial institutions to monitor and manage exposure have the potential to destabilize financial markets. Here, there is a possible “fallacy of composition,” in that strategies designed to mitigate the risk facing individual agents may do nothing to diminish aggregate risk and could even increase it. When market-sensitive risk management systems are combined with increased transparency and faster communications, the consequence may simply be herding and contagion, which exacerbates market fluctuations. For example, VAR-type methodologies to control portfolio risk commonly call for broad-based sales of risky assets when risk rises due to increased volatility in one portion of the market. Such strategies may enhance contagion across countries and assets, and create destabilizing feedback loops in which sales in one market trigger programmed selling of other assets. In the case of LTCM, a cascade of this type arguably escalated to the point where market liquidity almost evaporated. The use of dynamic hedging strategies to protect against losses may have similarly destabilizing market effects. In other words, techniques that make sense at the individual level to manage risk may create systemic risk at the macro level. I believe this should be an important policy concern for central banks and other financial regulators.

Michael Woodford’s paper poses an important set of questions concerning whether and how the operation of monetary policy will be impacted by IT. He concludes that IT won’t vanquish economic fluctuations and won’t diminish the ability of central banks to deal with them. I agree with both conclusions. His analysis tackles deep ques-

tions in monetary theory: How can the Federal Reserve, to take one example, succeed in controlling the price level in a \$10 trillion economy via its status as monopolistic supplier of a commodity—central bank balances—the demand for which amounts to only around \$15 billion? And as IT-related innovations even further diminish the demand for reserves and clearing balances (computer technology already allows depository institutions to sweep not only business but also consumer transaction deposits into nonreservable accounts and better information or the establishment of new settlement systems could diminish the Fed’s role in clearing), will the Fed’s monetary leverage disappear altogether? These are provocative questions. Woodford’s conclusion is reassuring: Central banks will continue to have the ability to set short-term interest rates and to determine the level of prices even in an extreme limiting case where the demand for Central Bank balances approaches zero. But effective monetary control is likely to require, for the Fed at least, significant but feasible changes in tactics, including the payment of interest on excess reserves and clearing balances, and the conversion of the discount window to a standing facility.

Central banks must also be concerned with the impact of IT on the transmission mechanism. Michael Woodford argued that increased information about the economy will strengthen the impact of monetary policy if central banks are transparent about their goals and strategies for the simple reason that transparency enables market participants to factor new economic information into longer-term yields even before the central bank acts. In effect, the lags involved in monetary policy then become shorter. In the United States, at least, such a mechanism has been evident throughout the second half of the 1990s, prompting some observers to argue—incorrectly—that the Fed has no impact on the economy because all it does is “follow the futures.” There are also some additional channels Michael didn’t mention by which information technologies might affect the transmission mechanism. These were discussed by the Euro-Currency Standing Committee of the G-10 in its 1994 Hannoun Report. The committee asked, for example, whether the use of derivatives by individuals and firms might enable them to hedge interest and/or exchange rate fluc-

tuations to such a degree that their spending decisions would become immune to monetary policy. They also considered the implications of a development that Roger Ferguson emphasized yesterday—that new financial instruments could widen access to credit for groups that have been subject to borrowing constraints. This occurred a long time ago for housing and could occur for consumer borrowing as well. Such developments could diminish the importance of the portion of the transmission mechanism that operates through credit availability. These are interesting questions worthy of further research, although, in my view, they are not of first-order importance for monetary policy.

The IT-related development that I personally consider of first-order importance for monetary policy relates to the increase in global capital mobility that improved communications and new financial technologies have fostered. The dilemma is straightforward and Robert Mundell exposed it in the 1960s, before most countries had even opened their capital accounts. He pointed out that once capital had become perfectly mobile, central banks would find it impossible to simultaneously conduct independent monetary policy and peg the exchange rate. He thereby prophesied the dilemma now facing most central banks—whether to give up monetary policy, and possibly an independent currency, or to float. Central banks of large countries with well-developed capital markets are likely to continue living with floating rates, but my guess is that, in the decades ahead, a growing number of central banks will decide to close shop, abandon an independent currency, and dollarize or join a currency area rather than live with the often destabilizing economic consequences of flexible exchange rates. This development, if it happens, can be viewed as a logical consequence of the IT revolution.

Yesterday, Larry Summers stressed that the fundamental characteristics of the business cycle have been unchanged over centuries in the face of enormous structural change. I certainly agree that business cycles are, by no means, dead; but, as John Taylor noted, research shows that the U.S. economy has become more stable in the postwar period and the difference is due to improved macroeconomic management, particularly monetary policy. It would be treacherous to apportion

the credit for what amounts to a major, welfare-enhancing, productivity gain. Certainly, though, the Federal Reserve System deserves our gratitude, not only for its effective conduct of policy but also for its efforts, via in-house research and symposia like this, to expand the base of knowledge, which is the foundation for successful policy. So, let me conclude by expressing my thanks to Tom Hoenig and the Kansas City Fed for putting together yet another engaging and informative Jackson Hole symposium and to the Federal Reserve for its continuing support of R&D on monetary policy.

Endnote

¹ Alan S. Blinder and Janet L. Yellen. *The Fabulous Decade: Macroeconomic Lessons from the 1990s*, The Century Foundation Press, New York, 2001.