CHAPTER 3

DANCING TOGETHER? SPILLOVERS, COMMON SHOCKS, AND THE ROLE OF FINANCIAL AND TRADE LINKAGES

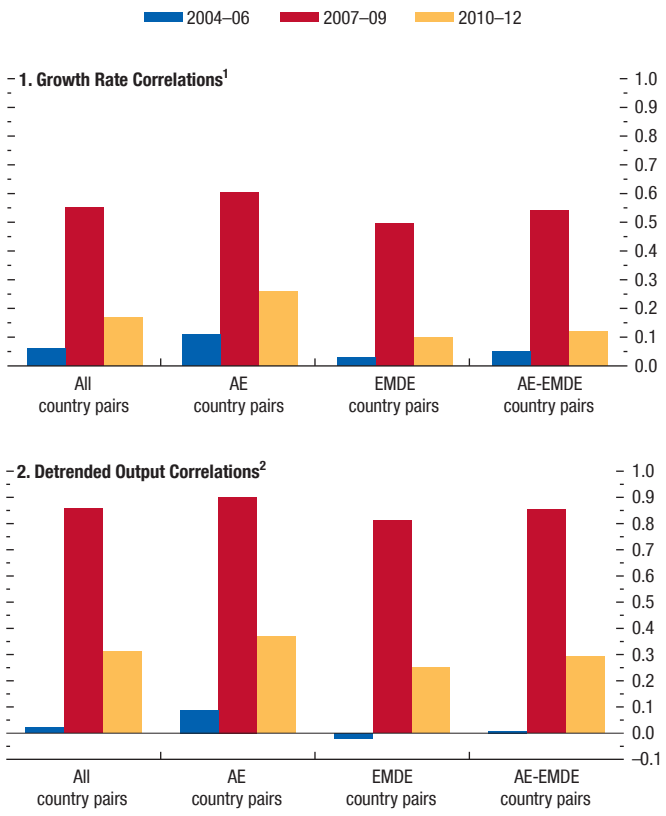
The world's economies moved much more in lockstep during the peak of the global financial crisis than at any other time in recent decades. Correlations of GDP growth rates, which had been modest in the years before the crisis, rose dramatically during 2007–09 (Figure 3.1, panel 1).[1] The increased comovement was not confined to the advanced economies, where the global financial crisis was centered, but was observed across all geographic regions and among advanced, emerging market, and developing economies.

Since 2010, however, correlations have fallen back sharply (Figure 3.1, yellow bars). The move from a period of globally synchronized collapse and recovery to one in which the world's economies move more independently of each other—which recent issues of the *World Economic Outlook* (WEO) call a "multispeed global economy"—can thus be considered a return to relative normalcy.

Could output comovements rise sharply again? Answering this question requires shedding light on the factors that drove these sharp changes in correlations. One possibility is that greater comovements in output were induced by large common shocks simultaneously affecting many countries—such as a sudden increase in financial uncertainty or a wake-up call that triggered a change in investors' perceptions of the world.[2] A second possibility is that output spillovers—defined as the transmission of country-specific shocks to output in other countries—became more important due to the strengthening of financial and trade linkages. A third possibility is that the nature of shocks changed. In particular, shocks to countries' financial sectors, such as banking crises and liquidity freezes, were more prevalent during

Figure 3.1. The Evolution of Output Comovements, 2004–12

Output comovements, whether measured by growth correlations or detrended output correlations, rose sharply at the peak of the global financial crisis in 2007–09. But they declined sharply in recent years.



Sources: Haver Analytics; IMF, *World Economic Outlook*; Organization For Economic Cooperation and Development; and IMF staff calculations.
Note: Sample includes 34 advanced economies and 29 emerging market and developing economies. AE = advanced economy country pairs; EMDE = emerging market and developing economy country pairs; AE-EMDE = advanced economy and emerging market and developing economy country pairs. See Appendix 3.1 for country groupings.
[1]Simple average of pairwise correlations of quarterly GDP growth rates.
[2]Simple average of pairwise correlations of moving average detrended output.

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[1]Correlations of detrended GDP show a similarly sharp increase (Figure 3.1, panel 2, blue and red bars).

[2]See, for example, Goldstein (1998); Forbes (2004); Fratzscher (2009, 2012); Didier, Mauro, and Schmukler (2008); Acharya and Schnabl (2010); and Bekaert and others (2011).

the global financial crisis. These financial shocks might be transmitted to other countries in a more virulent manner during crises than real shocks, which are more prevalent during normal times. Examining the roles played by these factors is of more than academic interest, because policymakers need to know the extent to which they will have to deal with such sudden increases in output comovements in years to come.

This chapter explores how output comovements have evolved in recent years and how they are influenced by various shocks and linkages. Using quarterly data from 1978 to 2012 for 63 economies, it examines what types of events drive large spikes in comovements and the role played by financial and trade linkages in transmitting shocks. It assesses the possible output spillovers from the potential shocks that most concern policymakers, including *policy shocks*, such as unexpected monetary or fiscal tightening; *financial shocks*, such as a systemic banking crisis or renewed financial turmoil; and *growth surprises* (which could be driven by either real or financial shocks) in advanced economies or in large emerging markets. In this regard, this chapter complements the existing work the IMF has done on spillovers, including the IMF spillover reports (IMF, various years). Finally, it discusses the implications for the outlook and for policy and financial regulation.

The chapter's main findings are as follows:

- Following an unprecedented increase in output synchronization between late 2008 and early 2009, the world's economies have once again decoupled. Global output comovements have fallen back to normal levels in the past two years, despite the turmoil in Europe.
- Spikes in regional and global output correlations occurred primarily during financial crises, such as those in Latin America in the 1980s and in Asia in the 1990s, but when a crisis occurred in an economy such as the United States—which is both large and a global financial hub—the effects on global output synchronization were disproportionately large. In this context, preserving financial stability is key to preventing synchronized output collapses in the future, but progress on global financial reform has been incomplete, and the world economy remains susceptible to risks from financial institutions that are too big to fail.
- During the global financial crisis, financial linkages contributed to the spread of these financial stresses across borders, but other factors—such as global panic, increased uncertainty, and wake-up calls that changed investors' perceptions—acted as a common shock and played a much larger role in increasing output synchronization.
- The effect of financial linkages on output comovements during normal times is the opposite of the effect during crises. During tranquil periods, increased financial linkages induce greater output divergence since capital is better able to move to where it is most productive.[3] The key, then, is to preserve the benefits of increased financial integration while minimizing the attendant risks through better prudential oversight, including better policy coordination and collaboration.
- The fact that comovements are now lower does not mean that policymakers should not worry about the effects of external shocks, such as growth slowdowns or monetary and fiscal tightening in major economies. But policymakers need not worry equally about all potential shocks. First, size matters: the United States still matters most from a global perspective, although the euro area, China, and Japan are important as sources of spillovers within their respective regions.[4] Second, the size of spillovers depends on the nature of the shock and the strength of linkages with the economy where the shock originates. For example, while a fiscal tightening in the United States or the euro area will most affect countries that have stronger trade linkages with these economies, the effect of interest rate normalization in the United States primarily affects countries that peg to the U.S. dollar.

The following section provides a conceptual framework for thinking about output comovements and describes their evolution in recent years. The next section examines the factors driving large spikes in output comovements. The chapter then looks more closely at how various shocks in major economies affect output elsewhere and ends with some implications for the outlook.

[3]These results were first established by Kalemli-Ozcan, Papaioannou, and Peydro (2013) and Kalemli-Ozcan, Papaioannou, and Perri (2013).

[4]These findings are consistent with the 2011 IMF spillover report, which uses a different approach and also finds significant spillovers from shocks originating from the United States but only modest spillovers from shocks elsewhere. The 2013 spillover report finds much larger effects from policies enacted in major economies over the previous year, because it posits that these policies helped avert major crises in the United States and Europe.

Output Comovements: Conceptual Framework and Stylized Facts

Conceptual Framework

How should we think about comovement and spillovers? In general, growth in each country can be thought of as being driven by common shocks that affect many countries simultaneously, shocks specific to the home country, and shocks specific to foreign countries that spill over and affect growth in the home country. Shocks in a foreign country can spill over to the home country in many ways, including through conventional linkages such as finance and trade. The nature of the shock, however, can change the manner in which shocks are transmitted or the importance of linkages in transmitting the shock—for example, financial linkages might transmit shocks to a country's financial sector in a different manner than shocks to the real sector.[5]

Under this framework, the existence of common shocks and of cross-border spillover effects from country-specific shocks implies correlated growth rates across countries. There are three ways in which these correlations can change. First, common shocks can become larger or more frequent relative to idiosyncratic shocks, increasing correlations by driving economies up and down together. Second, the linkages that bind countries together can change.[6] Finally, the kinds of shocks that buffet economies can change, from those that have mostly a domestic impact to those that have bigger cross-border effects.

Following this framework, the chapter assesses the factors behind larges spikes in comovements and the cross-border effects of observable shocks emanating from the world's major economies. The first part of the analysis assesses whether spikes in global comovements correspond to well-known historical events that hit many countries at the same time and whether shocks characterizing these events are transmitted through identifiable channels, such as financial and trade linkages. An important caveat in this analysis is that it is not possible to definitively distinguish between comovements attributable to common shocks and spillovers resulting from country-specific shocks transmitted quickly through other channels that are more difficult to quantify (such as global panic or self-fulfilling expectations): in the data these two types of comovement are observationally equivalent. Indeed, even for an event as thoroughly analyzed as the global financial crisis there is no consensus on whether it should be characterized as a global shock or a U.S. shock that spilled over to other countries.[7]

The second part of the analysis examines the cross-border effect of observable shocks emanating from the world's major economies and the channels through which these shocks are transmitted. The focus here is on shocks that reflect events and policies in major economies that are unlikely to be related to other factors influencing foreign economic activity in the short term.[8]

Stylized Facts

We begin by establishing the stylized facts on output comovements in recent years. The sample comprises 34 advanced economies and 29 emerging market and developing economies for which quarterly real GDP data are available. The regional and income groupings follow those in the WEO Statistical Appendix. (The countries included in this sample are listed in Appendix 3.1.)

