The "Big C": Identifying and Mitigating Contagion

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Introduction

In the Showtime TV series "The Big C," the main character is diagnosed with a deadly cancer—the "Big C." In response, this suburban housewife suddenly takes out-of-character, impulsive actions—from buying a bright red sports car to putting a large pool in her tiny backyard to having an affair with a painter. She denies the severity of her disease and undergoes alternative treatment (such as being stung by bees) rather than follow the standard protocol. All of these actions can provide a temporary distraction, but they often have unintended consequences and, in the end, do nothing to stop the "Big C." Eventually, the main character comes to grip with the inevitability of her disease and undergoes treatment—an extremely difficult decision that may not yield success, but is her best chance for long-term survival.

Similarly, the "Big C" that is the focus of this paper—Contagion—can be deadly. Contagion can cause a negative shock in one country to quickly spread to others through numerous real and financial channels—precipitating turmoil in global financial markets and sharp declines in output and standards of living. This legitimate fear of contagion can cause policymakers to take actions that they would

not normally consider. This paper will argue, however, that countries have become so interdependent in both good and bad times that contagion is extremely difficult to stop. Many measures aimed at minimizing contagion provide only a temporary reprieve and can aggravate contagion risks through other channels. Just as the main character in the "Big C" eventually admits the inevitability of her disease and undertakes painful treatment, policymakers concerned about contagion must fully address the underlying vulnerabilities and adopt difficult measures. On a more positive note, just as lifestyle changes can reduce the risks of many diseases in the future, policymakers concerned about contagion in the future can adopt structural reforms to reduce (although not completely remove) contagion risks in the long term.

This paper is divided into six sections. The remainder of this section summarizes the key points and results of the paper. Section II discusses various definitions of contagion and how use of the term has evolved. It also provides an overview of the different empirical strategies for measuring contagion. The discussion shows that debate on these fundamentally important issues of how to define and measure contagion is complicated and unresolved. The rest of the paper focuses on the definition of contagion preferred by many policymakers (although not many in the academic community)—when an extreme negative event in one country affects others. This type of "contagion" is distinct from "interdependence"—when events in one country affect others in all states of the world and not just after negative events. This section on the definitions and measurement of contagion can be skipped for readers who would like to move directly to the new analysis and the evaluation of policy recommendations.

Section III uses these definitions to evaluate whether interdependence and contagion have increased over time based on two methodologies. First, it analyzes bilateral correlations in stock market returns around the world since 1980. It shows that markets have become significantly more correlated and this does not result from global shocks or increased volatility. Moreover, this comovement has increased substantially more between countries in the euro area than in other countries. Markets around the world, and especially in the euro area,

are now more interdependent through good times as well as bad. The second part of the analysis measures only the transmission of negative shocks across countries. It uses extreme value analysis to document that countries today are more likely to experience extreme negative stock market returns than in the past, especially in the euro area, and these extreme negative returns are more likely when other countries are also experiencing negative returns. There continues to be robust evidence of this contagion even after controlling for global shocks.

Section IV then moves to the critically important issue of why countries' markets are so closely linked and how contagion occurs. It summarizes the theoretical and empirical literature and divides this extensive literature into four main channels of contagion: trade, banks, portfolio investors and wake-up calls/fundamentals reassessment. There are other ways to categorize the channels for contagion, but this framework is useful later in the paper when assessing how contagion occurs and evaluating policy responses. A graphical analysis shows a striking increase in integration through trade, banking and portfolio investment across countries over time—especially in the euro area. Given this increase in integration, it is not surprising that interdependence and contagion have increased over time—especially in the euro area.

These trends are confirmed in a more formal regression analysis of how extreme negative returns are transmitted across countries. There is evidence that all four channels of contagion (trade, banks, portfolio investment and fundamentals reassessment) are significant determinants of a country's vulnerability to extreme returns in other countries. Contagion in the euro area does not exhibit any different patterns than for the full sample. The empirical results, however, also suggest that the simplistic interpretation that "more integration =more contagion" misses important subtleties. Although greater international exposure through portfolio investment liabilities can *increase* vulnerability to contagion, greater exposure through portfolio assets can *reduce* vulnerability. This may result from better risk diversification or the ability of countries with large international investment positions to "retrench" by selling foreign assets after negative shocks to provide stability at home. The results also suggest

that greater reliance on debt (versus equity) tends to increase country vulnerability, undoubtedly due to the natural risk-sharing properties of equity. A final important result is the role of leverage in the domestic banking system. Leverage is a significant determinant of a country's vulnerability to contagion—and even more consistently important than the country's overall international banking exposure.

Section V uses the results of this empirical analysis to evaluate various policies to mitigate contagion. This section does not attempt to provide a full cost-benefit analysis of each of these options. Instead, it focuses on whether the policies can effectively reduce contagion risks over two horizons. It begins with a discussion of long-term, structural reforms that could effectively reduce a country's vulnerability to contagion in the future, such as: reducing leverage in the banking system, diversifying trade across countries and industries, supporting portfolio investment abroad to balance portfolio liabilities, ensuring that portfolio flows are not distorted by an overreliance on debt (versus equity), improving macroeconomic fundamentals and better communicating in advance the policies of international financial institutions in different scenarios. This list of long-term policies to reduce contagion risks does *not* include options that would slow the long-term trends toward increased integration through trade and financial flows. It is not clear that the costs would outweigh the benefits in terms of mitigating contagion risks, as certain types of integration can provide an important buffer against contagion.

While these policies, if adopted *a priori*, could reduce a country's risk of contagion in the future, of greater concern to most policymakers (especially today) is how to mitigate a country's imminent vulnerability to contagion. Any discussion of how to best address immediate contagion risks should also consider additional issues. For example, can the policy effectively stop a form of contagion that would not otherwise occur (such as a bank run) or simply delay an inevitable adjustment (such as through changes in relative prices affecting trade)? Does the policy effectively internalize an externality that might not otherwise be considered in one country's or investor's cost-benefit analysis?

Analyzing policy options using these criteria can help prioritize responses. For example, if there is a risk of banking contagion resulting from bank runs, deposit insurance (accompanied by appropriate regulation) should be prioritized as it could directly stop an unnecessary shift to a bad equilibrium. If there is a risk of contagion through portfolio investors, priority should be given to policies that ensure liquidity and well-functioning markets. If contagion through banks or investors results primarily from weak economic fundamentals in one country causing an adjustment in prices and contraction in lending elsewhere, financial support is more difficult to justify if it simply delays a needed adjustment. Credible policies to address key macroeconomic vulnerabilities—such as debt sustainability and banking stability—should be prioritized and adhered to in order to reverse negative "wake-up calls." A key consideration for any policy, however, is the fiscal impact; actions that increase fiscal liabilities in a country with solvency concerns should generally be avoided as they risk generating additional contagion through a negative reassessment of fundamentals. Finally, two additional policies that should be avoided are capital controls and easing bank regulations. Even though these policies might provide short-term relief from contagion, they would both increase a country's vulnerability to contagion in the future.

While this paper focuses on contagion around the world, Section V ends by extending the evaluation of policy responses to the current challenges in the euro area.[1] It is not surprising that the area's high levels of integration through trade, banking and portfolio investment—integration that was a key goal of union—correspond to high levels of interdependence and contagion within the region today. Policies aimed at mitigating contagion should be evaluated using the same criteria as for other countries, although the unique structure of the euro area creates additional considerations. For example, the lack of an independent currency and central bank complicates countries' adjustment to negative shocks that originate elsewhere and highlights the importance of having flexible economies. The lack of a traditional lender-of-last resort to back large international bank exposures increases vulnerability to contagion through bank runs and highlights the importance of addressing this channel of contagion.

The institutional and macroeconomic similarities between many euro area countries increase contagion risks through "wake-up calls." This makes it even more important to consider externalities to other countries when designing policies. For example, policies that impose additional fiscal liabilities on other countries (even through joint institutions such as the ECB, ESM or EFSF) can create additional risks by increasing their vulnerability to contagion through negative reassessments of their debt sustainability.

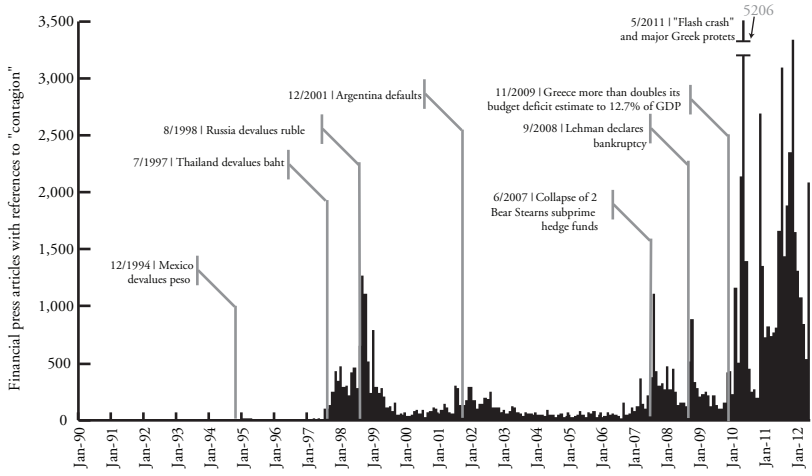
The discussion in this paper highlights why it is so difficult—if not impossible—to stop contagion. Contagion can take many forms and most of the channels of contagion result from a healthy interdependence between countries in good times, as well as bad. Although there are steps that can be taken to reduce vulnerabilities to contagion in the future, once a negative shock occurs in one country, there are no easy fixes for ending contagion in an integrated world. But this does not mean that the risks should be ignored. Just as the other "Big C" can be deadly, contagion can be devastating. Just as there are legitimate protocols that can successfully fend off certain types of cancer, there are policies that can effectively fend off certain forms of contagion. A careful evaluation of options to address both "Big Cs" needs to thoroughly consider not only what the action can realistically accomplish, but also if there will be any side effects that increase risks in the future.

II. Defining and Measuring Contagion

A. What Do We Mean by Contagion?

Although contagion is currently part of the standard lexicon of economists and investors, use of the term to describe the international transmission of financial turmoil is fairly recent. Chart 1 shows results from a Factiva search of monthly use of contagion in articles in the economics or financial/commodities press since 1990.[2] The term contagion was rarely used before 1995, after which it occasionally appeared in articles discussing the impact of the Mexican peso crisis on other countries in Latin America. Use of the term was extremely limited, however, and barely visible on Chart 1 without a magnifying glass. It was not until Thailand's 1997 devaluation affected other

Chart 1
Media References to "Contagion"



Source: Factiva monthly search for number of articles using the term "contagion" in the commodity/financial news or economic news.

countries in Asia, and when Russia's 1998 devaluation affected global financial markets, that contagion became standard economics terminology and fears of contagion became a regular concern of policymakers. These events prompted a series of academic papers in the early 2000s attempting to measure, understand, predict and prevent international financial contagion.

Despite the numerous papers on this topic and widespread use of contagion to describe the international spread of financial crises, there is extensive disagreement on exactly what the term means.[3] Table 1 shows the diversity in definitions adopted in academic papers on the subject. Most papers agree that if a shock to one country is transmitted to another country to which it is not traditionally linked through channels such as trade, bank loans or other investment flows, then this qualifies as contagion. A common example of this obvious case of contagion is when the 1998 Russian crisis affected stock markets as diverse as those in Brazil, Thailand and the United States. Some economists have proposed using the more specific terms "shift-contagion" or "pure contagion" to describe this scenario when there is a significant increase or "shift" in cross-market linkages after a shock to an individual country. Most economists also agree that a major

Table 1
Definitions of Contagion

Paper	Definition of Contagion
King and Wadhwani (1990)	a model in which correlations between markets increase after an idiosyncratic shock to one market because information is imperfectly revealed
Masson (1999)	the residual in a model of market comovement; the comovement that is not explained by global shocks, linkages through normal trade and economic relationships and country-specific shocks
Forbes and Rigobon (2002)	"a significant increase in cross-market linkages after a shock to one country (or group of countries)"
Kodres and Pritsker (2002)	"a price movement in one market resulting from a shock in another market"
Karolyi (2003)	"irrational co-movements" which are the residual in a model after controlling for "fundamentals-based co-movements" (from real and financial linkages) and "rational investor-based co-movements" (from rational investment decision making by financial agents)
Bae, Karolyi and Stulz (2003)	the fraction of "exceedance events" in a region that are not explained by the covariates (exchange rates, interest rates, market volatility) but are explained by "exceedance events" from another region; "exceedance events" are extreme returns shocks (above or below the 5th or 95th quantile of the marginal return distribution) in equity indices
Hartmann, Straetmans and de Vries (2004)	a significant increase in the conditional probability of having a crash in one market, given one occurred in another
Boyer, Kumagai and Yuan (2006)	"excess correlation" between stock markets during periods of high volatility, with "excess" defined as a significant increase in cross-market correlations for investable stocks (relative to less accessible stocks)
Dungey, Fry, González-Hermosillo and Martin (2010)	"the effects of contemporaneous movements in asset returns across countries having conditioned on a range of factors as represented by the common factors, regional and idiosyncratic factors"
Bekaert, Ehrmann, Fratzscher and Mehl (2011)	"the co-movement in excess of that implied by the factor model, i.e. above and beyond what can be explained by fundamentals taking into account their natural evolution over time"
Forbes and Warnock (2012)	large changes in a country's gross capital inflows or outflows "resulting from circumstances in another country or group of countries (but not the entire world)"

global shock—such as a sharp increase in commodity prices—does not qualify as contagion, even if it causes increased comovement in markets around the world.