There are various ways to measure comovements. Perhaps the simplest and most common measure of output comovements is the correlation of real GDP growth. Alternatively, one can look at correlations in detrended output, which requires the choice of a detrending method. In what follows, we use a five-year backward-looking moving average to filter out the trend.[9] It can be shown that for a wide variety of data-generating processes, correlations based on detrended output tend to be larger than those based on output growth.

[5]More formally, the growth rate of each country can be assumed to be determined as $y_{it} = \varepsilon_t + \varepsilon_{it} + \Sigma_j \rho_{ijt}\varepsilon_{jt}$, in which y_{it} denotes real GDP growth in country i, ε_t denotes common shocks, ε_{it} denotes domestic idiosyncratic shocks, ε_{jt} (for $j \neq i$) denotes other countries' idiosyncratic shocks, and ρ_{ijt} measures the linkages between country i and country j. See Doyle and Faust (2005) for a more in-depth discussion. In the analysis below, we focus on conventional linkages such as finance and trade: $\rho_{ijt}(h) = \rho^0(h) + \rho^1(h)Finance_{ijt} + \rho^2(h)Trade_{ijt}$. The dependence of ρ_{ijt} on h, with h indicating the nature of shocks (for example, real or financial), is meant to capture the possibility that the nature of the underlying shock can affect the sign and magnitude of the spillovers.

[6]Regarding the role of linkages, economic theory has ambiguous predictions about the impact of changing financial and trade integration on output comovements. See Kalemli-Ozcan, Papaioannou, and Peydro (2013) and Doyle and Faust (2005) and the references therein.

[7]See, for example, Fratzscher (2009, 2012); Acharya and Schnabl (2010); and Bekaert and others (2011).

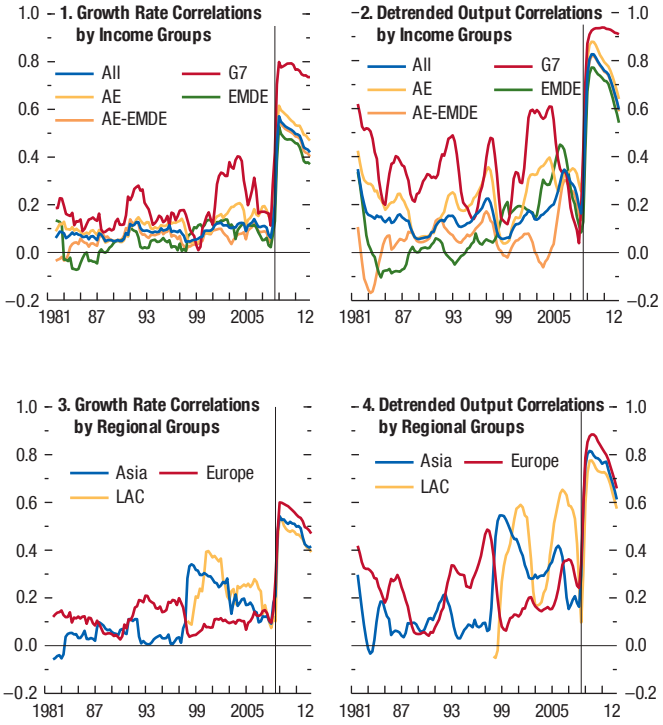
[8]Indeed, our results are essentially unchanged when we control for other observable factors influencing foreign output growth and when we include time-fixed effects to account for unobservable common and country-specific shocks.

[9]Sensitivity to using alternative detrending methods is explored in Appendix 3.1.

Figure 3.2. Output Comovements: 1978–2012

(Five-year rolling period correlations for various country groups)

Output growth correlations remained relatively low through much of the past three decades. But there was a sharp rise in these correlations in late 2008, evident across all country groups and regions. Correlations based on detrended output showed a similar sharp rise.



Sources: Haver Analytics; IMF, *World Economic Outlook*; Organization for Economic Cooperation and Development; and IMF staff calculations.
Note: All = all country pairs; AE = advanced economy country pairs; EMDE = emerging market and developing economy country pairs; AE-EMDE = advanced economy and emerging market and developing economy country pairs; G7 = G7 country pairs; LAC = Latin America and the Caribbean country pairs. See Appendix 3.1 for country groupings. Vertical line indicates the third quarter of 2008, when Lehman Brothers filed for bankruptcy.The Commonwealth of Independent States, Middle East and North Africa, and sub-Saharan Africa regions are excluded from panels 3 and 4 due to a lack of quarterly real GDP data for a sufficient number of countries.

Output growth correlations remained relatively low through much of the past three decades (Figure 3.2, panel 1). Simple averages of five-year rolling window growth correlations across all country pairs remained below 0.2 from the 1980s until 2007. Growth correlations tended to be higher among advanced economy pairs than among emerging market and developing economy pairs, even more so for country pairs within the Group of Seven (G7) countries (Canada, France, Germany, Italy, Japan, United Kingdom, United States), for which average correlations were between 0.3 and 0.4 in the early 2000s. Growth correlations within geographic regions were also relatively low (Figure 3.2, panel 3), although correlations in Asia rose to 0.3 following the Asian crisis.[10] Correlations based on detrended output were generally higher than, but similar in pattern to, those based on output growth (Figure 3.2, panels 2 and 4).

Growth correlations spiked sharply, however, during the global financial crisis (Figure 3.2, panels 1 and 3). Following the bankruptcy of Lehman Brothers in September 2008, there was a sharp, synchronized, and across-the-board collapse in output in the fourth quarter of 2008 and the first quarter of 2009. The synchronized collapse led to a sharp rise in growth correlations, exceeding 0.5 for all income groups and geographic regions, with the highest correlations observed among the G7 economies. Detrended output correlations exhibit a similarly sharp rise. The rest of this analysis restricts its attention to output growth correlations.

Whereas five-year correlations suggest that output comovements remain high, Figure 3.1 suggests that output comovements have already fallen sharply, and this is confirmed by the use of shorter-window or instantaneous correlations (Figure 3.3). If two-year rolling window growth correlations are used, there is a sharp drop in output synchronization in the first quarter of 2011—when the first quarter of 2009 drops out of the rolling window. Two measures of "instantaneous" correlation also indicate that average output comovements are now much lower than at the peak of the global financial crisis (Figure 3.3, panel 2).[11] Output growth correlations during 2011–12 have actually been quite close to precrisis levels, despite the intensification of the crisis in Europe during this period.[12]

[10]The Commonwealth of Independent States; Middle East, North Africa, Afghanistan, and Pakistan (MENAP); and sub-Saharan Africa regions are included in the chapter analysis but are excluded from these figures because of a lack of quarterly real GDP data for a sufficient number of countries. Box 3.1 presents stylized facts on output comovements in the MENAP and the Caucasus and Central Asia based on yearly output growth correlations.

[11]One such measure is based on the dynamic conditional correlations from a multivariate GARCH model, as described by Engle (2002). A second measure is an instantaneous quasicorrelation, defined as $(g_{it} - \bar{g}_i)(g_{jt} - \bar{g}_j)/\sigma_i\sigma_j$. Note that although this measure is similar to a correlation, it is not bounded by 1 in absolute value. If growth rates in both countries are simultaneously far above or below their respective means—as occurred during the synchronized global collapse in late 2008 and early 2009—this quasicorrelation can exceed 1 by a large margin.

[12]Interestingly, financial market comovements—as measured for example by equity price correlations—rose at various times during 2010–12 (Forbes, 2013). This chapter's focus is on output spillovers; Chapter 4 of the April 2009 WEO analyzed the transmission of financial stress from advanced to emerging market economies.

Could the same shocks that sharply increased output comovements in recent years reemerge? Answering this question requires focusing on the factors that drove these sharp changes in correlations, which is explored in the next section.

The Role of Common Shocks and Financial and Trade Linkages

This section examines whether spikes in global comovements correspond to well-known historical events that hit many countries at the same time and whether shocks characterizing these events are transmitted by identifiable channels such as financial and trade linkages.

What Drives Sharp Spikes in Output Comovement?

Given the sizable impact of the global financial crisis on comovements, it is natural to ask whether other historical events have also been associated with sharp increases in comovements. Spikes in global comovement correspond to well-known global or regional events (Figure 3.4, panel 1).[13] These include the second oil shock in 1979 and the recessions in the United States and Europe that began in 1980; the Latin American debt crisis in the early to mid-1980s; the "Black Friday" stock market crash in 1987; the U.S. recession in 1990–91; the Exchange Rate Mechanism (ERM) crisis and European recession in 1992; the tequila, Asian, and Russian crises in the mid- to late 1990s; the dot-com bust in 2000, which was followed by a U.S. recession; and the recent global financial crisis. With the exception of the 1979 oil price shock, these events were either financial in nature or were associated with downturns in the United States or Europe.

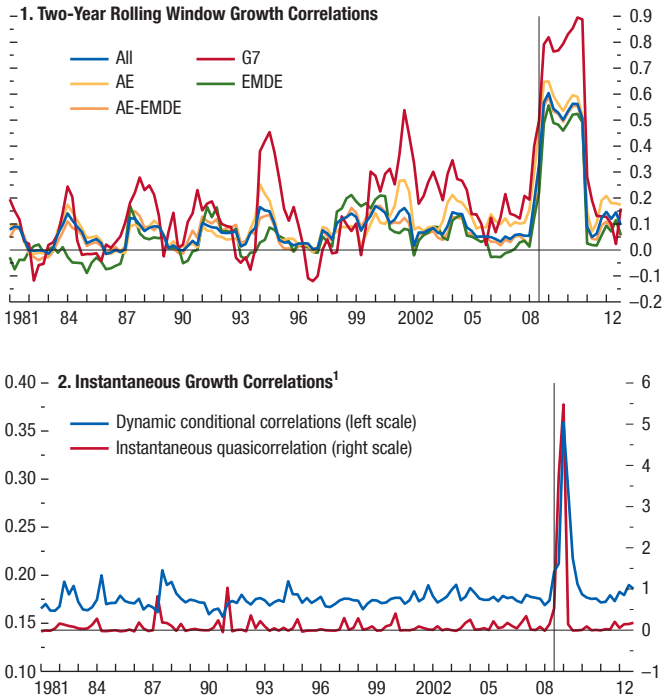
The importance of financial shocks in inducing spikes in output comovements is made clear in panels 2–4 of Figure 3.4. These charts repeat the earlier exercise for different regional subsamples, and they superimpose the number of financial crises in the region from the chronology of Laeven and Valencia (2012).[14] For Asia, the crisis in 1997–98—during which many countries experienced a combination of a currency crisis and a systemic banking crisis—was a common shock whose effect on regional comovements was almost as large as that of the recent global crisis. For Europe, a regional shock occurred during the recession of the early 1980s and during the ERM crisis in the early 1990s, but these are dwarfed by the global financial crisis, when 18 of the region's economies experienced some type of financial crisis. And in Latin

[13]Econometrically, spikes in global comovement are captured by the coefficients on the time dummies when country-pair comovements are regressed on country-pair and time-fixed effects. In Figure 3.4, panel 1, comovements are measured by instantaneous quasicorrelations, and the time dummy coefficients are estimated over the entire sample. These time dummies capture shocks common to all countries (the ε_t in the conceptual framework above) but also pick up spillovers from country-specific shocks because we do not control for such spillovers in this regression.

[14]These include systemic banking crises, currency crises, and debt crises. Multiple instances of these in a year in a given country (for example, twin banking and currency crises) are counted as a single instance.

Figure 3.3. Output Comovements: Back to Precrisis Levels?

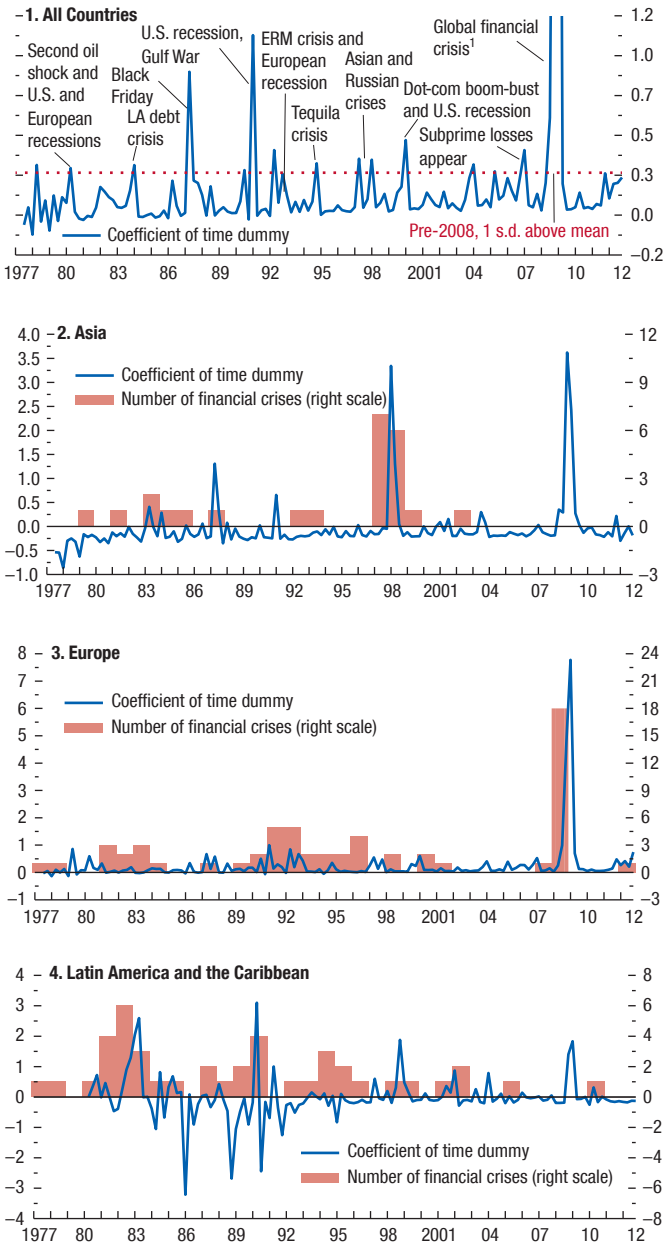
The use of shorter-period or instantaneous correlations indicates that output comovements have already returned to precrisis levels.



Sources: Haver Analytics; IMF, *World Economic Outlook*; Organization for Economic Cooperation and Development; and IMF staff calculations.
Note: The vertical line indicates the third quarter of 2008. All = all country pairs; AE = advanced economy pairs; EMDE = emerging market and developing economy pairs; AE-EMDE = reporter is from advanced economy, partner is from emerging market and developing economy; G7 = G7 country pairs. See Appendix 3.1 for country groupings.
[1]Based on mGARCH dynamic conditional correlations (plotted on the left *y*-axis) and on average quasicorrelations (plotted on the right *y*-axis). The blue line shows dynamic conditional correlations from the mGARCH model of G20 quarterly GDP growth rates. The red line shows the simple average of $(g_{it} - \bar{g})(g_{jt} - \bar{g}_j)/\sigma_i\sigma_j$.

Figure 3.4. What's behind "Common Shocks"?

Spikes in global comovement correspond to well-documented global events such as oil shocks, financial shocks, and recessions in major advanced economies. Regional output comovements confirm the importance of financial crises in increasing output synchronization.



Sources: Laeven and Valencia (2012); and IMF staff calculations.
Note: s.d. = standard deviation; LA = Latin America; ERM = exchange rate mechanism. The blue lines plot the time dummies from a regression of instantaneous quasicorrelations on country-pair and time dummies. U.S. and euro area recessions are from the National Bureau of Economic Research and Center for Economic and Policy Research, respectively. Financial crises include currency, debt, and systemic banking crises and are taken from Laeven and Valencia (2012); if a country has more than one type of crisis in a given year (e.g., twin currency and banking crises) they are counted as one crisis.
[1]Time-fixed effect rises above 5 in 2008:Q4 and 2009:Q1.

America, the largest common shocks were the debt crises that affected many of the region's economies in the early 1980s and again in 1989–90, when Argentina and Brazil both had financial crises.

Panel 1 of Figure 3.4 also shows that the recent global financial crisis—a financial shock that originated in the world's largest economy and a global financial hub—stands head and shoulders above the other events in the sample in terms of inducing strong output comovements. It is literally off the charts, with an impact on output comovements four times larger than that of any other event during the past several decades.

The general takeaway is that financial shocks, even though they hit individual countries, often act as common shocks that tend to raise output comovements regionally or globally. When financial shocks emanate from a large financial center or a major economy, the resulting spikes in comovements are disproportionately large.

Do Financial and Trade Linkages Amplify the Effects of Shocks on Comovements?

To assess the role of financial and trade linkages in amplifying the effect of shocks, we regress the correlation of output growth between country pairs on the trade and financial linkages between them.[15] We focus our attention on the past 10 years and divide this period into two five-year periods: a "normal" period consisting of the precrisis years (2003–07) and a "crisis" period corresponding to the past five years (2008–12). The crisis period is characterized by a major financial shock, and the normal period is most likely dominated by real demand and supply shocks. We allow the effect of trade and financial linkages to differ across these two periods, since the shocks at work in each period are different. This allows us to test whether the effect of finance and trade linkages differs between tranquil times and periods of financial turmoil.

The econometric estimation suggests that an increase in financial linkages tends to lower output correlations during normal times (Table 3.1).[16] The coefficient on

[15]We follow the empirical strategy used in Kalemli-Ozcan, Papaioannou, and Peydro (2013) and Kalemli-Ozcan, Papaioannou, and Perri (2013). Further details on sources for and definitions of the variables, and on the empirical methodology, can be found in Appendix 3.2.

[16]Cross-sectional studies typically find a positive correlation between trade and financial integration and output comovements (Imbs, 2006; and Kalemli-Ozcan, Papaioannou, and Peydro, 2013;

Table 3.1. Financial Linkages and International Comovement—Two Periods

	(1)	(2)	(3)	(4)	(5)
Crisis	0.45***	0.58***	0.45***	0.63***	0.64***
	(24.06)	(9.89)	(23.51)	(8.88)	(8.91)
Financial Linkages	–0.06**	–0.06***			–0.06*
	(–2.03)	(–2.12)			(–1.94)
Financial Linkages × Crisis		0.03***			0.02
		(0.01)			(0.02)
Trade Linkages			0.08	0.05	0.05
			(1.16)	(0.69)	(0.70)
Trade Linkages × Crisis				2.61	0.03
				(2.61)	(1.27)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations (*N*)	539	539	539	539	539
R Squared	0.720	0.723	0.713	0.721	0.727
Country Pairs	307	307	307	307	307

Note: The table reports panel (country-pair) fixed-effect coefficients estimated in two nonoverlapping five-year periods during 2003:Q1–2007:Q4 and 2008:Q1–2012:Q4 using all country pairs. The dependent variable is the pair-wise correlation of real GDP per capita between country *i* and country *j* in each of the two periods. The crisis period equals 1 for the second period (and zero in the first period). Financial linkages are measured by the log of the share of the stock of bilateral assets and liabilities between countries *i* and *j* in quarter *t* relative to the sum of the two countries' total exposure in the beginning of each period. *T* statistics for robust errors are reported in parentheses. *, **, *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

the financial linkage variable is negative and significant, indicating that increased financial linkages are associated with less-synchronized growth of output in normal times. The magnitude of the estimated coefficient suggests that if a country pair moves from the 25th to the 75th percentile in terms of financial integration—which is similar to the increase in integration between Italy and Portugal in the past 10 years—the correlation of their growth rates would decline by 0.1, a significant amount given the mean correlation in the sample of 0.2. This supports the view that financial integration allows countries to diversify during tranquil times, with capital flowing to where it is most productive.[17]

During the crisis period, however, this negative association was attenuated because financial sector shocks were transmitted through financial linkages. Countries that were more strongly integrated with each other through the international banking system experienced a bigger increase in their growth correlations during the crisis. This is consistent with the idea that financial linkages, while facilitating efficient capital allocation during normal times, also transmit large financial shocks across borders during crisis times. Even though the partial effect of financial integration on output synchronization during the recent crisis was reversed and became positive, the total effect is still negative; that is, the crisis only weakened the overall negative relationship between financial integration and output synchronization, roughly halving it.