The disagreements on how to define contagion are more numerous. When a shock to one country spreads to others that are economically similar or that are closely linked through trade or financial flows—is this contagion? For example, if U.S. growth falters and equity markets decline and this affects Canada, would this necessarily constitute contagion? Another set of disagreements is on whether only certain types of cross-market linkages constitute contagion. More specifically, some economists argue that only the transmission of the most extreme negative events should qualify as contagion.

Others argue that only any residual transmission of shocks after controlling for "fundamentals" is contagion. Still others argue that "rational" investor behavior that transmits shocks through financial markets is not contagion, but "irrational" behavior is. Even if there was agreement on what constituted "fundamental linkages" or "rational behavior," these stricter definitions of contagion are extremely difficult to implement and measure in practice. For example, if mutual funds respond to a fall in Brazil's market by selling investments in Bulgaria in order to satisfy investor withdrawals, does this qualify as a "fundamental" linkage between the countries, which share little other than their names starting with a "B"?

Finally, one issue that has received little attention in the debate on how to define contagion is what constitutes a "global shock." In earlier work on contagion, changes in U.S. growth or U.S. interest rates were considered "global" shocks and were *not* classified as contagion. But would a shock to the United States (such as the subprime crisis in 2007) that spreads to other countries qualify as contagion? Taking this one step further, what if a shock to a smaller country triggers a global or systemic shock?[4] In earlier work on contagion, changes in global liquidity, global risk, or global interest rates were not considered contagion. Many of the recent academic papers analyzing the spread of the Global Financial Crisis (GFC) avoid the term contagion—undoubtedly due to this difficulty in classifying these global shocks that were a key transmission mechanism for the crisis and inherently different than the bilateral linkages that were previously the focus of academic work.[5] Most policymakers today, however, would consider global shocks that originate in the world's largest economies or result from shocks to smaller economies as examples of contagion. This suggests that even aspects of the definition of contagion on which there was initial agreement have evolved over time.

This debate on exactly how to define contagion is not just academic; it has important implications for measuring contagion and evaluating policy responses. Many economists argue a more restrictive definition of contagion is useful in order to better understand how crises are transmitted and what should be done. They highlight the importance of differentiating between cross-country linkages

that exist at all times—what is often called interdependence—versus linkages that only exist briefly after shocks. For example, if a crisis in one country spreads to others through fundamental trade linkages that exist in all states of the world, policies that provide liquidity or financial assistance will be less effective in reducing contagion and just delay a necessary adjustment. But if the crisis spreads through transmission channels that only exist briefly after shocks—such as panicked selling by investors or a temporary withdrawal of liquidity by banks—then policies to provide liquidity or financial assistance until economic relationships stabilize could potentially avoid an unnecessary and painful adjustment.

On the other hand, most citizens and government officials prefer a broader definition of contagion. For example, ECB (2005) writes: "When a crisis in the stock market of one country causes a crisis in the stock market of another country this can be thought of as financial market contagion." If a country's economic outlook suddenly deteriorates after a crisis in a neighboring country, citizens do not generally care how the shock has been transmitted to them. They simply know that they are being affected by problems that originated in another country and classify any spillover effects as contagion. Blaming contagion—even if it occurred through fundamental linkages that exist at all times—can be a powerful justification for policy action to support an economy. Moreover, even if policymakers wished to use a stricter definition, identifying the various forms of contagion can be extremely difficult in real time.

This paper will adopt what has evolved into the most common definition of contagion—the transmission of an extreme negative shock in one country to another country (or group of countries). This definition is broader than the terminology used in much of the academic literature and includes the spread of crises through trade, banks and other fundamental linkages between countries that exist in stable as well as crisis periods. It also includes examples in which a shock to one country evolves into a global shock—such as a contraction in global liquidity or an increase in risk aversion. This broad definition of contagion is closest to the use by governments, citizens and policymakers—the fear that negative events in another country, outside of their

control, could spread and have deleterious effects at home. While this definition of contagion only focuses on spillovers from extreme negative events, the paper will also use the term "interdependence" to capture cross-country spillovers in all states of the world.

B. Measuring Contagion

Table 1 shows not only the different definitions of contagion in the academic literature, but also the range of approaches for measuring it. Much of the earlier literature focused on the fundamental question of whether contagion actually occurred during major crises—an apparently straightforward question complicated by several statistical issues. This section briefly summarizes the advantages, disadvantages and key insights of the five general strategies for measuring contagion: probability analysis, cross-market correlations, VAR models, latent factor/GARCH models and extreme value analysis.[6] Most of these papers focus on contagion across equity markets because data is available at a high frequency for a large sample of countries over long periods of time. Equity valuations are also useful if they reflect expectations about future economic activity. A few papers also consider contagion in bond markets, interest rates and exchange rates. This section only summarizes the literature measuring contagion in general and leaves a discussion of the specific channels of contagion (such as through trade, banks, etc.) to Section IV.

1. Probability Analysis

One of the earliest approaches for evaluating the existence and importance of contagion used probability models to assess whether a crisis occurring in a "ground zero" country affected the likelihood that another country would have a crisis.[7] These papers generally find evidence that the probability of a country having a crisis increases if there is a crisis elsewhere—their definition of contagion—especially for countries in the same region. This general approach has been extended more recently to test for a role of contagion in explaining sharp movements in capital flows (i.e., Forbes and Warnock 2012) and default probabilities derived from credit default swaps (i.e., Constancio 2012). These papers generally find evidence of contagion, although they have limited success in controlling for endogeneity

(feedback effects) and omitted variables that could simultaneously cause events to occur in multiple countries.

2. Cross-Market Correlations

In the late 1990s, the most popular framework for analyzing contagion was to test if correlations in equity returns (or interest rates, exchange rates, or sovereign spreads) across different economies increased significantly after a crisis.[8] These studies generally found evidence that market comovement increased significantly during most crises, which was interpreted as evidence of contagion. Forbes and Rigobon (2002), however, show that the increased volatility during crises automatically generated an upward bias in correlation coefficients. They show that markets are highly "interdependent" in all states of the world, and we are simply more aware of this usual interdependence during periods of high volatility. Corrections for this heteroskedasticity in asset price movements lead to much less evidence of contagion—although different corrections require fairly restrictive assumptions that are often not satisfied in practice.[9] Moreover, even if this challenge of adjusting for heteroscedasticity in returns is resolved, tests for contagion based on correlation coefficients also have challenges controlling for any feedback effects (endogeneity) and common shocks (omitted variables) when estimating the effect of a crisis in one country on another. These econometric challenges in using correlation coefficients to measure contagion caused most academics to stop using cross-market correlations to analyze the transmission of crises.

3. VAR Models

Closely related to using correlation coefficients to analyze contagion is the use of a vector autoregression (VAR) framework.[10] These models generally predict stock market returns or yield spreads while controlling for global factors and country-specific factors, as well as for the persistence of these factors through error-correction techniques. Contagion is then measured with an impulse-response function predicting the impact of an unanticipated shock to one country on others. These tests are less conservative than those based on correlation coefficients as they generally do not adjust for the

heteroskedasticity in returns (and attempts to make this adjustment generate fragile results). Not surprisingly, papers using VARs generally find more evidence of contagion.

4. Latent Factor/GARCH Models

The challenges of using correlation coefficients and VARs to analyze contagion prompted a series of papers using latent factor and GARCH models that allow return variances to change across regimes.[11] Many of these papers focus on estimating spillovers in volatility, i.e., cross-market movements in the second moments of asset prices, instead of spillovers in prices. Studies using this approach generally find evidence of contagion from one country to others in certain circumstances, but not in all crises. Most of these studies also attempt to control for fundamental factors in their analysis and define contagion more strictly as the "excess correlation" after controlling for fundamentals. Since this measure of contagion is based on the correlation in the model residuals, this raises some questions about what is actually being captured in the residuals and whether any contagion could be caused by global shocks or any other omitted variables not captured in the model.

5. Extreme Values/Coexceedance/Jump Approach

A final approach to measuring contagion builds on the initial probability approach by using multivariate extreme value theory to test whether tail observations in returns are correlated across countries.[12] The extreme moments analyzed in these papers are periods when realizations of certain variables exceed a large threshold value (either in absolute value or relative to the distribution of returns)—with different approaches used to define these "exceedances." A closely related literature focuses on periods when there is a significant "jump" (i.e., large movement) in prices. These approaches have a number of advantages. They do not assume the transmission of shocks is linear or focus on daily relationships between markets. Instead they only focus on the impact of large (usually negative) shocks, which is closer to the broader definition of contagion of concern to policymakers. These approaches are also robust to different distributional assumptions about returns and therefore can avoid many of the econometric

problems with other approaches (such as VAR and correlation analyses). Papers using this approach generally find evidence of contagion during some crises (such as the Russian crisis), but not all. This approach has two disadvantages: the sample of extreme moments is often small and it is difficult to control for any global shocks that could cause an extreme value in multiple markets at once and, therefore, be interpreted as contagion.

Each of these approaches for measuring contagion has its advantages and disadvantages. The preferred strategy depends largely on the operational definition of contagion being tested. For example, correlation analysis is useful for measuring the interdependence between markets in all states of the world and factor models are useful for measuring spillovers in volatility across markets after controlling for measurable fundamentals. Extreme-value analysis is emerging as potentially the cleanest approach to measuring the most common definition of contagion—any transmission of extreme negative shocks. Each approach has the imposing challenge, however, of controlling for global shocks that simultaneously cause a crisis in one country while increasing comovement between many countries. More important, even when these approaches are successfully used to identify whether contagion does or does not occur, they still do not answer the fundamental question of why a negative shock is transmitted internationally and through what channels contagion occurs.

III. Contagion over Time

Chart 1 shows that use of the term "contagion" in the business press has increased sharply since 1997—and especially since 2007. But has the incidence of contagion actually increased over time? Even though the term is relatively new to the lexicon of international economists, examples of contagion have existed for 200 years (if not longer). Kindleberger (1989) and Bordo and Murshid (2001) document historic examples of financial panics in one country spreading globally. For example, in 1825 a banking crisis started in Britain and quickly spread to continental Europe and then to Latin America. In 1857, the direction of transmission reversed, when a banking panic in the United States spread to the United Kingdom and continental Europe, and then affected regions as far away as South America,

South Africa and the Far East. Crises that start in one country and spread internationally, especially through banking and other financial channels, are not a new phenomenon.

Ironically, given this long history of crises being transmitted globally, much of the discussion about contagion in the mid-2000s argued that contagion risks had permanently declined.[13] This discussion was prompted by the fact that recent crises had much weaker international repercussions. For example, although the 1997 and 1998 crises in Thailand and Russia both spread internationally, the 2001 crises in Argentina and Turkey had minimal spillover effects. One reason cited for reduced contagion was that investors had improved their risk analysis and country assessment tools. Another reason was that emerging markets had improved their macroeconomic policies in ways that would reduce their vulnerability to external events (such as greater exchange rate flexibility). Didier et al. (2008) discuss these arguments and show that when contagion is measured as bilateral correlations in bond spreads, there was less contagion in emerging markets in 2000-07 relative to 1994-99.

The last few years, however, have unfortunately shown that these forecasts of diminished contagion were optimistic. A crisis that began in the U.S. subprime market in 2007 had global ramifications. Events in the euro area have been a key driver of global markets throughout 2010-12. The remainder of this section tests whether interdependence and contagion across global markets have increased over time and whether these relationships have evolved differently in the euro area. Section A uses a framework popular in the academic and investor literature—examining patterns in cross-market correlations—to test for changes in interdependence between countries in all states of the world. Section B then builds on the recently popular approach of focusing on the coincidence of extreme returns to measure contagion from extreme negative events. Although a number of papers in the 2000s examined the evolution of contagion over time, many reached conflicting results and did not address the econometric issues discussed in Section II.[14] This is the first analysis (to my knowledge) that: (1) uses extreme value analysis to study the evolution of contagion over time;

and (2) examines whether interdependence and contagion within the euro area has evolved differently than in other countries.

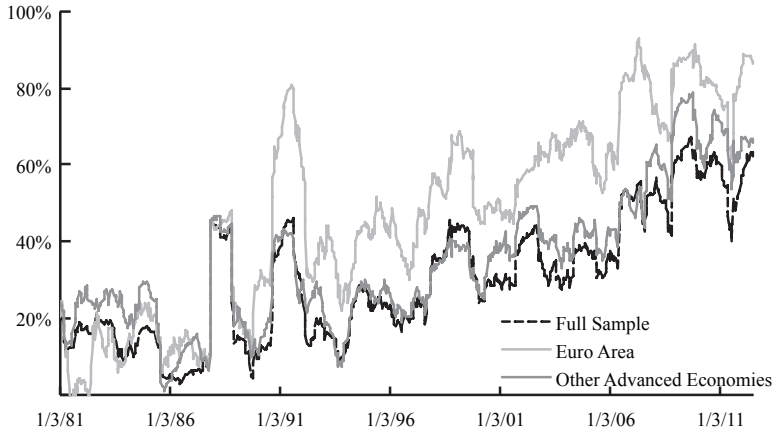
A. Correlation Analysis

This section analyzes the bilateral correlations in equity returns from 1980 through June 2012 in a sample of 48 countries around the world. Equity returns are a useful basis for this analysis as they should incorporate all available information on the expected future profitability of companies in a country—and, therefore, capture expected changes in real indicators. Equity returns are also available at a high frequency; this ability to better identify the effect of various shocks is critically important during crises when events have rapid effects. Finally, although other high frequency measures are useful (such as CDS or bond spreads), many of these are not available for as long a time series or for as broad a set of countries as equity returns.

To calculate the comovement in stock returns across the 48 countries in the sample (listed in Appendix A), I begin by calculating the moving 52-week correlations between each pair of countries for each week possible.[15] This generates a large matrix of bilateral correlations—of up to 1,128 country-pairs by 1,638 weeks. I calculate this matrix using stock returns in local currency and then in U.S. dollars.[16] Then I calculate the average 52-week correlation each week for: (1) the full sample of countries; (2) only current members of the euro area (and only their correlations with other euro area countries); and (3) other advanced economies that are not currently in the euro area (and only their correlations with other members of the group).

Chart 2 graphs correlations for these three groups over time and shows several noteworthy trends. First, correlations within all three groups generally increase over time, especially since the mid-1990s, despite substantial fluctuations around this upward trend. Second, correlations between current euro area countries have increased by more than for other countries, including other advanced economies. Finally, correlations between current euro area countries have been substantially higher than for other countries since the early 1990s. Columns 1-3 of Table 2 report correlations for each group of countries in five-year intervals over the same period and confirm these

Chart 2
Average Bilateral Correlations in Equity Returns



Notes: Averages are 52-week moving averages of the bilateral correlations in equity returns based on local currency stock indices for all countries in the specified group. "Euro Area" is the group of countries currently in the euro area. "Other Advanced Economies" is advanced economies other than those in the euro area as specified by the IMF in April 2012.

Table 2
Stock Market Correlations and Volatility Over Time

	Correlations			Volatility			Correlations With Controls for Global Shocks		
	Full Sample (1)	Euro Area (2)	Other Advanced (3)	Full Sample (4)	Euro Area (5)	Other Advanced (6)	Full Sample (7)	Euro Area (8)	Other Advanced (9)
1981-84	0.155	0.119	0.231	0.024	0.024	0.024	0.153	0.127	0.218
1985-89	0.158	0.210	0.195	0.032	0.025	0.027	0.155	0.206	0.184
1990-94	0.229	0.449	0.252	0.034	0.024	0.027	0.220	0.444	0.238
1995-99	0.293	0.497	0.294	0.033	0.025	0.026	0.288	0.491	0.283
2000-04	0.333	0.582	0.400	0.032	0.030	0.028	0.312	0.546	0.378
2005-09	0.491	0.759	0.554	0.032	0.028	0.027	0.472	0.730	0.527
2010-Jun 2012	0.567	0.802	0.659	0.028	0.032	0.025	0.481	0.728	0.556
Change from 1981-84 to:									
2010-12	***0.412***	***0.683***	***0.428***	***0.004***	***0.009***	***0.002***	***0.328***	***0.601***	***0.338***
2005-09	***0.336***	***0.640***	***0.323***	***0.008***	***0.004***	***0.004***	***0.319***	***0.603***	***0.309***

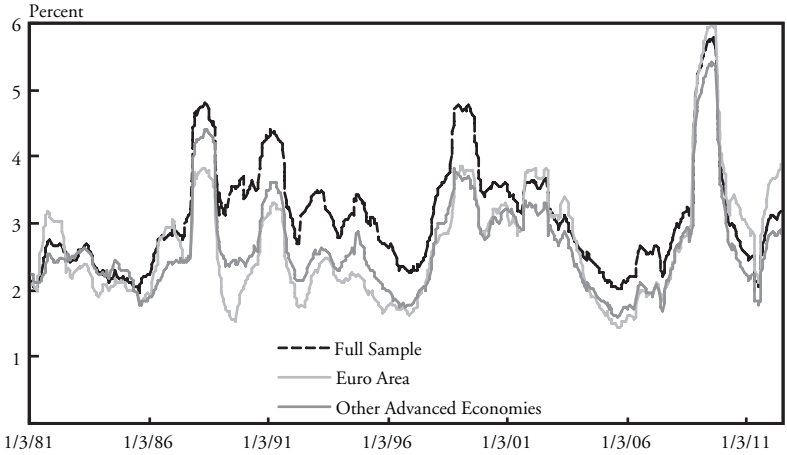
Notes: Columns 1-3 and 7-9 report average 52-week bilateral correlations in weekly stock market returns based on indices in local currency. Columns 4-6 report average 52-week standard deviations for the same returns. "Full Sample" is the full sample of 48 countries. "Euro Area" is all current members of the euro area in the sample. "Other Advanced" is advanced economies other than those in the euro area as specified by the IMF in April 2012. Countries in each group are listed in Appendix A. Columns 7–9 include controls for three global shocks: changes in the *Economist* All-Commodity Dollar Index, changes in U.S. interest rates (on a 10-year constant maturity government bond) and the TED spread.

trends. Average correlations have increased steadily over each five-year window for each group of countries since 1985. These correlations have also increased more in the euro area than in other advanced economies. Even though correlations within the euro area were lower than in other groups at the start of the sample, they increased quickly to be higher over most of the period, including today.

This increase in correlations over time (and within the euro area) may result purely from increased volatility (over time and within the euro area) and not necessarily any change in cross-country linkages. As shown in Forbes and Rigobon (2001, 2002), higher volatility in one country's stock market will automatically increase the unconditional correlation in returns between the two countries for purely statistical reasons. If volatility in one country increases, even if the transmission mechanism between the two countries is constant, a larger share of the return in the second country will be driven by the larger, idiosyncratic shocks in the first country. Although this would still qualify as contagion using the broad definition of contagion in this paper (albeit not in many academic papers), it is still useful to understand if the increased correlations in Chart 2 and Table 2 are simply an artifact of increased market volatility.

To analyze the impact of changes in volatility over time, I calculate the 52-week, moving-average standard deviation in stock returns for the same sample of 48 countries from 1980 through June 2012. Chart 3 graphs average volatilities for the same three groups of countries. Chart 3 graphs that volatility increases during key crisis periods as expected—such as during the 1987 U.S. stock market crash, 1998 LTCM collapse and the peak of the GFC. The graph also shows, however, that there is no steady upward trend in volatility over time as for the cross-market correlations in Chart 2. There is also no evidence of a greater increase in volatility in the euro area relative to other countries (except in the last few months) or of higher levels of volatility within the euro area throughout the sample. These trends are confirmed in Table 2, columns 4-6. Therefore, the increase in cross-market correlations for the full sample (and the euro area) since 1980 does *not* simply result from greater market volatility over time (or in the euro area).

Chart 3
Volatility in Equity Returns



Notes: Volatility is the 52-week standard deviation in equity returns based on local currency stock indices for all countries in the specified group. "Euro Area" is the group of countries currently in the euro area. "Other Advanced Economies" is advanced economies other than those in the euro area as specified by the IMF in April 2012.

An alternative explanation for this increase in cross-market correlations could be a greater role of global shocks in determining equity returns. This could result from global shocks that are larger in magnitude (such as greater swings in commodity prices) or from countries becoming more vulnerable to these global shocks. Either of these effects could cause cross-market correlations to increase, even if there is no change in the direct linkages between economies. To test if global shocks could explain the correlation patterns in Chart 2 and Table 2, I recalculate the bilateral correlations between each pair of markets, except now controlling for global shocks. I use several controls for global shocks: the change in commodity prices, the change in U.S. interest rates, the TED spread and the VXO.[17] The resulting graphs of average, cross-market correlations are virtually identical to Chart 2 (and therefore not shown). In Table 2, columns 7-9 report the resulting correlations over five-year windows with controls for global shocks. Controlling for these global shocks slightly reduces average cross-market correlations (as expected), but does not affect the main trends discussed above.

To summarize, Charts 2 and 3 and Table 2 show that cross-market correlations have increased over time for the full sample of countries,

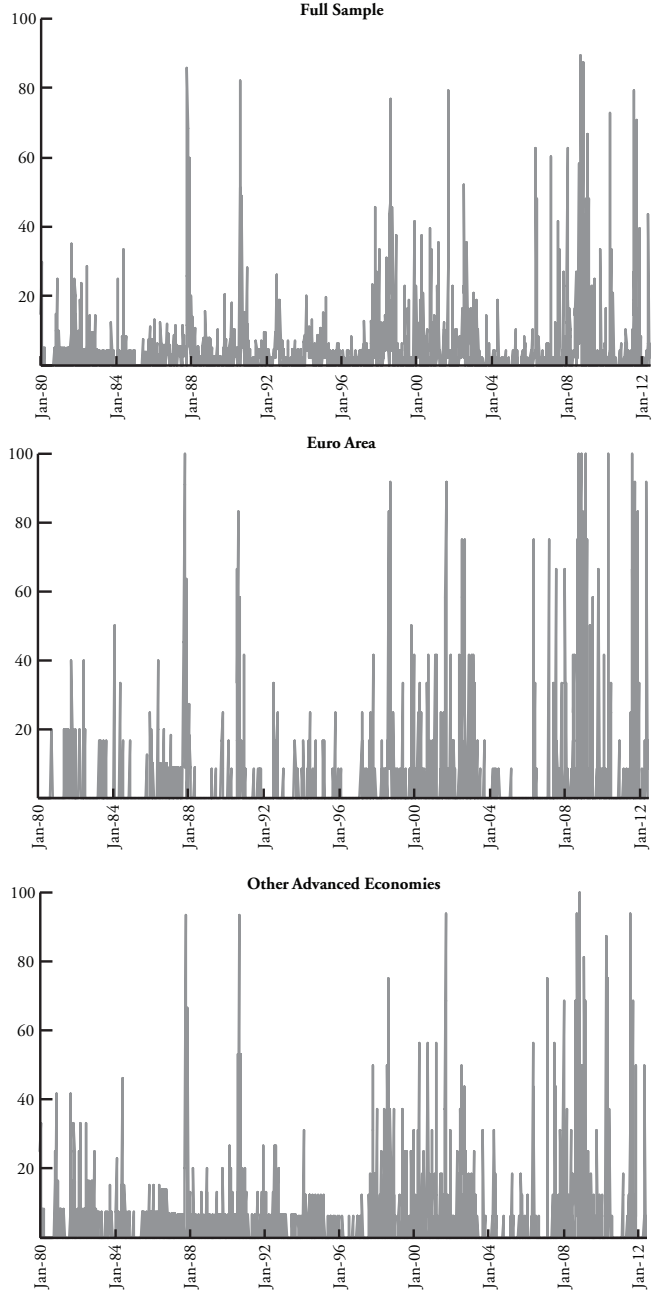
and by even more within the euro area, so that correlations within the euro area are now higher than in other groups. These increases in correlations do not result from changes in volatility or from global shocks. Instead, countries' markets appear to have become more closely linked and more interdependent over time, especially within the euro area. As discussed in Section II.B, however, these correlations capture comovements between markets during boom years as well as after negative events and crises. Correlations calculated over long windows may also miss important links between markets that only exist during short windows after a shock. Therefore, although the results in this section document trends in interdependence over time and within the euro area, this does not necessarily capture contagion when defined as the transmission of extreme negative events.

B. Extreme Value Analysis

To better capture contagion, this section uses a form of extreme-value analysis to examine the incidence and cross-country patterns in extreme negative returns over time. More specifically, I identify the weeks from 1980 through June 2012 when each country has an extreme-negative return, defined as a return in the bottom 5 percent of that country's return distribution. If countries' extreme negative returns result purely from idiosyncratic shocks and are not related to events in other countries or global shocks, than about 5 percent of the sample should experience extreme negative returns in each week. If extreme negative returns are more likely when other countries have negative returns (due to either contagion or global shocks), then the percent of countries with extreme returns should vary across time.

The top panel of Chart 4 graphs the percent of countries in the full sample with an extreme negative return in each week. There is clearly not an even distribution with a steady 5 percent of the sample experiencing extreme negative returns each week. Instead, there is substantial volatility in the coincidence of extreme returns and several spikes when a large percentage of the sample has extreme negative returns—such as 86 percent of the sample in the week ending Oct. 24, 1987 (after "Black Monday") and 90 percent for the week ending Oct. 11, 2008 (during the GFC). There also appears to be an increase in extreme negative values over time—with more frequent

Chart 4
Percent of Sample with Extreme Negative Returns



Notes: Extreme negative returns are defined as weeks when a country's weekly stock market return in the bottom 5 percent of each country's return distribution over the full sample. "Euro Area" is the group of countries currently in the euro area. "Other Advanced Economies" is advanced economies other than those in the euro area as specified by the IMF in April 2012.