Most of the spike in correlations, however, is captured by the crisis dummy itself. This suggests that, while financial linkages contributed to spreading the financial stress to other countries, other factors played a much larger role in raising output synchronization. In other words, there was a very important common shock element to the recent crisis, a point made by Bacchetta and van Wincoop (2013), among others, who suggest that global panic and self-fulfilling expectations played an important role in the global financial crisis.

Finally, in contrast to the significant effects of financial linkages on output comovements, the measured influence of trade linkages is statistically insignificant. This could be due to the limited time variation in trade data from quarter to quarter relative to finance data, since the methodology used here evaluates the effect of changes in finance and trade linkages on changes in output correlations. As shown by Frankel and Rose (1998) and many others, the level of trade linkages over the long term is strongly and positively associated with the level of output comovements.[18]

among others). The difference in the results between cross-sectional and panel studies is driven by omitted-variables bias arising from common time-varying shocks and, most important, by unobservable country-pair characteristics, such as common borders and language, that affect both comovements and linkages.

[17]Previous studies also show that financial integration increases risk sharing and reduces consumption volatility. See, for example, Bekaert, Campbell, and Lundbad (2005, 2006, 2011); Bekaert and others (2007); Kose, Prasad, and Terrones (2009); Kalemli-Ozcan, Sørensen, and Yosha (2001, 2003); Kalemli-Ozcan, Sørensen, and Volosovych (2010); and Kalemli-Ozcan, Papaioannou, and Peydro (2009), among others.

[18]The caveat for such average level effects is that they are difficult to separate from the effect of a common border or language, a common currency, or historical ties, because such countries will also tend to trade more with each other.

A multiperiod version of the same regression—which uses the full sample going back to 1980 and allows for the inclusion or exclusion of time dummies—corroborates the findings above. The results confirm the findings that (1) higher financial integration tends to reduce output comovements during normal times and (2) the effect is weakened during crises, which tend to induce greater synchronization in country pairs that are more financially integrated.

Spillovers of Country-Specific Shocks to Other Countries and the Role of Financial and Trade Linkages

The decline in correlations to precrisis levels does not imply that spillovers are no longer relevant or worth analyzing. As demonstrated in this section, various shocks in major economies affect output in other countries.

The analysis in this section assesses the impact of country-specific shocks on output in other countries and the role of trade and financial linkages in transmitting these shocks, applying the statistical approach used by Romer and Romer (2010), among others. In particular, two econometric specifications are used, first to establish whether these shocks materially impact other countries and then to determine whether the effects vary with the strength of linkages. The first specification estimates the average response of real GDP growth in other countries to current and past shocks originating in one of the major economies (China, euro area, Japan, United States). The second specification allows the output response to vary with the strength of trade and financial linkages between each country and the country where the shock originated, estimating spillovers from conventional channels.[19]

Several types of shocks are considered in the analysis. First, we consider *growth surprises* for China, the euro area, Japan, and the United States. These shocks are identified for a given country-quarter as the deviation from the country's average growth over the entire period and from average growth for all countries in the sample in that quarter (Morgan, Rime, and Strahan, 2004). The analysis then considers *financial shocks*, such as the Lehman Brothers bankruptcy; a measure of banking sector risk (based on credit default swap—CDS—spreads) for the euro area and the United States; and the excess bond premium of U.S. corporate bonds (Gilchrist and Zakrajšek, 2012). Finally, the analysis covers *fiscal policy shocks*, such as exogenous tax changes identified by Romer and Romer (2010) for the United States and by Devries and others (2011) for the euro area, and exogenous *monetary policy shocks* in the United States identified by Coibion (2012).[20]

Estimated Effects of Country-Specific Shocks

The analysis starts with an examination of the effect of growth surprises in large economies on output in other countries. Note that growth surprises as constructed above do not identify the underlying source of the shock, which could be real or financial. These regressions should thus be considered to be indicative of broad output linkages without any deep structure, and therefore we refrain from interpreting the sign of such growth surprises or the transmission mechanism behind the results. As discussed in the conceptual framework, growth surprises in one country can lead to an increase or decrease in other countries' growth rates depending on the type of shock that drives the growth surprise and the policy response to it.[21] After growth surprises, we study in greater detail well-iden-

[19]In terms of our conceptual framework, these shocks correspond to observable ε_{jt}. In the first specification, we estimate the spillover effects of these shocks, assuming linkages (ρ_{ijt}) do not vary over time, while in the second specification, we relax this assumption by allowing linkages to vary with trade and finance, and we estimate ρ^0, ρ^1, and ρ^2. Note that if we fail to control for all common and idiosyncratic shocks, and if these are correlated with the country-specific shocks considered in the analysis, the result will be inconsistent estimates of the ρ parameters. However, our series of shocks reflects events and policies that are unlikely to be related to other factors influencing foreign economic activity in the short term. Thus, there is no reason to expect systematic correlations between these shocks and other determinants of foreign output growth. Indeed, our results are essentially unchanged when we control for other factors influencing foreign output growth in the first specification (Appendix 3.3, Figure 3.16) and when we include time-fixed effects in the second specification (Table 3.2). See Appendix 3.3 for details.

[20]We analyze monetary policy shocks only for the United States, as these are the only ones for which we have exogenous measures. See Appendix 3.3 for details.

[21]The findings of positive spillover effects in the foreign country from a positive growth surprise in the home country are not inconsistent with our previous results of lower comovement for more financially integrated economies during normal times. Those regressions attempt to separate real and financial shocks by focusing on normal and crisis periods, and normal times are presumed to be periods during which countries mostly face real demand and supply shocks. The growth surprises constructed here do not identify the underlying source of the shock, which could be real or financial.

Table 3.2. Spillover Effects Identified via Financial and Trade Linkages

Linkages	Financial Shock		Fiscal Policy Shock		Monetary Policy Shock	
Financial × Shock	–5.917	–5.104	–0.129	–0.114	0.504	–0.052
	(18.27)	(13.27)	(0.04)	(0.03)	(0.43)	(0.00)
Trade × Shock	–0.520	–0.143	–2.676*	–3.331**	2.559	2.955
	(0.02)	(0.01)	(2.44)	(4.49)	(1.00)	(1.15)
Time-Fixed Effects	No	Yes	No	Yes	No	Yes
Observations (*N*)	2,183	2,183	1,633	1,633	3,567	3,567
Adjusted *R* Squared	0.390	0.320	0.210	0.250	0.260	0.330
Financial–Differential in Output (%)	–2.680	–2.300	–0.300	–0.100	0.230	–0.020
Trade–Differential in Output (%)	–0.230	–0.060	–0.900	–1.500	1.160	1.338

Note: Output effects for financial and policy shocks, and industrial production effects for monetary policy shocks are based on the estimated equation $\Delta y_{it} = \alpha_i + \beta_t + \varphi_1(l)\,Shock_{tm} + \varphi_2(l)Global_t + \varphi_3(l)Shock_{tm}\,(Link_{imt} - Link_{im}) + \varphi_4(l)Link_{imt} + \varepsilon_{it}$. Financial shock = Lehman crisis; fiscal shock = exogenous tax change (Romer and Romer, 2010); monetary policy shock = large exogenous increase in interest rates (Coibion, 2012). Linkages are defined as the product of the shock and financial and trade linkages with the United States. The differential in output (in percent) measures the output effect of the shock in a country at the 75th percentile of linkages compared with a country at the 25th percentile. All regressions include country-fixed effects. *F* statistics of joint significance, based on robust standard errors, are reported in parentheses.

tified shocks, such as exogenous fiscal and monetary policy shocks and financial shocks, and their spillovers.

Growth surprises: Growth surprises in the United States have larger and more long-lasting effects than shocks to economic activity in China, Europe, or Japan. In general, effects are modest for growth surprises occurring in major economies other than the United States, although the effects on neighboring countries tend to be higher.[22] In particular, a 1 percent positive growth surprise in the United States increases the level of output in other countries by 0.2 percent after two years; the effect of growth surprises in China and Japan is about 0.1 percent; for the euro area, it is close to zero (Figure 3.5). However, we also find evidence that effects of growth surprises in China and Japan tend to be higher on other Asian countries,[23] while the effects from euro area growth surprises tend to be much more significant for other European countries (Figure 3.6). The lower impact of growth surprises in China and Japan may simply reflect the difference in the size of these economies relative to the United States.

Financial shocks: Financial crises are typically associated with significant and long-lasting output effects (Cerra and Saxena, 2008; Reinhart and Rogoff, 2009; Chapter 4 of the October 2009 *World Economic Outlook*). The Lehman Brothers collapse was no exception. In particular, it reduced the level of output in other economies by about 7½ percent after eight quarters, compared with a drop in U.S. real GDP of about 9½ percent (Figure 3.7, panel 1). The nearly one-for-one drop corroborates the view that the Lehman crisis acted like a common shock, despite having originated in the United States (see Figure 3.4).

More generally, financial shocks in the United States tend to have significant effects on output in other economies, whereas financial shocks in the euro area have more limited effects. An increase of 1 standard deviation in the U.S. CDS-spreads-based risk indicator tends to reduce real GDP in other economies by about 2 percent after one year (Figure 3.7, panel 2), but the same size shock in the euro area reduces real GDP in other economies by only about ½ percent after one year (Figure 3.7, panel 3).[24] That is, an increase in the U.S. CDS-spreads-based risk indicator to the level observed during the Lehman crisis (when spreads rose by 1.8 standard deviations) would reduce output in other economies by about 3.2 percent; and an increase in the euro area CDS-spreads-based risk indicator to the level observed during the peak of European financial turmoil (when spreads rose by about 3½ standard deviations) would reduce output in other economies by about 1.8 percent. A renewal of stress in the U.S. banking sector would have the largest impact on Europe and Asia, whereas financial sector stress in the euro area would have a greater effect on other countries in Europe as well as those in Latin America (Figure 3.8).

Fiscal shocks: Existing estimates of fiscal spillovers suggest that while they are on average typically

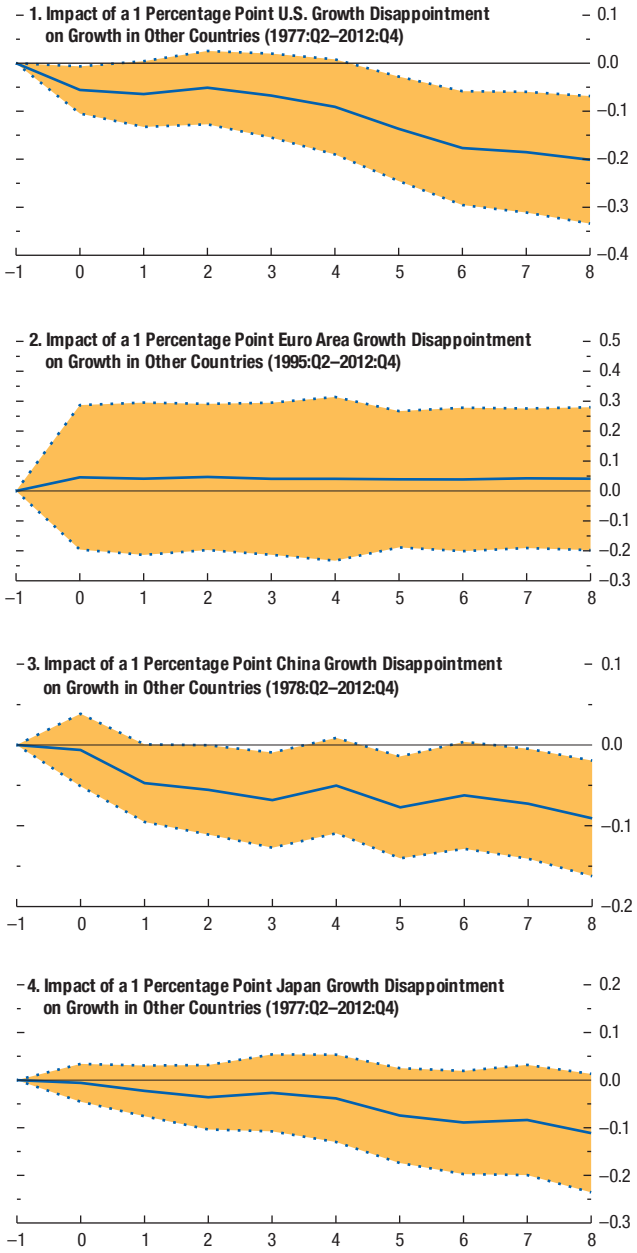
[22]Here we focus on the effect of growth innovations in the source country on the growth innovation (the idiosyncratic, uncommon growth component) in other countries.

[23]The results for China are consistent with the 2012 IMF spillover report and Ahuja and Nabar (2012), who find larger spillover effects on Asian supply chain countries.

[24]The effect of a U.S. (euro area) financial shock on U.S. (euro area) output is not statistically different from the effect in other countries. Given the relevance for nonbank financial institutions in the United States, we repeat the analysis using the excess bond premium of U.S. corporate bonds as a measure of financial shock. The results obtained using this measure confirm that U.S. financial shocks have sizable and statistically significant output spillover effects (Appendix 3.3).

Figure 3.5. Growth Surprises in the United States, Euro Area, and China and their Impact on Growth in Other Countries

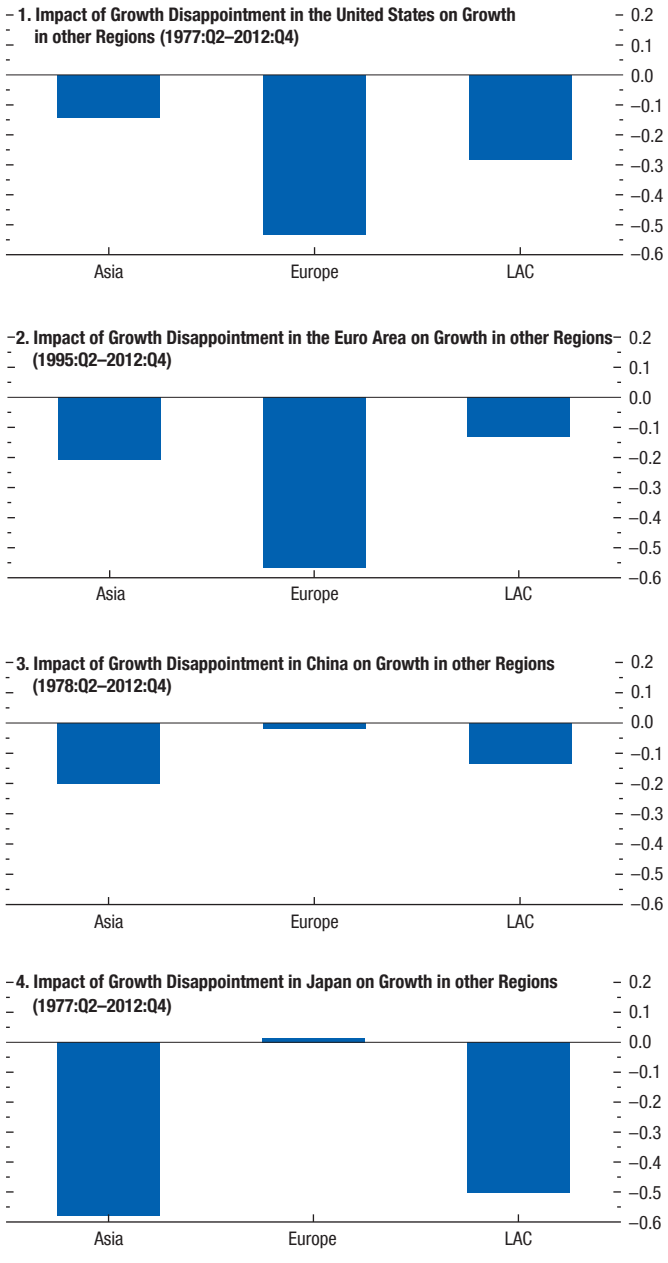
Spillovers from U.S. growth disappointments tend to be larger and more persistent than those from other large economies, such as China, the euro area, and Japan.



Source: IMF staff calculations.
Note: *X*-axis units are quarters; $t = 0$ denotes the quarter of the growth surprise. Dashed lines indicate the 90 percent confidence interval around the point estimate.

Figure 3.6. Peak Impact of Growth Disappointments on Other Regions

Negative growth surprises in the United States and the euro area would have the largest impact on Europe; a negative growth surprise in China and Japan would have the largest impact on Asia.

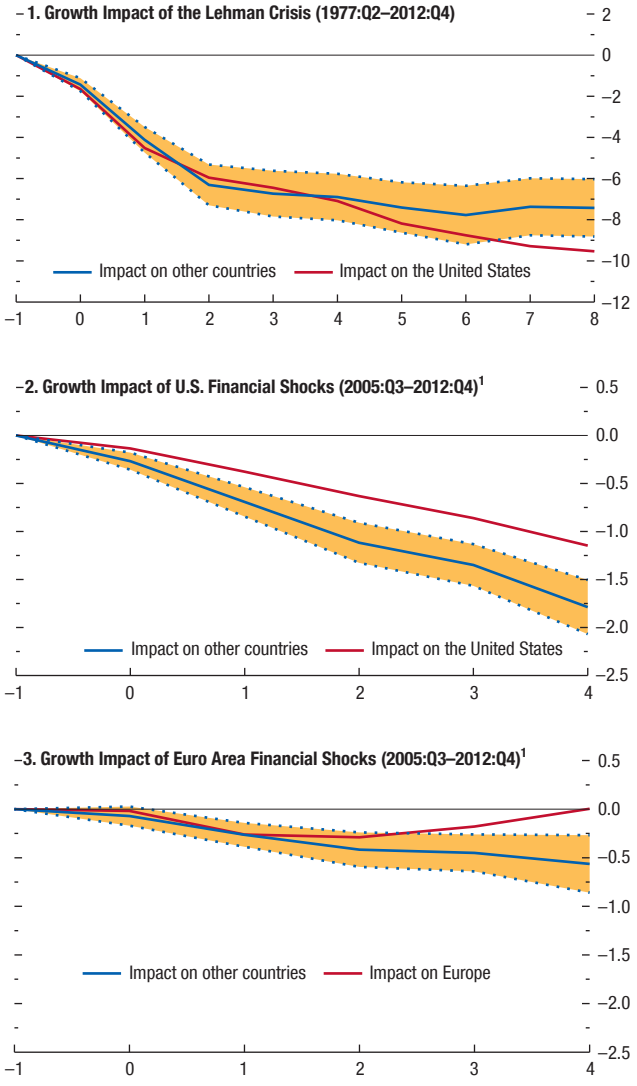


Source: IMF staff calculations.
Note: LAC = Latin America and the Caribbean.