Table 3
Percent of Group with Extreme Negative Returns

	Full Sample (1)	Euro Area (2)	Other Advanced (3)
1981-84	3.3	2.6	3.9
1985-89	4.3	3.7	4.1
1990-94	4.7	3.0	4.5
1995-99	5.2	3.3	4.3
2000-04	5.1	6.7	6.0
2005-09	6.5	7.7	6.8
2010-Jun 2012	4.7	8.3	5.3
Change from 1981/84 to:			
2010-12	***1.5***	***5.7***	***1.3***
2005-09	***3.3***	***5.1***	***2.9***
Number of weeks with an extreme negative return for:			
100 percent of group	***0***	***6***	***1***
80 percent of group	***4***	***17***	***8***
50 percent of group	***22***	***44***	***38***

Notes: Top of table reports the percent of each group of countries that has an extreme negative return each week in the specified period. Extreme negative returns are local currency stock returns in the bottom 5 percent of the return distribution for each country over the full period. "Full Sample" is the full sample of 48 countries. "Euro Area" is all current members of the euro area in the sample. "Other Advanced" is advanced economies other than those in the euro area as specified by the IMF in April 2012. See Appendix A for members of each group.

spikes later in the sample. These patterns are confirmed in Table 3, column 1, which reports the average percent of the sample with an extreme value each week over five-year windows. The percent of the sample experiencing extreme negative returns has steadily increased over time (at least until 2010), nearly doubling from only 3.3 percent of the sample from 1981-84 to 6.5 percent from 2005-09. Countries have become more likely to experience extreme negative returns simultaneously.

Next, to test if countries in the euro area were more or less likely to experience extreme returns simultaneously and whether this has changed over time, the middle and bottom panels of Chart 4 graph the percent of countries in the euro area and in other advanced economies, respectively, that experienced extreme negative returns each week. These graphs are similar to that for the full sample in the top panel. One noteworthy difference, however, is that the graph for the

Table 4
Extreme Value Analysis: Regression Results

	Full Sample			Euro Area			Other Advanced Economies		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Percent with an extreme negative return	6.092** (0.222)	6.187** (0.230)	6.206** (0.229)	6.366** (0.297)	6.407** (0.325)	6.371** (0.332)	6.317** (0.362)	6.448** (0.380)	6.446** (0.393)
Commodity prices		0.017** (0.006)	0.019** (0.006)		0.017 (0.016)	0.021 (0.017)		0.029** (0.011)	0.034** (0.012)
U.S. interest rates			0.137 (0.134)			-0.197 (0.355)			0.145 (0.333)
TED spread			0.030 (0.044)			0.090 (0.099)			0.097 (0.076)
Observations	***69,190***	***69,190***	***68,758***	***18,226***	***18,226***	***18,118***	***25,549***	***25,549***	***25,405***

Notes: Dependent variable is a dummy variable equal to 1 if a country has an extreme negative return in any week. Extreme negative returns are local currency stock returns in the bottom 5 percent of the return distribution for each country. Regressions estimated using the complementary logarithmic estimator with standard errors clustered by country." Percent with an extreme negative return" is the percent of the group with an extreme negative return in the given week. Commodity prices is the change in the *Economist* All-Commodity Dollar Index. U.S. interest rates are changes in the interest rate on a 10-year constant maturity government bond. "Full Sample" is the full sample of 48 countries. "Euro Area" is all current members of the euro area in the sample. "Other Advanced" is advanced economies other than those in the euro area as specified by the IMF in April 2012. See Appendix A for members of each group.

euro area has taller spikes, showing that a larger share of this group has extreme negative returns at the same time. There are six weeks when 100 percent of euro area countries had an extreme negative return simultaneously (compared to only one week for the other advanced economies). Table 3 confirms these observations. Although countries in the euro area were less likely to experience extreme negative returns simultaneously in the 1980s and 1990s, since then they have had a greater increase in the joint coincidence of extreme returns. As a result, countries in the euro area are now more likely than other advanced economies to experience extreme negative returns simultaneously.

The coincidence of extreme negative returns, however, is only a rough proxy for contagion across countries. As mentioned above, a number of countries could experience large negative returns simultaneously due to a global shock. To disentangle the effect of global shocks from linkages between markets, I next estimate a series of regressions. More specifically, I estimate the conditional probability that a country has an extreme negative return in any week as a function of the percent of the sample that also has an extreme negative

return and global shocks. I include different combinations of global shocks: the change in a commodity price index, the change in U.S. long-term interest rates and the TED spread (with all variables defined in Section III.A.). The formal specification is:

$$Prob(ENR_{it} = 1) = F(\alpha + \beta * Global_t + \gamma * ENR_t^{All}) \quad (1)$$

where ENR_{it} is a dummy equal to 1 if country i is experiencing an extreme negative return in week t, with an extreme negative return defined above. Globalt measures global shocks during week t. ENR_t^{All} is the percent of the sample that has an extreme negative return during week t. The appropriate methodology to estimate equation (1) is determined by the distribution of the cumulative distribution function, F(•). Because extreme negative returns occur irregularly (95 percent of the sample is zeros), F(•) is asymmetric. Therefore I estimate the equation using the complementary logarithmic (or cloglog) framework, which assumes that F(•) is the cumulative distribution function of the extreme value distribution.[18] I also cluster the standard errors by country.

Table 4 reports regression results without any controls for global shocks and then with different combinations of controls.[19] It also reports results for the full sample of countries, for countries currently in the euro area and for other advanced economies. For each specification and group of countries, the estimates show that the percent of the sample with extreme negative returns is significantly and positively correlated with a country's probability of having an extreme negative return in each week.[20] These results are stable even after controlling for global shocks, suggesting that much of this joint coincidence of extreme negative returns results from linkages between these economies and contagion.

To summarize, Section III provides evidence of increased interdependence and contagion over time. The evidence for interdependence is based on cross-market correlations and for contagion is based on extreme value analysis. The increases in cross-market correlations and the coincidence of extreme returns do not result from global shocks or changes in volatility. Therefore, interdependence during all states of the world, as well as contagion after negative events,

appears to be greater today than in the past and greater for countries in the euro area than in other advanced economies (and the world as a whole). These results, however, do not answer the fundamental question: what causes these trends in interdependence and contagion across time and countries?

IV. The Channels of Contagion

A. Theory and Trends

Understanding the channels through which shocks are transmitted across countries is the key issue for policymakers hoping to mitigate any negative effects. A large literature models and tests various channels of contagion.[21] There are several ways in which these channels can be categorized—such as by the theoretical models that explain why actors make certain decisions (i.e., imperfect information, information cascades, compensation structures, etc.) or by the actors that cause contagion (i.e., banks, investors, etc.). For this paper, I divide this extensive literature into four main channels of contagion: trade, banks, portfolio investors and wake-up calls. These categories are broad and there are important links between them. For example, portfolio investors may be a key source of funding for banks; a wake-up call can cause portfolio investors to liquidate positions; banks may withdraw credit and, therefore, affect trade. These four categories are useful, however, to directly link the discussion of contagion channels to the empirical analysis and evaluation of policy responses. This section briefly summarizes the theoretical and empirical evidence on each channel and examines trends showing how these channels have evolved over time for the full sample and the euro area. The second part of the section then uses this framework to estimate the role of these four channels in causing contagion around the world since 1980.

Trade

Trade can cause contagion through two effects: bilateral trade and competition in third markets.[22] A crisis in one country can reduce income and the corresponding demand for imports, thereby affecting exports from other countries through bilateral trade. In addition, if a country devalues its currency, this can improve the country's relative export competitiveness in third markets. The greater use of global

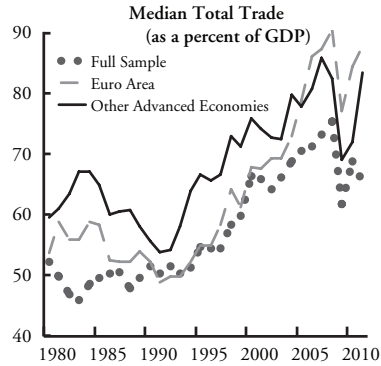
supply chains could magnify these effects. Most empirical papers find that trade channels are significant and play an important role in transmitting crises. They also find that trade does not explain all of the contagion observed during recent crises and other transmission channels are also important.

The top two graphs in Chart 5 show the median and mean trade exposures (measured as imports plus exports relative to GDP) for the different groups of countries in the sample from 1980 through 2011.[23] The graphs show the well-known trend that trade exposure has increased substantially for countries around the world since 1990. It also shows that trade has increased relatively more for euro area economies, so that these economies are now more exposed to trade than other advanced economies (especially when compared using average exposures). This is not surprising; one of the key goals of the European Union was to reduce barriers to trade between members. These trends in trade exposure could be a factor causing increased contagion over time, especially in the euro area.

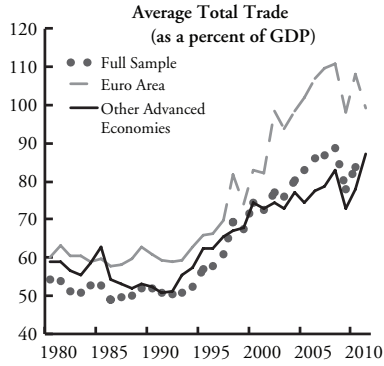
Banks and Lending Institutions

One important financial channel for contagion is through banks and other financial intermediaries.[24] A shock to one country can cause banks to reduce the supply of credit in other countries, reducing liquidity and raising the cost of credit. This could occur in a number of different ways. For example, the initial shock could occur because individuals withdraw bank deposits, because a weak economy increases nonperforming loans and reduces asset values, and/or because a bank's holdings of sovereign debt lose value. Any of these effects could force the bank to reduce lending in other countries in order to restore capital adequacy, meet other regulations, or adjust exposures to follow VaR models. The reduction in credit in other countries could occur through: (1) a contraction in direct, cross-border lending by the foreign banks; (2) a contraction in local lending by the foreign banks' affiliates; and/or (3) a contraction in lending by domestic banks resulting from the funding shock to their balance sheets from declines in interbank, cross-border lending.

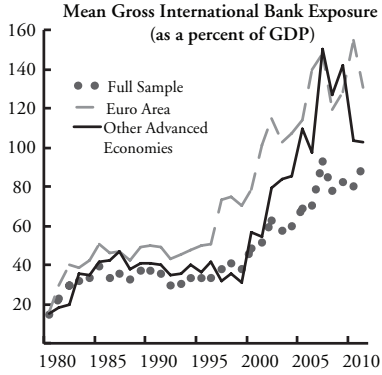
Chart 5
Channels of Contagion



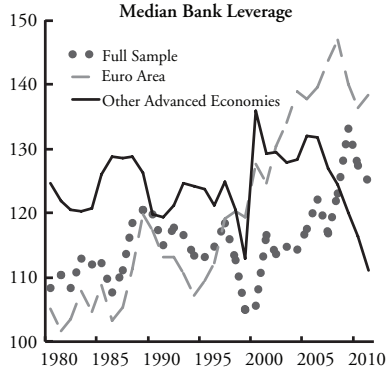
Notes: Sum of imports plus exports as a percent of GDP.



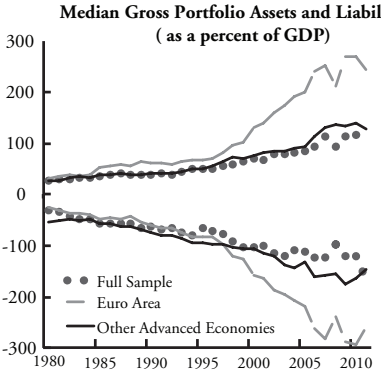
Notes: Sum of imports plus exports as a percent of GDP. Mean values exclude the two largest and smallest values for each country group.



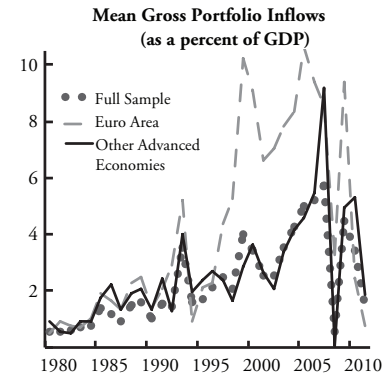
Notes: Sum of gross international banking assets plus liabiliites as a percent of GDP. Mean values exclude the two largest and smallest values for each country group.



Notes: Ratio of private credit by deposit money banks and other financial institutions to bank deposits, including deamand, time and saving deposits in nonbanks.



Notes: Gross portfolio assets (positive) and liabilities (negative) as a percent of GDP.



Notes: Gross portfolio inflows (equity plus debt) as a percent of GDP. Mean values exclude the two largest and smallest values for each group.

Moreover, the role of banks in causing contagion can be aggravated by characteristics of banks: their close relationship to the solvency of their sovereign, their high degree of leverage and their extensive interconnections. As recently seen in Ireland and shown in Acharya et al. (2011), a shock to a country's banking system can not only cause contagion directly through bank lending, but also indirectly through increased risks to country solvency. As shown in Greenwood et al. (2011), Van Wincoop (2011) and Shin (2012), any negative shocks to banks are magnified in the presence of leverage, causing an even greater reduction in loans and unwinding of positions. This has been called "liquidation spirals," "rapid deleveraging," or a "diabolic loop." As shown in Allen et al. (2012), common asset holdings and similar funding maturities across banks can aggravate contagion and systemic risk.

The middle two graphs in Chart 5 show key characteristics of banking systems from 1980 through 2011: gross international bank exposure (measured as international bank assets plus liabilities relative to GDP) and bank leverage (measured as the ratio of private credit by deposit money banks and other financial institutions to bank deposits, including demand, time and saving deposits in nonbanks). There is a striking increase in international bank exposure in the euro area and advanced economies since the middle and late 1990s. There is also a steady increase in bank leverage in the euro area over the same period. These high levels of international bank exposure and leverage have been slower to adjust after the GFC in the euro area relative to in other advanced economies. These trends of increased international banking exposure and banking leverage in euro area countries could be another factor causing increased contagion over time, especially in the euro area.

Portfolio Investors

Another financial channel for contagion is portfolio investors.[25] An extensive literature explains various mechanisms by which investors can transmit shocks across countries.[26] In the simplest versions, an idiosyncratic shock to one country reduces the value of investors' portfolios, forcing them to sell assets in other countries to meet

margin calls or cash requirements or to rebalance portfolios according to VaR models. More complicated models show how increased risk aversion after a negative shock or informational asymmetries and other forms of imperfect information can cause investors to sell assets across countries and "overreact." For example, investors may find it less costly to "herd" and follow other investors, especially if they are unable to differentiate between idiosyncratic shocks and informed trading by others, or if they are evaluated relative to an index. These models can be further complicated in situations of self-fulfilling expectations and multiple equilibria. For example, Masson (1999) shows how investors could suddenly withdraw from a country if they fear that others may sell first and they will be left with no claim on a limited pool of foreign exchange reserves. Allen and Carletti (2006) show how the creation of new financial instruments—such as to transfer credit risk—can aggravate contagion through portfolio investors. Several papers use detailed fund-level information to document contagion through portfolio investors and find that these effects can be substantial.[27]

Moreover, recent research highlights that it is not just the *net* value of a country's international portfolio flows and investment positions which determines contagion, but instead it is the *gross* flows and positions.[28] Even if a country's current account is relatively balanced, if this masks large capital inflows balanced by large outflows, the country is still vulnerable to any disruption in capital inflows, counterparty risk, or breakdown in international payments. Similarly, even if a country has a moderate net international investment position, large underlying gross investment assets and liabilities make the country vulnerable to shocks which affect the relative values or liquidity of its assets and liabilities.

The bottom two graphs in Chart 5 graph gross portfolio investment positions (equity and debt) and gross portfolio inflows (both relative to GDP) from 1980 through 2011. The graphs show an increase in international investment positions and portfolio inflows in the 2000s for the group of other advanced economies, and a much sharper increase for countries in the euro area starting in the mid-1990s (although portfolio inflows fell sharply during the GFC for all groups). The much

greater increase in international portfolio investment exposure in the euro area is not surprising as one of the key goals of the euro was to increase financial integration across members. These trends of increased exposure to international portfolio investment and inflows, especially for the euro area, could be another factor causing increased contagion over time, especially in the euro area.

Wake-up Calls/Fundamentals Reassessment

A final (and closely related) mechanism by which contagion can occur is wake-up calls—when additional information or a reappraisal of one country's fundamentals leads to a reassessment of the risks in other countries.[29] Wake-up calls could happen because investors were not focused on or aware of certain vulnerabilities, or because fundamentals only become problematic during a crisis—thereby generating multiple equilibria. Weaker fundamentals—or even just increased concern about a country's fundamentals—could also strengthen various channels of contagion. For example, if a shock to banks in one country reduces funding for banks in other countries, this would be more likely to generate a wake-up call and bank runs for a country with a weaker financial system. The risk of these types of wake-up calls is also greater when there is more uncertainty—especially about economic fundamentals or financial institutions in the country.

These wake-up calls can involve many forms of reassessment—including not only the macroeconomic, financial or political characteristics of the country—but also the functioning of financial markets or the policies of international financial institutions. For example, if a shock to one country increases uncertainty about the ability of major financial institutions to trade assets or provide liquidity, financial markets could freeze up.[30] Or one country's terms for its debt restructuring or financial support package could provide information on how other countries would be treated in a similar situation. Chen (1999) shows that generous financial support for one country could even be interpreted as evidence that other countries might receive *less* instead of *more* support if a package depletes a limited supply of funds. Any such reassessment of the functioning of financial markets or policies of international institutions could cause investors to sell assets across countries, thereby causing contagion.

B. Regression Results

The last section discusses four important channels for contagion: trade, banks, portfolio investors and wake-up calls. Recent increases in trade, international bank exposure, and international investment positions for many countries in the world would therefore be expected to increase linkages between countries in all states of the world as well as after extreme negative events. This is especially true for the euro area where integration has proceeded even more quickly along most of these measures than in other advanced economies. But how important are these channels in explaining recent episodes of contagion? Since many of these trends of increased integration occurred simultaneously, are certain types of integration more important than others? This section empirically tests if these four channels for contagion can explain the coincidence in extreme negative stock returns around the world since 1980.

For this analysis, I estimate the conditional probability that a country has an extreme negative return in each week as a function of global shocks and the four channels of contagion. Each channel is interacted with the percent of the sample that has an extreme negative return that week. The equation is:

$$Prob(ENR_{it}=1) = F(\beta * Global_t + \gamma_1 * ENR_t^{All} Trade_{it} + \gamma_2 * ENR_t^{All} Banks_{it} + \gamma_3 * ENR_t^{All} Portfolio_{it} + \gamma_4 * ENR_t^{All} WakeUp_{it}), \quad (2)$$

where ENR_{it} is a dummy equal to 1 if country *i* is experiencing an extreme negative return in week *t*. Extreme negative returns are defined as weeks when the country's return is in the lowest 5 percent of its distribution for the sample period (as discussed in Section III.B). $Global_t$ measures global shocks during week *t*, such as the change in commodity prices, change in U.S. interest rates, or a measure of risk and/or volatility—such as the TED spread or VXO. ENR_t^{All} is the percent of the entire sample that has an extreme negative return during week *t*. $Trade_{it}$, $Banks_{it}$, $Portfolio_{it}$, and $WakeUp_{it}$ are measures of the four channels of contagion for country *i* at time *t*. I estimate equation (2) using the complementary logarithmic (or cloglog) framework and cluster standard errors by country (as discussed in Section III.B.)

There are a number of different ways to measure these channels of contagion, so I begin with a parsimonious specification that follows the discussion in the previous section. More specifically, the trade channel is measured by the country's total exposure to trade. The banking channel is measured with two variables: gross international banking exposure and banking leverage. The portfolio investor channel is also measured by two variables: gross international portfolio investment exposure and gross portfolio inflows. All variables except leverage are calculated as a share of the country's GDP and are defined in more detail in Section IV.A. The wake-up call channel is measured by two dummy variables: "medium credit rating" (which is equal to 1 if the country's average credit rating is below investment grade but above "Substantial Risks") and "low credit rating" (which is equal to 1 if the country's average credit rating is "Substantial Risks" or below).[31]

Table 5 reports estimates of Equation 2 with and without controls for global shocks (which have no effect on the key results). Columns 1-3 report results for the full sample, and column 4 includes only the euro area. The estimates show that several channels of contagion are significant and follow theoretical predictions—while others are insignificant. The estimates for the euro area generally mirror those for the full sample, suggesting that contagion in the euro area does not occur through significantly different channels than in other countries.[32] The positive and significant coefficients on *Trade* and *Leverage* indicate that countries with greater trade exposure and more leveraged banks are more likely to have extreme negative returns when other countries are also experiencing extreme negative returns. The positive coefficients on the credit rating variables indicate that countries with weaker credit ratings are more vulnerable than the most highly rated countries to extreme negative shocks elsewhere in the world. The insignificant coefficients on a country's international exposures through banks and portfolio investment suggest that total exposure through these channels may not affect vulnerability to extreme returns occurring elsewhere—at least after controlling for leverage in the banking system.

Table 5
Channels of Contagion: Regression Results

	Full Sample			Euro Area
	(1)	(2)	(3)	(4)
*Trade * ENR^{All}*	1.592**	1.580**	1.479**	3.436**
	(0.373)	(0.371)	(0.357)	(1.116)
*Bank exposure * ENR^{All}*	0.231	0.229	0.180	-0.288
	(0.157)	(0.158)	(0.161)	(0.568)
*Leverage * ENR^{All}*	2.776**	2.764**	2.578**	2.194**
	(0.271)	(0.270)	(0.271)	(0.467)
*Portfolio investment exposure * ENR^{All}*	-0.058	-0.058	-0.044	0.050
	(0.051)	(0.050)	(0.046)	(0.116)
*Portfolio inflows * ENR^{All}*	0.383	0.398	0.369	-0.130
	(0.608)	(0.602)	(0.525)	(0.190)
*Middle credit rating * ENR^{All}*	1.157**	1.144**	0.986**	-4.674**
	(0.555)	(0.548)	(0.487)	(2.290)
*Lowest credit rating * ENR^{All}*	0.870*	0.873*	0.800*	3.246**
	(0.528)	(0.523)	(0.466)	(1.218)
Commodity prices		-0.007	0.004	-0.007
		(0.009)	(0.011)	(0.016)
U.S. interest rates			-1.594**	-1.850**
			(0.302)	(0.396)
TED spread			0.126	-0.315**
			(0.080)	(0.124)
Observations	***23,459***	***23,459***	***23,350***	***7,994***

Notes: Dependent variable is a dummy variable equal to 1 if a country has an extreme negative return. Extreme negative returns are local currency stock returns in the bottom 5 percent of the return distribution for each country in any week. Estimated using the complementary logarithmic estimator with standard errors clustered by country. $ENRA_{ll}$ is the percent of the sample with an extreme negative return in the given week and this variable is interacted with each of the channels for contagion. Trade is (imports + exports) / GDP. Bank exposure is (gross banking assets + liabilities) / GDP. Leverage is the ratio of private credit by deposit money banks and other financial institutions to bank deposits, including demand, time and saving deposits in nonbanks. Portfolio investment exposure is (gross portfolio assets + liabilities) / GDP. Portfolio inflows is gross portfolio inflows / GDP. Middle credit rating is a dummy variable equal to 1 if countries have a credit rating below investment grade but above "substantial risks" and Lowest credit rating is countries with a credit rating of "substantial risk" and below. Commodity prices is the change in the *Economist* All-Commodity Dollar Index. U.S. interest rates are changes in the interest rate on a 10-year constant maturity government bond.

Since international financial exposure through banks and portfolio investors is believed to be an important determinant of country vulnerability to contagion, Table 6 further explores these channels. Columns 1 and 2 break bank exposure into gross international bank assets and liabilities. It also controls for gross international bank inflows and outflows in column 1. Column 3 performs the same breakdown for international portfolio investment. The coefficient

Table 6
A Closer Look at Financial Channels of Contagion

	Breakout Banking		Breakout Portfolio Investment		
	(1)	(2)	(3)	(4)	(5)
*Trade * ENR^{All}*	1.088**	1.352**	1.694**	1.239**	1.825**
	(0.370)	(0.386)	(0.299)	(0.318)	(0.288)
*Bank exposure * ENR^{All}*			0.995**	0.509	0.800**
			(0.358)	(0.345)	(0.303)
*Leverage * ENR^{All}*	2.795**	2.726**	2.201**	1.165**	2.083**
	(0.291)	(0.278)	(0.243)	(0.339)	(0.235)
*Portfolio investment exposure * ENR^{All}*	-0.096	-0.073			
	(0.065)	(0.063)			
*Middle credit rating * ENR^{All}*	0.608	0.834	0.982*	-0.597	0.738
	(0.870)	(0.577)	(0.525)	(0.860)	(0.545)
*Lowest credit rating * ENR^{All}*	1.181	0.885*	1.041**	-0.347	1.061**
	(0.749)	(0.507)	(0.471)	(0.654)	(0.478)
Commodity prices	0.010	0.004	0.006	0.015	0.003
	(0.013)	(0.011)	(0.011)	(0.010)	(0.011)
U.S. interest rates	-1.849**	-1.587**	-1.528**	-1.160**	-1.645**
	(0.330)	(0.301)	(0.309)	(0.256)	(0.289)
TED spread	0.114	0.147*	0.138	0.033	0.106
	(0.102)	(0.087)	(0.087)	(0.087)	(0.088)
Gross assets	1.952**	1.381*	-2.609**	-1.216	-2.423**
	(0.685)	(0.825)	(0.883)	(0.944)	(0.739)
Gross liabilities	-1.165**	-0.817	1.815**	0.887	1.737**
	(0.573)	(0.620)	(0.626)	(0.710)	(0.551)
Gross inflows	1.221		0.858	-0.384	1.008
	(1.072)		(1.507)	(1.037)	(1.542)
Gross outflows	-1.983		0.714	1.005	0.359
	(1.369)		(1.145)	(1.066)	(1.325)
Share of debt in portfolio positions				4.903**	
				(1.204)	
Share of debt in portfolio flows					0.293**
					(0.117)
Observations	***16,060***	***23,350***	***23,142***	***23,056***	***22,476***

Notes: See notes to Table 5 for estimation strategy and variable definitions. Gross assets, gross liabilities, gross inflows and gross outflows all report coefficient estimates when the gross position or flow is measured for banking or portfolio investments as specified at the top of the column. Share of debt in portfolio positions or flows is the share of total portfolio investment positions or flows in the form of debt (instead of equity).

estimates from these disaggregated international positions and flows are reported near the bottom of the table. The coefficients on international banking positions tend to fluctuate in significance—as shown by the changes in columns 1 and 2 (as well as in a number of unreported sensitivity tests). The coefficients on international portfolio investment positions, however, are more robust (including in a number of unreported sensitivity tests). Countries with greater portfolio investment liabilities are more vulnerable to contagion, but this vulnerability can be reduced if the country holds greater international portfolio assets. These results highlight the importance of separating out gross assets and liabilities and not just looking at net or total positions.