Figure 3.7. Cross-Border Impact of Financial Shocks

(100 basis points)

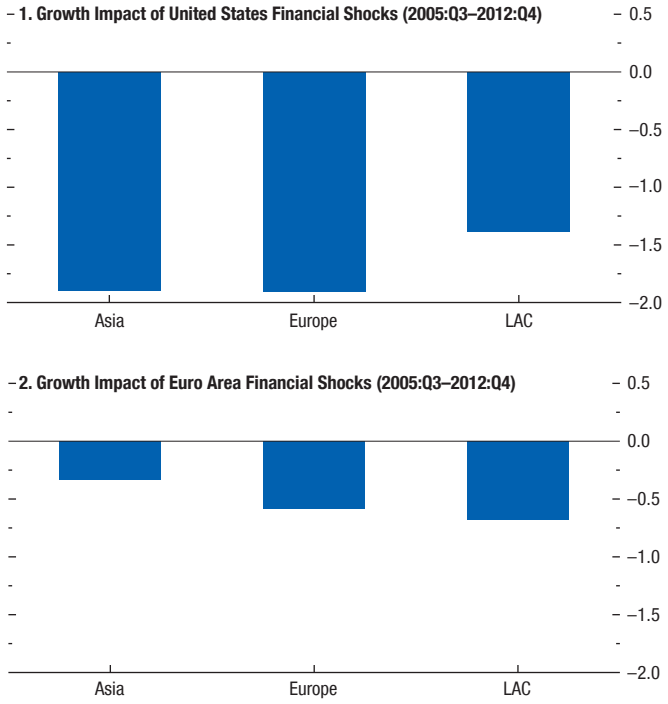
The Lehman crisis had a significant and persistent effect on output in other economies. More generally, financial shocks in the United States tend to have significant spillover effects on output in other economies, while financial shocks in the euro area have more limited effects.



Source: IMF staff calculations.
Note: *X*-axis units are quarters; $t = 0$ denotes the quarter of the financial shock. Dashed lines indicate the 90 percent confidence interval around the point estimate.
[1]The impact of U.S. and euro area financial shocks is estimated to four quarters because of the short time series for these shocks.

Figure 3.8. Impact of U.S. and Euro Area Financial Shocks

Renewed financial stress in the U.S. banking sector would have the largest impact on Europe and Asia, whereas financial sector stress in the euro area would have a greater effect on other countries in Europe and on those in Latin America.



Source: IMF staff calculations.
Note: LAC = Latin America and the Caribbean.

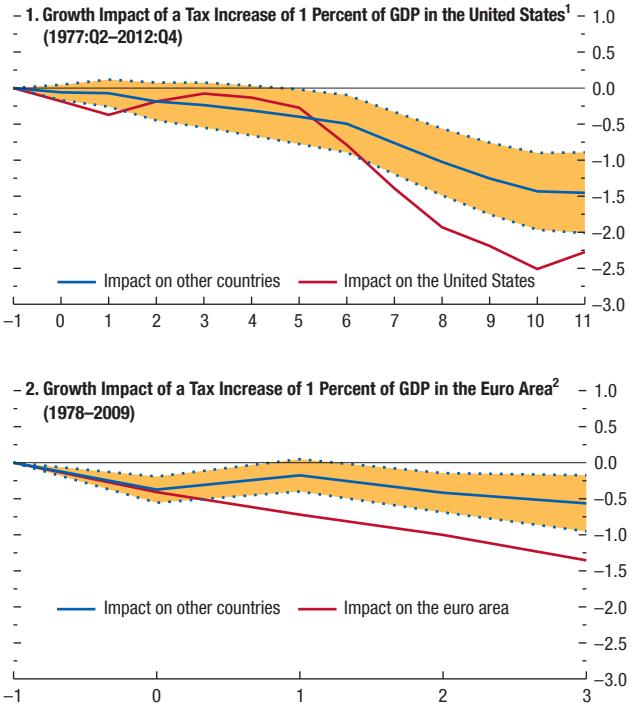
limited, they tend to become large for shocks emanating from large economies (Beetsma, Giuliodori, and Klaassen, 2006) and for shocks occurring during downturns (Auerbach and Gorodnichenko, forthcoming), and spillovers tend to become large for countries that are closely interconnected (Beetsma, Giuliodori, and Klaassen, 2006; Bénnasy-Quéré and Cimadomo, 2012). The results for U.S. fiscal shocks suggest that cross-country output effects tend to be important and long-lasting. In particular, a tax increase of 1 percent of GDP in the United States is found to typically reduce output in other economies by about 1½ percent after three years, compared with an output contraction in the United States of about 2½ percent (Figure 3.9, panel 1).[25] The effect is larger (above

[25]Similar results for fiscal shock spillovers have been obtained by Ilzetzki and Jin (2013), who find that a tax increase of 1 percent of GDP in the United States decreases foreign industrial production by about 1½ percent after two years.

Figure 3.9. Cross-Border Impact of Fiscal Policy Shocks

(100 basis points)

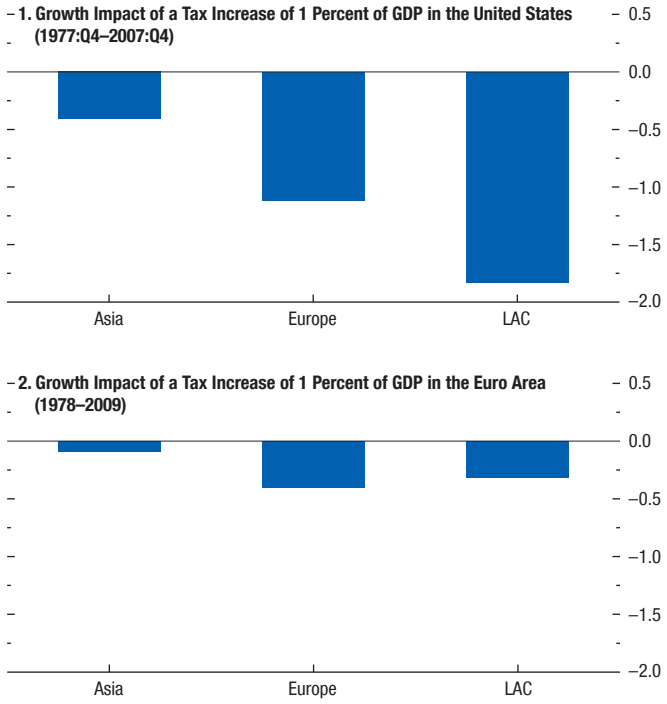
U.S. fiscal shocks tend to have sizable spillovers, while fiscal policy shocks in the euro area tend to have more limited effects.



Source: IMF staff calculations.
Note: Dashed lines indicate the 90 percent confidence interval around the point estimate.
[1]The *x*-axis units are quarters; $t = 0$ denotes the quarter of the policy shock.
[2]The *x*-axis units are years; $t = 0$ denotes the year of the policy shock.

Figure 3.10. Peak Impact of Fiscal Policy Shocks on Other Regions

Although the spillover effect of fiscal tightening in the United States is largest in Latin America, fiscal tightening in the euro area has the largest impact on Europe.



Source: IMF staff calculations.
Note: LAC = Latin America and the Caribbean.

1 percent) for Latin America and Europe and somewhat smaller (about 0.3 percent) for Asian economies (Figure 3.10). Although the estimates of the impact of U.S. tax shocks on U.S. economic activity are in line with those found by others (Romer and Romer, 2010, for the U.S.; Cloyne, 2013, for the United Kingdom; and Alesina, Favero, and Giavazzi, 2012; and Guajardo, Leigh, and Pescatori, forthcoming, for a panel of countries) there is a wide range of estimates in the literature. In addition, Appendix 3.3 examines the effect of spending-based policy shocks and finds that spending-based shocks have smaller and less persistent spillover effects than tax-based policy shocks.[26]

Fiscal policy shocks for the euro area tend to have more limited effects. In particular, a tax increase of 1 percent of GDP in the euro area is found to typically reduce output in other economies by about ½ percent after three years, compared with an output contraction in the euro area of about 1½ percent (Figure 3.9, panel 2).[27] The spillover effect of a euro area fiscal tightening is larger for other countries in Europe and for Latin America, while it is much smaller for Asian economies (Figure 3.10, panel 2).

[26]Various recent empirical studies find similar results (Alesina, Favero, and Giavazzi, 2012; Mountford and Uhlig, 2009; and Chapter 3 of the October 2010 *World Economic Outlook*, among others). In fact, while most estimates of spending multipliers are less than 2, some are as high as 5; see Ramey (2011) for details. The focus of the chapter, however, is not on the exact magnitude of fiscal multipliers, but rather on the impact of fiscal shocks on other economies relative to their domestic impact. For a more detailed discussion on fiscal multipliers, see IMF (2013).

[27]Because the euro area fiscal shocks used in the analysis are available at annual frequencies, spillover effects have been estimated using real annual GDP.

Monetary shocks: Monetary policy shocks in major economies—defined as changes in policy rates that are not a response to inflation or economic conditions—may have strong impacts on economic conditions in other countries, particularly those with pegged exchange rate regimes (di Giovanni and Shambaugh, 2008).[28] A key result is that U.S. monetary policy shocks tend to have a significant effect on economic activity in other countries.[29] In particular, this chapter's analysis finds that a surprise increase of 100 basis points in U.S. monetary policy rates typically contracts the level of industrial production in other countries by about 0.7 percent after eight months, compared with 1.7 percent in the United States (Figure 3.11).[30] The effect, however, varies across regions, with Latin American countries typically recording the largest contraction in output (Figure 3.12).

Transmission channels: The role of financial and trade linkages

The empirical evidence presented above suggests that U.S. idiosyncratic shocks tend, on average, to have important effects on economic activity in other countries. What is the role of trade and financial linkages in the transmission of such country-specific shocks?

For financial shocks, the literature on contagion provides compelling evidence that they spread mostly through financial linkages (Forbes, 2013; Claessens, Tong, and Zuccardi, 2012). For fiscal policy shocks, studies suggest that trade linkages are the most important channels (Auerbach and Gorodnichenko, forthcoming; Beetsma, Giuliodori, and Klaassen, 2006). For monetary policy shocks, there is evidence that they impact economic activity in other countries mostly through the interest rate channel, while financial and trade linkages are not found to play a significant role

[28]Similar results have been found by Reinhart and Reinhart (2001) and Frankel and Roubini (2001) for the emerging market and developing countries and by Kim (2001) for G7 economies.