International portfolio investment can be further disaggregated into the proportion of this investment in the form of debt versus equity. Columns 4 and 5 of Table 6 control for the share of total portfolio investment or flows in the form of debt. The results suggest that countries with a greater share of international portfolio investment or flows in debt tend to be more vulnerable to contagion. It is also worth noting that in column 4, the coefficients on gross investment liabilities and assets become insignificant when a control for the debt share of portfolio investment is included. Although not a definitive test, this may indicate that the form of any portfolio investment may be even more important than the volume of investment in determining a country's risk of contagion.

C. Implications of Regression Results

This series of regression results has a number of important implications. First, there is evidence that contagion through all four channels—trade, banking, portfolio investors and macroeconomic fundamentals/wake-up calls can be important in explaining a country's vulnerability to extreme returns in other countries. (The evidence on wake-up calls, however, is weakest given the challenges in formulating a clear test for this channel.) Therefore, it is not surprising that as international integration through trade, banking and portfolio investment has increased over time, contagion has also increased. Second, there is no evidence that contagion in the euro area occurs through different channels than in the full sample. Third, leverage

in the domestic banking system plays a critically important role. In each regression and with a variety of controls (including several tests not reported), leverage is a highly significant determinant of country vulnerability to extreme events elsewhere in the world.

Finally, these results also indicate that the simple interpretation that "more integration = more contagion" is not accurate and there are important subtleties in how integration affects country vulnerability. Although greater international portfolio investment liabilities *increase* vulnerability, greater international portfolio investment assets *reduce* vulnerability. This supports analysis in Milesi-Ferretti and Tille (2011) and Forbes and Warnock (2012) that countries with large international asset positions can liquidate foreign assets after negative shocks and this "retrenchment" of funds can provide stability during crises. The results also suggest that greater reliance on debt (versus equity) tends to increase country vulnerability. The natural risk sharing properties of equity may reduce country vulnerability after extreme negative events. Therefore, it is not just the level of financial integration, but its structure that determines a country's vulnerability to contagion.

V. Policy Implications for Mitigating Contagion

The high levels of interdependence in global stock markets generally do not concern policymakers—except during periods of contagion when an extreme negative shock in one country affects others. Many channels of contagion, however, result from healthy trends toward greater integration in the global economy. Can the risks from contagion be mitigated without reversing these trends? Will attempts to reduce contagion lead to even greater costs—such as generating additional contagion through other channels?

This section evaluates policy options for mitigating contagion. It begins with a discussion of measures that could be taken a priori to reduce contagion over the long term, focusing on the underlying structural trends that determine the channels for contagion. Then it shifts to situations when contagion risks are imminent and policies are aimed at providing immediate relief. This discussion shows that

some of the mechanisms aimed at mitigating contagion in the short term directly contradict recommendations to reduce vulnerability to contagion in the longer term. The end of the section extends this discussion to special considerations for the current situation in Europe. This entire section is not intended to provide a full cost-benefit analysis of the range of policies that may be considered to address contagion. Instead it focuses on evaluating policies simply based on the single goal of mitigating contagion. A full evaluation of the pros and cons of each of these policies—including issues such as the political feasibility and legality—are beyond the scope of this paper.

A. Policies to Mitigate Contagion over the Long Term

Are there any long-term structural policies that could be taken before a negative shock raises concerns about contagion in order to reduce a country's vulnerability in the future? In order to address this question, this section considers the four major channels for contagion discussed in Section IV (trade, banks, portfolio investors and wake-up calls) and assesses policies aimed at shaping these channels.

Trade

Section IV shows that an increase in a country's trade exposure significantly increases its vulnerability to extreme negative returns elsewhere in the world. Limiting trade might, therefore, be an option to reduce vulnerability to contagion in the future. A long literature, however, has documented the substantial benefits of trade, and it is unlikely that the potential reduction in future contagion through trade would outweigh these substantial benefits. Moreover, contagion through trade is usually more moderate, predictable, and gradual than other forms of contagion—as demand and exports generally adjust slowly to changes in relative prices and incomes. Policymakers therefore have more time to respond to contagion through trade using traditional macroeconomic tools to facilitate any necessary adjustment. For all of these reasons, limiting trade is not an attractive strategy for reducing a country's long-term vulnerability to contagion. Instead, a better alternative would be to diversify trade across countries and industries. This would help reduce vulnerability to a negative shock in one country that would affect demand in that country or relative prices in a specific industry.

Banks and Lending Institutions

One of the strongest results in Section IV is that countries with more leveraged banking systems are significantly more vulnerable to negative returns elsewhere in the world. Leverage even appears to be a more important determinant of country vulnerability to contagion than the total international exposure of a country's banking system. This suggests that limiting leverage and enforcing strict capital requirements should be considered as a policy to reduce contagion in the future. Simulations suggest that the impact of stricter leverage requirements on reducing the negative impact of shocks can be substantial (i.e., Greenwood et al. 2011). Granted, this policy would also have costs by restricting the availability of credit in an economy and the profitability of the banking system. These costs, however, should be weighed against the substantial benefits from reducing country vulnerability to contagion through banks.

Portfolio Investors

The results in Section IV on the relationship between international portfolio investment and contagion are nuanced. Countries with a larger gross exposure to international portfolio investment (or portfolio inflows) are not more prone to contagion. Instead, countries with greater portfolio investment liabilities are more vulnerable to contagion, while countries with greater portfolio assets are less vulnerable. This suggests that policies aimed at reducing contagion through portfolio investors should not seek to limit total portfolio investment through mechanisms such as capital controls. Instead, policies should support investment abroad and ensure that portfolio liabilities are balanced by portfolio assets. A country with larger portfolio investments abroad will have a pool of investments that could be liquidated and brought home to support the domestic economy after negative shocks.

The empirical results also suggest that the type of portfolio investment affects vulnerability to contagion. For example, a higher share of debt (relative to equity) in portfolio positions and flows increases country vulnerability. The automatic risk-sharing properties of equities may be more stabilizing than of debt, which still requires a fixed

payment stream after a negative shock. This suggests that policymakers seeking to reduce contagion should ensure that debt is not given advantageous treatment over equities (such as through lower taxes on interest than capital gains or stricter controls on foreign investment in equities). Countries may even consider moderate forms of support for foreign investment in equities over debt to account for the externalities to the country in the form of reduced contagion risks.

Wake-up Calls/Fundamentals Reassessment

Countries perceived to have weaker economic fundamentals tend to be more vulnerable to contagion. Section IV finds evidence of this effect when fundamentals are measured by credit ratings, but this paper does not analyze this channel in detail or evaluate which fundamentals are important.[33] Countries should already have incentives to improve economic fundamentals for reasons other than contagion, but concerns about wake-up calls in the future should provide an additional, powerful justification for policymakers to prioritize addressing fundamental economic weaknesses that may not appear urgent today. For example, reducing a country's high debt levels may not seem urgent if the debt is easily funded and borrowing costs are low. If a negative shock occurred elsewhere in the world, however, investors could suddenly reassess the country's solvency risks and be less willing to finance its debt. Risk of this type of contagion and reassessment in the future should motivate policymakers to place greater priority on strengthening macroeconomic fundamentals today.

In addition to reassessments of country fundamentals, another type of wake-up call that can cause contagion is reassessments of the policies of international financial institutions. There are numerous anecdotes of how policy announcements can cause a reassessment of financial risks in other countries. For example, the July 2011 announcement that Greece's bailout would involve PSI and a "voluntary" haircut by the private sector was a wake-up call that other euro area countries might need to take similar actions, leading to a sharp widening of spreads on Portuguese, Spanish and Italian debt. In order to reduce contagion from these types of announcements, policymakers should seek to clarify in advance the "rules of the game" and expected policies in various scenarios. For example, one issue which

would benefit from greater clarity is the process for sovereign debt restructuring. Given the uncertainty about when and how debt is restructured, any information on one country's process is interpreted as providing information on risks in other countries. Of course, for international institutions to effectively reduce contagion by providing clarity on these types of "rules of the game," any guidance must be credible and policymakers must stick to their preannounced strategies. This can be challenging, however, as policymakers may want flexibility to respond to uncertain scenarios in the future.

To conclude, this section discusses several long-term policies that would reduce risks from contagion in the future. Several policies that could have substantial benefits are: reducing leverage in the domestic banking system, diversifying trade across countries and industries, supporting portfolio investment abroad to balance portfolio liabilities, ensuring that portfolio investment and flows are not distorted towards debt (versus equity), improving macroeconomic fundamentals and clarifying in advance the expected policies of international financial institutions under different scenarios. It is worth noting that this list of policies to reduce a country's vulnerability to contagion does *not* include options that would slow the long-term trend towards increased integration through trade and financial flows. Even if integration could be slowed, it is not clear that the costs would outweigh the benefits of any reduction in contagion. Moreover, certain forms of integration—such as larger holdings of international investment assets—appear to provide an important buffer against contagion.

B. Policies to Mitigate Imminent Risks of Contagion

All of the policies discussed above are aimed at reducing a country's vulnerability to contagion in the future and many are structural policies that could take a substantial amount of time to implement and become effective. Of pressing concern to most policymakers—especially today—is how to mitigate a country's current vulnerability to contagion from a recent or imminent negative shock elsewhere in the world. If there is no time to implement these long-term reforms a priori, are there any policies that could mitigate contagion in the

midst of a crisis? In order to answer this question, this section follows the same framework as above and considers policies that target each of the four main channels for contagion.

Before discussing these policy options, however, it is useful to consider two rationales for these short-term actions to mitigate contagion. If these policies do not address a country's long-term structural vulnerability to contagion—what can they hope to accomplish? First, certain types of contagion may be transitory and even avoidable (such as contagion resulting from multiple equilibria, imperfect information, asset mispricing, liquidity spirals, bank runs, or other forms of panic). A policy that avoids a shift to the bad equilibrium could prevent contagion that would not otherwise occur. A second justification for policy intervention is if contagion generates externalities that are not incorporated in the actions of the policymakers, investors, or other actors. For example, the domestic costs of recapitalizing a bank may outweigh the domestic benefits, but if the bank collapse triggers a bank run in other countries, the cost of recapitalization may be substantially less than the global benefit. Similarly, individual traders and banks do not account for the impact of their behavior on others—such as on overall risk or liquidity. These types of externalities could justify policy action in order to internalize the global costs and benefits related to contagion. The remainder of this section uses these criteria to evaluate policies aimed at mitigating imminent risks caused by the four main channels of contagion.

Trade

If a country is concerned about an imminent impact on its trade due to contagion, there are limited attractive policy options. If demand for a country's exports is expected to fall due to a recession in a trading partner or adjustment in a trading partner's currency, this is a natural adjustment and any policies to avoid this adjustment (such as subsidizing exporters) could generate long-term costs with minimal benefit. The best strategy is to focus on reforms to boost the country's competitiveness—especially any policies that reduce the domestic costs of production so that exporters remain competitive.

Banks and Lending Institutions

There are more policy options, however, to address imminent risks of contagion through banks and lending institutions. In fact, many of the mechanisms by which banks can cause contagion (as discussed in detail in Section IV.A.) are exactly the mechanisms which justify short-term policy action. Empirical studies suggest that policies to support financial institutions can play a significant role in reducing contagion and supporting economies after negative shocks.[34] There are four broad approaches toward reducing contagion through banks: guaranteeing bank deposits, providing additional liquidity or loans to the banks, recapitalizing the banks and easing regulatory requirements. These policies could all have substantial costs—especially of increasing moral hazard and inefficient lending in the future. While a full evaluation of each of these policies—and the various forms which they could take—is beyond the scope of this paper, this section considers which strategies can be justified based on the criteria for short-term intervention laid out above, as well as if they are likely to be effective in accomplishing the primary goal of mitigating contagion.

Beginning with the justification for policy action, if a negative shock in one country risks causing a bank run in another country, short-term policy support that could prevent this shift to a bad equilibrium should be considered. This is an example of preventing a form of contagion that would not otherwise occur—and not just delaying a necessary adjustment. This is also an example when policy support that avoids a bank run in one country could generate significant externalities by preventing additional contagion through banks to other countries. The most direct policy response to avoid contagion through bank runs is to provide some sort of deposit insurance, although other forms of financial support that alleviate concerns about bank funding (such as direct capital injections and loans) might also succeed. Of course, any of these policies must also involve careful supervision of the banks receiving the support and consideration of the fiscal liabilities undertaken to provide deposit insurance or any additional funding (an issue discussed in more detail below).

Policies to address other forms of banking contagion require more careful evaluation than in the case of bank runs. For example,

contagion may occur through banks reducing domestic lending in response to a negative shock in another country that reduces the value of the bank's international assets or its access to international funding. This reduction in lending could slow domestic growth, and if the domestic economy was already vulnerable, aggravate a recession and/or spark a painful domestic deleveraging. Policy measures—such as direct bank recapitalization, providing additional liquidity or loans, or easing regulatory requirements—could mitigate these negative effects. Financial support that also requires banks to use any funding to increase lending (such as the Bank of England "funding for lending" program) could increase the effectiveness of these policies. These types of policies, however, are less likely to avoid a sudden shift to a bad equilibrium and may only ease a necessary adjustment in bank balance sheets. Moreover, the fiscal cost of this type of support is likely to be substantially greater than policies such as deposit insurance (especially if the insurance avoids a shift to a bad equilibrium). If this fiscal cost raises concerns about the solvency of any government providing the support, this could risk additional contagion through a reassessment of country solvency. Any policies that generated this additional form of contagion through "wake-up calls" should be avoided.

Finally, it is worth highlighting that one proposal to reduce contagion through banks—easing regulatory requirements—would actually increase a country's vulnerability to contagion in the future (as discussed in Section V.A). There are a variety of ways in which regulatory requirements could be eased to reduce imminent contagion risks through banks, such as: reducing capitalization requirements, expanding the types of assets that qualify towards liquidity buffers, or easing assumptions in stress tests. These types of regulatory changes may be faster and politically easier to implement than other policies to reduce bank contagion. They may also appear to be less expensive as no immediate funding outlay is required—thereby avoiding additional contagion through reassessments of fiscal solvency. Given that financial shocks that generate contagion are rarely one-off events and financial crises often involve multiple phases, however, any short-term benefit from easing banking regulation may generate

substantially greater costs in the future. Therefore, this policy should generally be avoided.

Portfolio Investors

Policies to mitigate imminent contagion through portfolio investors should be evaluated based on similar criteria as for contagion through banks. Four potential policies are: capital controls, purchasing portfolio assets directly or indirectly (such as lending funds to institutions that will purchase assets), guaranteeing assets and ensuring that markets function (such as through swaps). A key issue to consider when evaluating each of these policies is what causes portfolio investors to suddenly liquidate investments or change their behavior in other ways. If the change results from a temporary shock that will normalize in the future, or from a shift to a bad equilibrium that could be completely avoided, policy action is more easily justified. A clear example of this type of situation is if markets freeze up and investors attempt to sell at any price due to concerns about their ability to complete transactions in the future. In these types of situations, policies to support the normal functioning and price discovery of markets should be prioritized. If, on the other hand, actions by portfolio investors and the corresponding contagion are caused by a permanent and informed reassessment of the value of their investments (such as a rapid liquidation of sovereign bonds based on concerns that the debt will be written down), policies to reduce contagion are harder to justify.

If a legitimate justification can be made to adopt policies to reduce contagion through portfolio investors, it is still necessary to consider the costs of the policy. If the policy creates additional financial liabilities that raise concerns about a country's solvency, this could generate additional contagion through a reassessment of macroeconomic risks. Policies to purchase or guarantee assets are more likely to entail a substantial cost—especially if any contagion is not short-lived or the financing is used to prop up markets that will eventually require a price adjustment. Capital controls might appear to be the lowest cost option to slow contagion through portfolio investors, but they can be difficult to enforce and lead to substantial distortions as investors evade the controls, especially in countries with highly

developed and integrated financial markets.[35] Moreover, if capital controls make investors less willing to "retrench" by bringing funds home after shocks, controls could reduce this important buffer against contagion. Therefore, the most attractive policy for reducing contagion through portfolio investors appears to be temporary policies aimed at ensuring the functioning of asset markets (such as through swap lines), especially if structured so as to minimize any fiscal liabilities.

Finally, part of a strategy to reduce contagion through portfolio investors may be to delay and buy time before any necessary adjustment takes place. At first glance, this strategy is difficult to justify. It does not fit the criteria of preventing an unnecessary adjustment in asset prices. Artificially supporting markets could also involve a substantial cost as private sector investors use the opportunity to liquidate positions, while sovereigns or banks assume additional liabilities that will need to be written down in the future. This could make the long-term resolution of a crisis even more challenging. Moreover, if a larger share of debt is assumed by senior creditors, a larger haircut could eventually be required, complicating restructuring negotiations and even generating more panicked selling at an earlier stage as investors take this into account. On the other hand, anecdotal evidence suggests that delaying an inevitable adjustment in debt or equity markets can substantially reduce contagion.[36] By giving investors time to adjust their portfolios and liquidate positions in the crisis country, they are less likely to be forced to quickly sell assets in others countries. Of course, this policy comes at a substantial cost; another entity—such as the sovereign or banking system—will need to absorb greater losses. This could generate additional contagion through banking channels—which may be even greater than the initial reduction in contagion provided by the delay.

Wake-up Calls/Fundamentals Reassessment

Even if a negative shock to one country has already generated contagion through a wake-up call and reassessment of another country's macroeconomic fundamentals, it is not too late to adopt short-term policies to mitigate contagion through this channel. Macroeconomic reforms to strengthen fundamentals often take a substantial amount

of time, but credible announcements of concrete plans to enact these reforms, and immediate steps to show the country's commitment, can be important. For example, if a wake-up call is focused on a country's debt sustainability, a credible program to reduce spending and increase revenues will be critically important to reduce contagion through this channel. In order to be effective, the country must also strictly adhere to any programs—or else risk generating additional negative reassessments.

A key component of any program aimed at mitigating contagion by improving investor assessment of a country's fundamentals will be policies to support long-term economic growth. Exactly which policies make sense will depend on the country's situation, but one policy which should be considered is monetary policy. In some cases, monetary easing could be a powerful tool to raise growth and/or to stabilize a financial system so that investors positively reassess a country's risks and therefore reduce contagion effects. This is particularly true if monetary easing avoids a bad equilibrium—such as a "diabolic loop" from a sharp contraction in liquidity. This could also be true if an economy must undergo an inevitable and painful adjustment—such as a sharp reduction in exports due to contagion through trade—in which case monetary easing might support the domestic economy during this transition. Any such use of monetary policy, however, would need to be weighed against the costs and other considerations in the standard framework for evaluating monetary policy decisions.

To conclude, this section discusses policies to address imminent concerns about contagion. Although it does not provide a full cost-benefit analysis of all possible policies, it does present some important considerations which help establish a hierarchy of policies to address different channels of contagion. If the greatest concern is contagion causing bank runs, some type of deposit insurance (albeit accompanied by appropriate regulation and supervision) should be prioritized in order to avoid a shift to a negative equilibrium. If contagion is causing a contraction in bank lending, policies to strengthen the financial system need to be evaluated based on whether they will prevent an excessive contraction in lending or simply prolong a needed adjustment. If contagion is occurring through portfolio

investors, priority should be given to policies that ensure market functioning and accurate price discovery. Policies supporting demand in these markets—through guarantees, asset purchases or loans—might be justified to avoid unnecessary overreactions in prices and markets, but it is important to ensure they are not just used to avoid legitimate price adjustments. Credible policy packages to directly address key macroeconomic vulnerabilities should be prioritized and adhered to in order to reverse any negative wake-up calls.

A key consideration for any of these policies is their fiscal impact; actions that increase fiscal liabilities in a country with solvency concerns should be avoided as they risk generating additional contagion through a fundamentals reassessment. Two other policies that should be avoided are capital controls and easing banking regulations. Even though these policies might reduce contagion in the short term, they would increase a country's future vulnerability to contagion. This is of particular concern during crises, which can have various phases so that contagion risks persist for an extended period.

C. A Closer Look at Contagion in the Euro Area

Although the primary goal of this paper is to analyze contagion around the world, the analysis and policy implications also apply to the current challenges in the euro area. This section assimilates the key results from throughout the paper to show that contagion from current events in Europe should come as no surprise and follows the same channels documented for the rest of the world. An evaluation of policy responses to mitigate contagion in the euro area, however, also involves several additional considerations resulting from the unique structure of the euro area.

Section III showed that interdependence and contagion have increased steadily since 1980 for the full sample of countries, and especially for countries within the euro area. This trend is particularly striking in measures of interdependence. The euro area has experienced a substantial increase in cross-market correlations since 1980, so that these markets now show very high degrees of comovement in all states of the world. This is not surprising given the trends documented in Chart 5. Many factors linking countries—such integration through

trade, banks and portfolio investment—have increased more rapidly within the euro area than in other advanced economies. This rapid increase in integration within the euro area is also not surprising as it naturally follows from the requirements to join the common European market and adopt the common currency—such as requirements for removing barriers to the cross-border movement of goods and capital, regulatory harmonization and the freedom of establishment.

Not only should high levels of interdependence and contagion within the euro area be expected, but contagion from the euro area to other countries should also come as no surprise. If the euro area is treated as a single country, it would have the second largest economy in the world, the largest share of world trade and the largest international banking exposures. It is highly integrated with countries around the world through trade, banking flows and portfolio investment—three of the primary channels through which shocks are transmitted internationally. A number of studies have analyzed the expected spillovers through these channels from moderate changes to growth in the euro area (i.e., IMF 2011). These spillover effects resulting from interdependence in normal times can be challenging enough for other countries, even without a crisis or extreme negative event.

It is contagion from these extreme negative events, however, which presents the greatest challenges. Several papers have already attempted to measure contagion from the recent crisis in the euro area using several different definitions of contagion and measurement strategies.[37] The evidence suggests that contagion within the euro area is occurring through the standard channels discussed throughout this paper. For example, several papers highlight the role of euro area banks in transmitting the crisis across borders, others focus on portfolio investors, and others highlight the wake-up call effects from new information in one country on others. Column 4 of Table 5 reports results that support this conclusion; the regressions testing the channels of contagion find similar results for the euro area as the full sample. There is no evidence that contagion within the euro area is occurring through any new mechanisms, or that the level of contagion within the euro area is greater than would be expected given the high degree of trade and financial integration in the region.

Policy proposals to mitigate contagion in the euro area should also incorporate the same considerations as discussed above for contagion anywhere in the world—both in terms of long-term structural reforms to reduce contagion risks a priori as well as short-term policies to mitigate imminent risks. Just as for contagion in other regions, it is critically important to assess whether any policy response will prevent a bad equilibrium and thereby avoid a form of contagion that would not otherwise occur (such as bank runs or markets that stop functioning) versus a policy response that would simply delay an inevitable adjustment resulting from interdependence between countries. As the key considerations for evaluating different policies to mitigate contagion have been thoroughly discussed in the last two sections, I will not repeat the discussion here.

There are, however, several additional considerations unique to the euro area that are important when evaluating responses to contagion in this region. First, each country lacks a national currency and independent central bank. Currency depreciations and monetary easing can provide key mechanisms by which countries adjust to negative shocks. Since individual euro area countries do not have these adjustment mechanisms, they may need to undergo more prolonged and painful internal adjustments to shocks that originate elsewhere. This makes it more important for euro area countries concerned about contagion to support flexible economies that can more easily adjust to external shocks. In extreme circumstances, the more limited tools for adjustment in the euro area may justify additional policy support through other mechanisms to avoid slipping into a negative equilibrium. On a more positive note, the lack of independent currencies within the euro area will prevent sudden currency devaluations that cause contagion through trade. Even if relative prices adjust over time through internal devaluations, trading competitors should have more time to adjust to this slow-moving contagion.

A second consideration for the euro area is the relatively large international exposures of the banks backed by sovereign governments which cannot provide the traditional "lender of last resort" function available in most countries. This aggravates the risk of contagion through banks—especially through bank runs. Since contagion

through bank runs clearly justifies policy action (as discussed above), euro area officials should prioritize preventing this avoidable form of contagion. It is critically important to restore confidence that money deposited in banks will be accessible in the future. The best alternative appears to be well-designed deposit insurance combined with appropriate banking regulations and supervision. This is likely to involve support from an entity other than the sovereign, one with large enough financial resources that the financial backing is credible and sufficient to restore confidence.

A third issue that merits special consideration for the euro area is the heightened risk that policies and information in one country generate contagion through wake-up calls/reassessments about others. Although there are important differences between euro area countries, they also share a number of macroeconomic and institutional similarities—including shared governance over a number of policies. Any new information about the actions and treatment of one country will provide information about prospects for other euro area countries. These externalities should be incorporated when evaluating various policy responses to contagion. For example, the treatment of different bondholders in Ireland's bank restructuring was closely watched to provide information about how bondholders would be treated in other countries. These types of externalities should be considered when evaluating any policy responses to mitigate contagion, but they are especially important in the euro area where the shared governance and institutional similarities aggravate the risks of contagion through wake-up calls.

A final (and closely related) consideration is the current structure for sharing certain liabilities through institutions such as the ECB, ESM and EFSF. In other regions, financial support to help mitigate contagion generally comes from sources (such as the IMF) that have sufficiently large resources and widely shared liabilities that any increase in financial support does not increase solvency risks for individual nations. In the case of the euro area, however, much of the financial support is being provided (implicitly or explicitly) from other euro area nations that are vulnerable to contagion through wake-up calls about their own fiscal situation. For example, if Spain or Italy requires a large

increase in financial support to prevent contagion and this support is provided by the ESM or EFSF, this could substantially increase the fiscal liabilities of countries such as France. This could generate contagion to France through a negative reassessment of its fiscal solvency. There could be further feedback effects on the credit ratings and borrowing costs of the institutions intended to provide financial support. As a result, any financial support provided by euro area nations and their joint institutions must be carefully evaluated based not only on the benefit to the country receiving the support and any corresponding reduction in contagion, but also on the additional externalities arising from the fiscal liabilities and corresponding risks of contagion through wake-up calls to other countries in the future.

V. Conclusions

Global integration has increased dramatically since 1980 when measured by countries' international exposures through trade, banking and portfolio investment. Not surprisingly, this increased integration has caused countries' financial markets to move together more closely during good times and bad. This increased interdependence causes extreme negative events in one country to quickly affect others. These extreme negative events, and their joint coincidence across countries, have increased over time, creating substantial challenges for countries affected by contagion.

But exactly how does this contagion occur? This paper analyzes extreme negative stock returns to show that contagion occurs through several channels—including trade, banks, portfolio investors and wake-up calls/fundamentals reassessments. Countries with more leveraged banking systems, greater trade exposure and weaker macroeconomic fundamentals are significantly more vulnerable to contagion. A country's total international exposure through portfolio investment does not to increase country vulnerability, but countries with greater international portfolio liabilities are more vulnerable, while countries with greater international portfolio assets are less vulnerable.