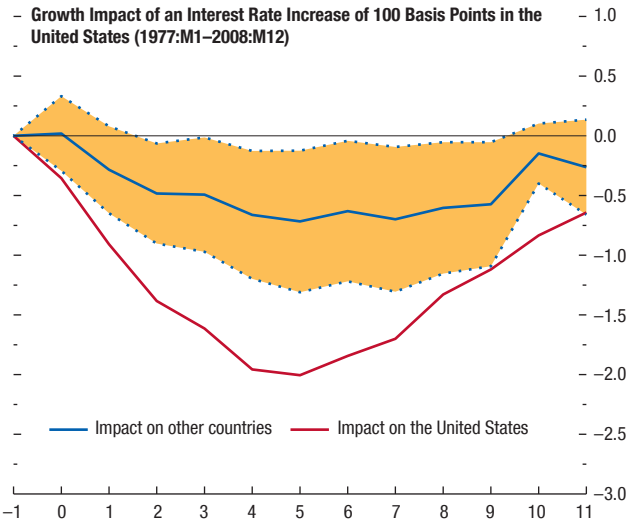
[29]Because the monetary policy shocks used in the analysis are available at monthly frequencies, spillover effects have been estimated using industrial production (see Romer and Romer, 2004).

[30]A 1 percent change in U.S. industrial production typically translates into a 0.3 percent change in U.S. GDP, suggesting that a surprise increase of 100 basis points in U.S. monetary policy rates will tend to lower U.S. GDP by about half a percent. The results for industrial production are consistent with Romer and Romer (2004), who also find relatively large effects of U.S. monetary policy shocks on industrial production. Estimated magnitudes using this methodology tend to be larger than those found in the literature based on the vector autoregression approach (Coibion, 2012).

Figure 3.11. Cross-Border Impact of Monetary Policy Shocks on Industrial Production

(100 basis points)

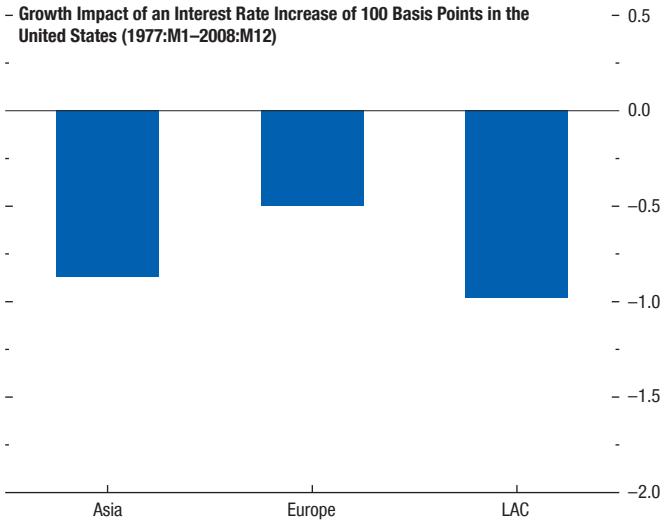
U.S. monetary policy shocks tend to have sizable spillovers.



Source: IMF staff calculations.
Note: Dashed lines indicate the 90 percent confidence interval around the point estimate. The *y*-axis shows the cumulative impact on the level of industrial production. *X*-axis units are months; $t = 0$ denotes the month of the policy shock.

Figure 3.12. Peak Impact of Monetary Policy Shocks on Other Regions

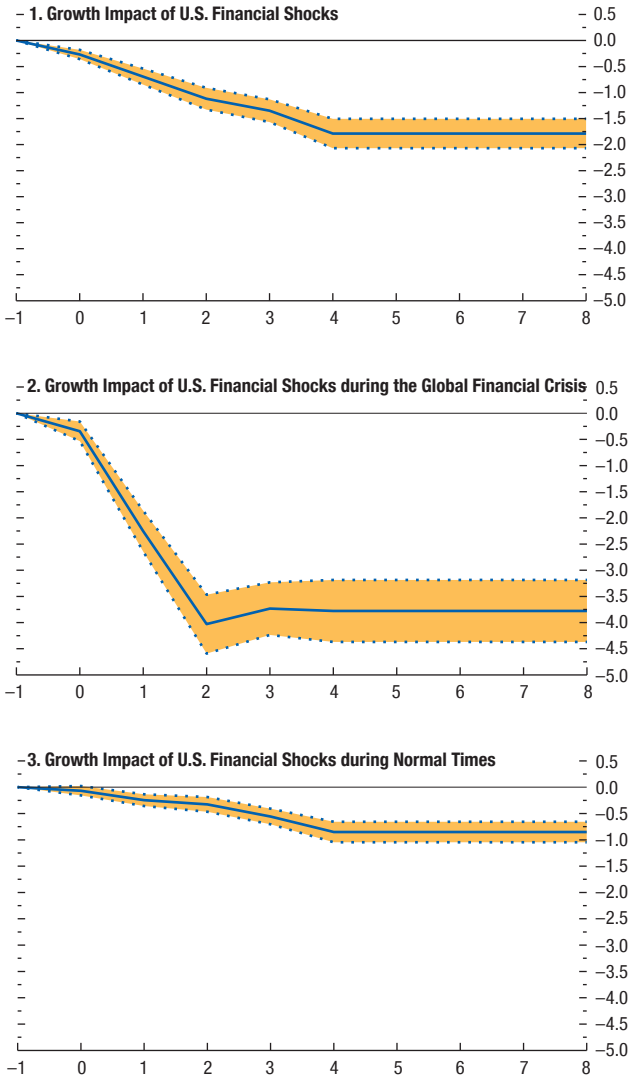
U.S. monetary policy tightening has the biggest effect in Latin America and Asia.



Source: IMF staff calculations.
Note: LAC = Latin America and the Caribbean.

Figure 3.13. Impact of U.S. Credit Supply Shocks

Spillovers from U.S. financial shocks were large during the global financial crisis but relatively small during other periods.



Source: IMF staff calculations.
Note: *X*-axis units are quarters; $t = 0$ denotes the quarter of the credit supply shock. Dashed lines indicate the 90 percent confidence interval around the point estimate.

(di Giovanni and Shambaugh, 2008). The results in this chapter's analysis corroborate those findings (Table 3.2), as follows.

Financial shocks are mostly transmitted through financial linkages. The spillover effect of financial shocks through financial linkages is negative and statistically significant, while the effect through trade is not statistically different from zero. These results are consistent with the comovement regressions shown in Table 3.1. In particular, the differential spillover effect from the Lehman crisis of a country that has relatively high financial linkages with the United States (at the 75th percentile) compared with a country that has relatively low financial linkages (at the 25th percentile) is between –2.3 and –2.7 percent, depending on whether time dummies are included or excluded from the regression. In other words, following the Lehman crisis, the contraction in the level of output in a country that has relatively high financial linkages with the United States has been between 2.3 and 2.7 percent higher than in a country that has relatively low financial linkages.

Fiscal shocks are mostly transmitted through trade linkages. Economies with stronger trade linkages with the United States have larger spillover effects from fiscal policy shocks. The contraction in the level of output in a country that has relatively high trade linkages with the United States (at the 75th percentile) is between 0.9 and 1½ percent higher, depending on whether time dummies are included in the regression, than in a country that has relatively low trade linkages (at the 25th percentile).

Monetary shocks are mostly transmitted through the interest rate channel; financial and trade linkages have limited effects. A U.S. monetary policy shock tends to raise interest rates and contract output in other countries, and the magnitude of the effect is larger for countries that peg their exchange rate to the U.S. dollar (Box 3.2).

Are spillovers larger during recessions?

We considered whether country-specific financial shocks have different effects on other countries during periods of crisis.[31] Figure 3.13 suggest that this is

[31]The analysis could not be repeated for the policy shocks because data for them are available only for periods before the crisis. See Appendix 3.3 for details.

the case. For financial shocks arising from U.S. credit default swaps, spillover effects were large (about a 4 percent reduction in the level of output after one year) during the global financial crisis, but relatively small (about 1 percent after one year) during other periods.[32] In addition, the strength of financial linkages as a transmission channel increased during the most recent recession. Thus, the impact of the global financial crisis has been much bigger than the level predicted by the magnitude of the underlying financial shock, suggesting that other unobservable factors, such as a global panic, or what Bacchetta and van Wincoop (2013) describe as "a self-fulfilling shock to expectations," played an important role.

Summary and Implications for the Outlook

The global financial crisis triggered a high degree of output synchronization unprecedented in the post–World War II era. This chapter documents that rise in comovement and also shows that, over the past two years, output comovements have declined to precrisis levels. The world seems to have returned to a more normal state of greater divergence in output movements, which is consistent with the observed "multispeed" recovery discussed in recent WEO reports.

Spikes in regional and global output correlations tend to occur during financial crises, but when the crisis occurs in an economy like the United States—which is both large and a global financial hub—the effects on global output synchronization are disproportionately large. These financial stresses spread in part through financial linkages, but other factors—such as global panic, increased uncertainty, and wake-up calls that change investors' perceptions—act as a common shock and play a much larger role. Thus, a large financial shock could again induce the world's economies to rise and fall in tandem. As the chapter shows, spikes in global output comovements have often been driven by large financial shocks, such as banking crises or the failure of a global financial institution, as occurred with the Lehman Brothers collapse in 2008. There are still many systemically important financial institutions whose reach spans the globe. And as highlighted in past issues of the *Global Financial Stability Report*, progress on global financial reform has been incomplete, so the world economy remains susceptible to the risk that one of these large systemically important financial institutions will fail.

While financial linkages transmit financial stresses across borders in normal times when real supply and demand shocks are dominant, those linkages facilitate the efficient international allocation of capital. The key is to preserve the benefits of increased financial integration while minimizing the attendant risks through better prudential oversight, including better policy coordination and collaboration.