These results highlight that a country's financial integration with the rest of the world does not automatically increase contagion risks. Instead, holding portfolio assets in other countries can reduce vulnerability, most

likely by providing resources that can be "retrenched" when the domestic economy is under pressure. International bank exposure is less important than domestic bank leverage in determining country vulnerability. The type of international investment exposure is also important. A larger share of portfolio inflows or investment in the form of equity (versus debt) reduces the probability of contagion—undoubtedly as equity has more automatic risk-sharing properties. Therefore, although increased financial integration over time has increased interdependence and contagion between countries, certain forms of financial integration can also help reduce contagion risks.

Since contagion can occur through so many channels, can anything be done to mitigate the risks? For a foresighted policymaker, the best approach to minimizing contagion risks is through fundamental structural reforms before a negative shock occurs and contagion is imminent. The empirical analysis suggests that a top priority should be reducing leverage in banking systems. Countries should also support portfolio investors' efforts to diversify and invest abroad—especially to balance any international portfolio liabilities. Policies that give preferential treatment to riskier debt flows over equity should be avoided. Countries should also adopt policies to strengthen economic fundamentals; although this is true in any case, the risk of contagion in the future should provide an extra incentive to adopt important reforms sooner rather than later. Finally, international institutions should consider clearly specifying the rules of the game for issues such as debt restructuring in order to reduce uncertainty and wake-up calls that can cause contagion.

Although the policies recommended above could significantly reduce contagion in the future, most would take time to implement and become effective. The most pressing concern for policymakers today is reducing the imminent risk of contagion. In this case, policymakers need to carefully evaluate if a proposal could effectively stop contagion—or have the unintentional effect of creating additional contagion through other channels. Policymakers should consider exactly how a specific policy would work. For example, would it completely prevent a shift to a bad equilibrium and avoid a form of contagion? Does it account for an externality caused by contagion? If

the answer to either of these questions is yes, then the policy should be seriously considered (in the broader context of other costs and benefits). On the other hand, policies are much harder to justify if they simply delay a necessary adjustment to a negative shock elsewhere that will need to occur eventually in this integrated world.

Although this paper does not fully evaluate the pros, cons and political or legal feasibility of different responses to imminent contagion risks, the analysis does provide guidance on policies that should be prioritized and avoided in response to different forms of contagion. For example, to address contagion through banks, policies to prevent bank runs through mechanisms such as deposit insurance (combined with appropriate regulation) should be prioritized over other forms of financial support that simply provide liquidity for banks. To address contagion through portfolio investors, policies to ensure the functioning of financial markets should be prioritized over other measures to support the demand for securities (such as through direct purchases, subsidized loans, or guarantees). To address concerns about macroeconomic vulnerabilities, credible plans should quickly be announced and enacted. These plans could involve monetary easing—but only under certain criteria. Policies that should be avoided include capital controls, easing bank regulations, and any actions that increase fiscal liabilities for countries with high debt levels, as any of these policies could significantly increase contagion risks in the future.

Finally, this analysis has a number of direct implications for current challenges in the euro area. Integration through trade, banks and portfolio investment has proceeded even more quickly in this region than in the rest of the world. This has yielded substantial benefits for Europe and naturally increased the interdependence between euro area economies in all states of the world. This has also increased vulnerabilities to contagion after negative events in other countries in the region. There is no evidence, however, that contagion in the euro area occurs through any different channels or than would be expected given the high degree of interdependence in the region.

This does not mean that the euro area is powerless to mitigate contagion without sacrificing the integration that was a key goal of the common market and euro. Instead, European policymakers need to consider their unique institutional arrangements when evaluating how best to respond to contagion. Priority should be given to avoiding bank runs (most likely through some type of well-designed deposit insurance), given the large international bank exposures and lack of domestic institutions to act as a lender-of-last resort. Priority should also be given to increasing the flexibility of economies to adjust to contagion in the absence of independent central banks and sovereign currencies. Policymakers need to pay careful attention to the externalities of various actions on other countries, especially given their many institutional similarities and shared governance. Of primary importance, countries should avoid adopting reforms that increase fiscal liabilities for individual countries and generate additional contagion through new wake-up calls about solvency. Finally, when the economic situation stabilizes, top priority should be placed on enacting the structural reforms (including limits to bank leverage) that will reduce vulnerability to contagion in the future while still maintaining the benefits of integration.

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Appendix A
Country Groups for Empirical Analysis

Euro Area	Other Advanced Economies	Rest of Sample
Austria	Australia	Argentina
Belgium	Canada	Brazil
Finland	Czech Republic	Chile
France	Denmark	China
Germany	Hong Kong	Colombia
Greece	Israel	Hungary
Ireland	Japan	India
Italy	Korea	Indonesia
Luxembourg	New Zealand	Malaysia
Netherlands	Norway	Mexico
Portugal	Singapore	Pakistan
Spain	Sweden	Peru
	Switzerland	Philippines
	Taiwan	Poland
	United Kingdom	Russia
	United States	Saudi Arabia
		South Africa
		Thailand
		Turkey
		Venezuela

Notes: Country groupings based on IMF classifications as of April 2012. Several current members of the euro area are not included in this base sample due to data availability.

Endnotes

[1]There is, however, minimal discussion of contagion to low income countries. This does not imply that contagion to these countries is unimportant, especially given their more limited ability to respond to negative shocks. Data for these countries is more limited so they drop from the empirical analysis. Most contagion to lower income economies is also generally more predictable, more easily addressed through standard policies and generates fewer spillovers to the rest of the world. IMF (2011) discusses contagion from the euro area to low income countries.

[2]There are several earlier examples of use of the term financial contagion in the academic literature, such as King and Wadhwani (1990), Allen and Gale (2000) and the literature on domestic banking collapses.

[3]For more information on different definitions of contagion, see Claessens and Forbes (2001), Claessens, Dornbusch, and Park (2001), Forbes and Rigobon (2002), Karolyi (2003) and Dungey et al. (2010).

[4]In a paper ahead of its time, de Bandt and Hartmann (2000) discuss how a shock to one country can cause contagion and systemic risks through bank failures, financial markets and payment and settlement risks.

[5]Different papers focus on different global shocks, such as to international banking, liquidity, risk aversion, demand and counterparty risk. For examples, see Eichengreen et al. (2009), Chudik and Fratzscher (2011), Forbes and Warnock (2012), Fratzscher (2012) and Calomiris et al. (2010).

[6]More detailed reviews of the literature measuring contagion include: Claessens et al. (2001), Forbes and Rigobon (2001) and Dungey et al. (2010).

[7]See Eichengreen, Rose and Wyplosz (1996), De Gregorio and Valdés (2001) and Forbes (2002).

[8]For early examples of this approach, see King and Wadhwani (1990) and Bordo and Murshid (2001).

[9]For different approaches to resolving these issues, see Forbes and Rigobon (2002), Boyer, Gibson, and Loretan (1997) and Boyer, Kumagai and Yuan (2006).

[10]Examples of this approach are: Favero and Giavazzi (2002) and Constancio (2012).

[11]For examples of this literature, see Hamao et al. (1990), Bekaert et al. (2005), Dungey et al. (2010) and Bekaert et al. (2011).

[12]Morgenstern (1959) appears to be the first example of this approach—although he does not use the term contagion. More recent examples of papers using extreme value theory are: Bae et al. (2003), Longin and Solnik (2001), Hartman et al. (2004), Boyer et al. (2006) and Boyson et al. (2010). Papers analyzing jumps include: Ait-Sahalia, Cacho-Diaz and Laeven (2010) and Pukthuanthong and Roll (2012).

[13]For example, JP Morgan (2004) writes: "there has been a structural decline of contagion across emerging market credits as evidenced by the lack of volatility following Argentina's 2001 default."

[14]Noteworthy papers analyzing whether contagion has changed over time include: Bekaert and Harvey (1995), Karolyi (2003), Bordo and Murshid (2001), Goetzmann et al. (2005), Quinn and Voth (2008) and Bekaert et al. (2011). There is some disagreement across papers on whether contagion has increased over time.

[15]Weekly stock returns are calculated based on the Friday closing price for each index as retrieved from Global Financial Data Inc., accessed June 2012. The broadest index available is used for each country. Each country must have return data for the previous 52 weeks to calculate a correlation. Country groups are based on their classification by the IMF as of April 2012. Countries remain in their group for the full period.

[16]In the analysis below, I focus on local currency returns in order to exclude any increase in correlations resulting purely from similar exchange rate movements relative to the U.S. dollar. Cross-market correlations based on dollar returns tend to be slightly higher than those based on local currency returns due to this exchange rate effect. All of the key trends reported below, however, are unchanged when calculations are based on dollar returns.

[17]Some measures of global shocks may capture contagion resulting from the transmission of a negative event in one country to global variables. Data measuring the global shocks are from Global Financial Data Inc., accessed June 2012. Commodity prices are measured as the change in *The Economist* All-Commodity Dollar Index. U.S. interest rates are measured as the change in the 10-year constant-maturity government bond. Following the stock market data, all weekly prices are measured as the Friday market close. I do not include the VXO in the reported results as it is only available since 1986 and shortens the time series. The main results, however, are unchanged.

[18]This estimation strategy assumes that $F(z) = 1 - \exp[-\exp(z)]$. An alternative is to use a logit or probit model but these assume that the distribution of $F(\bullet)$ is logistic or normal, respectively, and therefore symmetric around zero.

[19]I have also included a control for changes in global risk as measured by the VXO. This has no effect on the key results but shrinks the sample size significantly because it is only available starting in 1986.

[20]Since this is a nonlinear probability function, interpreting the magnitude of the coefficients is not straightforward and requires calculating exponentiated coefficients (which are hazard ratios for the cloglog estimator). These ratios are the marginal effects in multiplicative form after controlling for differences in the baseline odds of experiencing an extreme negative return for each country. The exponentiated coefficients are similar for the different groups.

[21]For overviews of various channels of contagion and different ways to categorize them, see Claessens et al. (2001), Karolyi (2003), Forbes (2004), Allen et al. (2009) and Didier et al. (2010).

[22]For a theoretical model, see Gerlach and Smets (1995). For empirical evidence, see: Glick and Rose (1999), Forbes (2002, 2004) and Claessens et al. (2011). For evidence on the role of global supply chains, see Burstein et al. (2008).

[23]This section focuses on median values for each group of countries in order to reduce the effect of several extreme outliers. Mean values (when reported) are calculated after dropping the largest and smallest two values in each year.

[24]An extensive literature models or tests different mechanisms of contagion through banks. Allen and Gale (2000) provides the first model and Peek and Rosengreen (1997) the first empirical evidence. Other influential papers include: Van Rijckeghem and Weder (2001), Cetorelli and Goldberg (2010, 2012) and Shin (2012). An excellent discussion of mechanisms linking banks, crises and contagion is Allen et al. (2009).

[25]Portfolio investors include a range of investors, such as hedge funds, mutual funds, pension funds, individuals and some sovereign wealth funds. This includes their investments in equities and debt (government and corporate). It does not include investments classified as foreign direct investment (FDI)—when the investor owns 10 percent or more of the entity. Including FDI in the definition of portfolio investment does not change the paper's main results.

[26]For excellent surveys of this literature, see Gelos (2011) and de Bandt and Hartmann (2000). Important papers in this literature include: King and Wadhwani (1990), Kodres and Pritsker (2002) and Kyle and Xiong (2001).

[27]For evidence, see Fratzscher (2009) and Raddatz and Schmukler (2012).

[28]See Lane and Milesi-Ferretti (2007), Gourinchas and Rey (2007), Forbes and Warnock (2012) and Gourinchas (2012). This point also applies to contagion through banks, as highlighted in Shin (2012).

[29]Goldstein (1998) coined this term to capture the sudden awareness of risks in Asian financial systems during the 1997-98 crisis. For evidence of the role of wake-up calls and macroeconomic variables in transmitting crises, see Forbes (2004), Fratzscher (2009, 2012), Didier et al. (2010) and Bekaert et al. (2011).

[30]See de Bandt and Hartmann (2000) for a more detailed discussion of this risk and review of literature.

[31]Credit ratings are constructed as the average rating on the country's sovereign foreign-currency bonds as reported by S&P, Moodys and Fitch. All available ratings are incorporated in the average at each week. The cutoff for investment grade is BBB- for S&P and Fitch and Baa3 for Moodys. "Substantial Risk" is below B- for S&P and Fitch and below B3 for Moodys.

[32]The only exceptions are coefficients on credit ratings for the euro area; these estimates fluctuate in sign and significance across specifications due to the limited observations of euro area countries with low credit ratings.

[33]Bekaert et al. (2011) finds that a country's current account balance and fiscal position are the macroeconomic fundamentals most important in determining contagion risks.

[34]For example, see IMF (2011), Ehrmann et al. (2009), Bekaert et al. (2011) and Greenwood et al. (2011).

[35]See Forbes (2007) for a detailed discussion of the microeconomic costs and challenges of capital controls.

[36]Didier et al. (2008) argue that there was less contagion from the 2001 crises in Argentina and Turkey (as compared to the 2007-08 Asian and Russian crises), because investors had time to rebalance their portfolios.

[37]See Constancio (2012), De Santis (2012), and Caceres et al. (2010) for evidence of contagion from the euro crisis. Aizenman et al. (2012) finds that there has been little contagion from Europe to other countries.

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