Various shocks emanating from the major economies can affect output in other countries. In particular, the chapter sheds light on the potential spillover effects from various risks:

- Renewed financial turmoil in the euro area would have a significant effect on output in other economies, albeit one that is substantially smaller than financial shocks emanating from the United States. These effects would vary regionally: a renewal of stress in the U.S. banking sector would have the largest impact on Europe and Asia, whereas financial sector stress in the euro area would have a greater effect on other countries in Europe and in Latin America.
- A stronger-than-expected slowdown of growth in China is a major concern at present. The chapter finds that this would have the largest effect on Asia and Latin America.
- Because fiscal shocks are transmitted primarily through trade linkages, countries with stronger trade ties to the consolidating country will experience bigger spillovers. In response to fiscal tightening in the United States, real spillovers would be largest in Latin America.
- The effect of a normalization of U.S. interest rates that is faster than warranted by economic conditions is also currently of concern. In a given economy, the magnitude of spillovers in real terms from U.S. interest rate shocks does not seem to differ with the strength of its trade and financial linkages with the United States, but according to whether it fixes its exchange rate to the U.S. dollar. A rise in U.S. interest rates has the biggest effect on Latin America, but it also has significant effects on Asia and Europe.

For policymakers, these results indicate that not all potential spillovers are of equal concern: their size depends on the nature of the shock and the strength of

[32]Similarly, results have been obtained using the excess bond premium (Gilchrist and Zakrajšek, 2012) as a measure of U.S. financial shocks.

linkages. In general, shocks emanating from the United States still matter most from a global perspective, but China, the euro area, and Japan are important sources of spillovers for regions with strong linkages to these economies.

Regarding spillovers from monetary policy normalization in the United States, the chapter's findings suggest that these depend to a large extent on the recipient country's exchange rate regime. But the spillovers from an exit from quantitative easing are harder to assess because the exit is likely to entail a range of operational and other policy challenges.[33] While the Federal Reserve has various tools to help manage its exit from the current highly accommodative policy stance, enhanced policy agility, careful calibration of the timing, and effective communication will be essential.

Finally, the importance of common shocks in generating synchronized output collapses may give policy coordination a special role to play during such periods.[34] One element of policy coordination during crises is on the financial side. During global panics, liquidity is in short supply for everyone, and coordinated liquidity provision—for example, in the form of swap lines across central banks, which can be critical in supporting liquidity and funding stability in various interbank markets—is an essential part of the crisis response. But there can also be a macroeconomic element to policy coordination. As noted by Spilimbergo and others (2008), the international dimension of these crises means that without coordination, countries can end up providing too little fiscal stimulus (because of leakages reducing the domestic impact or incentives to free-ride on others' stimulus) or too much (since leakages imply the need to do much more to achieve a given level of output stabilization). If all countries act in concert, then the amount of stimulus needed by each country is reduced, supporting a coordinated approach to providing fiscal stimulus. The need for multilateral surveillance remains critical even during tranquil periods in order to prevent synchronized output collapses generated by another crisis.

[33]For an in-depth discussion of the challenges involved in exiting from unconventional monetary policy, see the *Selected Issues* Paper "Exiting from Unconventional Monetary Policy: Potential Challenges and Risks" that accompanied the 2013 IMF *Article IV Staff Report on the United States*.

[34]See Spilimbergo and others (2008) and Ostry and Ghosh (forthcoming).

Appendix 3.1. Data Definitions, Sources, and Country Groupings

Data Definitions and Sources

The primary data sources for this chapter are the Organization for Economic Cooperation and Development (OECD); the Bank for International Settlements (BIS); Haver Analytics; Bloomberg, L.P.; and the IMF's World Economic Outlook (WEO), Global Data Source (GDS), and Direction of Trade Statistics (DOTS) databases. The variables are listed in Table 3.3, with multiple sources listed in their splice order. Table 3.4 lists the countries included in the analysis and the definitions of the country groupings used in the chapter.

Bilateral trade linkages are constructed using (log) bilateral real exports and imports as a share of the two countries' total exports and imports, with data from the DOTS database.

Bilateral financial linkages are constructed as the (log) of real banks' bilateral assets and liabilities as a share of the two countries' total assets and liabilities, using confidential data from BIS locational banking statistics.

All comovement measures are based on quarterly real GDP in local currency prices. They are taken from the WEO database and spliced with GDS and OECD data. The primary measure of comovement used in the chapter is the correlation of real GDP growth rates, but correlations based on detrended output are also used for comparison. The detrended output correlations in the main text and Figures 3.1 and 3.2 are based on a backward-looking moving average filter. We also examined a Hodrick-Prescott (1997) filter, which removes low-frequency long-term trends from the output series; the band-pass filter of Baxter and King (1999), which retains output fluctuations with frequencies between 6 and 32 quarters; and the random walk filter of Christiano and Fitzgerald (2003). Figure 3.14 shows a comparison of output comovements using these filters. Detrended output correlations using these filtering methods show similar patterns, particularly the large spike in the late 2000s; however, the sharp rise in recent years *precedes* the global financial crisis. This is because the synchronized output collapse in late 2008 and early 2009 pulls the trend down, even in earlier quarters (due to the two-sided nature of these filters, in contrast to the one-sided backward-looking moving average filter), which induces a spurious increase in comovements as early as 2006 and 2007.

Table 3.3. Data Sources

Variable	Source
Global Conditions	
Real GDP (quarterly, seasonally adjusted, in local currency)	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Trade and Financial Linkages	
Trade Linkages (percent of total trade)	IMF, Direction of Trade Statistics Database
Financial Linkages (percent of total trade)	Bank for International Settlements
Synchronization Measures	
Bilateral Moving Correlation of GDP Growth	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Bilateral Moving Correlation of Cyclical Components (natural logarithm of GDP, measure based on the Hodrick-Prescott filter)	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Bilateral Moving Correlation of Cyclical Components (natural logarithm of GDP, measure based on moving averages)	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Bilateral Moving Correlation of Cyclical Components (natural logarithm of GDP, measure based on the Baxter-King filter)	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Bilateral Moving Correlation of Cyclical Components (natural logarithm of GDP, measure based on the Christiano-Fitzgerald filter)	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Average Quasicorrelations	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Multivariate Generalized Autoregressive Conditional Heteroscedasticity (mGARCH) Dynamic Conditional Correlations (DCC)	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Macroeconomic Shocks	
Growth Innovation Shocks	IMF, World Economic Outlook Database; IMF, Global Data Source; Organization for Economic Cooperation and Development
Global Uncertainty	Chicago Board Options Exchange S&P 100 Volatility Index (VXO)
Financial Shocks	Bloomberg, L.P.; IMF staff calculations
U.S. Fiscal Policy Shocks	Romer and Romer (2010)
U.S. Monetary Policy Shocks	Coibion (2012)

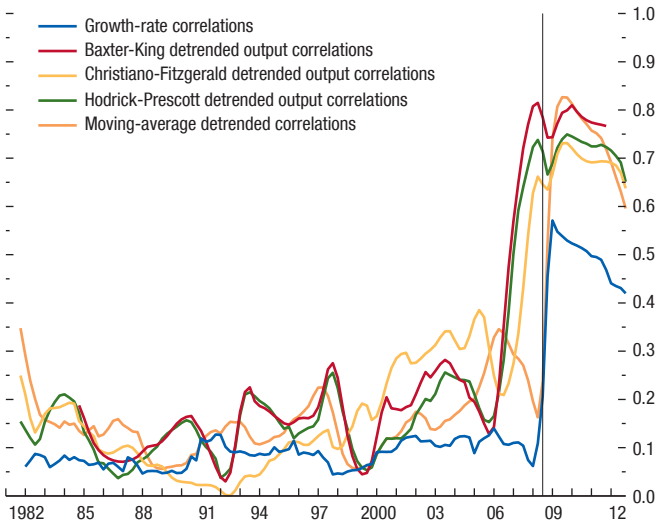
Table 3.4. Economy Groups

Advanced Economies[1]	Emerging Market and Developing Economies[2]
United States	Emerging Europe
Euro Area	Bulgaria
Germany	Croatia
France	Hungary
Italy	Latvia
Spain	Lithuania
Netherlands	Poland
Belgium	Romania
Austria	Serbia
Greece	Turkey
Portugal	Developing Asia
Finland	China
Ireland	India
Slovak Republic	Indonesia
Slovenia	Malaysia
Luxembourg	Philippines
Estonia	Thailand
Cyprus	Vietnam
Malta	Latin America and the Caribbean
Japan	Argentina
United Kingdom	Brazil
Canada	Chile
Korea	Colombia
Australia	Mexico
Taiwan Province of China	Peru
Sweden	Venezuela
Hong Kong SAR	Commonwealth of Independent States
Switzerland	Belarus
Singapore	Moldova
Czech Republic	Russia
Norway	Ukraine
Israel	Middle East, North Africa, Afghanistan, and Pakistan
Denmark	Pakistan
New Zealand	Sub-Saharan Africa
Iceland	South Africa

[1]Advanced economies (AEs) are listed by the size of the economy. San Marino, which is part of the WEO AE group, is excluded from the analysis in this chapter because quarterly data are not available. The G7 group comprises Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

[2]The emerging market and developing economies are listed by region because the chapter occasionally uses regional classifications.

Figure 3.14. Comparison of Various Output Comovement Measures



Sources: Haver Analytics; IMF, *World Economic Outlook*; Organization For Economic Cooperation and Development; and IMF staff calculations.
Note: Vertical line indicates the third quarter of 2008, when Lehman Brothers filed for bankruptcy.

Appendix 3.2. Multiperiod Comovement Regressions

We estimate a multiperiod version of the two-period regression described in the main text. The econometric framework follows Kalemli-Ozcan, Papaioannou, and Perri (2013), which contains a more thorough description and discussion. The regressions, on quarterly data, use a period-by-period synchronization index defined as the negative of the absolute value of growth differences between countries. This index, which follows Giannone, Lenza, and Reichlin (2010), is simple and easy to grasp. Moreover, it is not sensitive to the choice of filtering method, which can affect detrended output correlations, or to the length of the rolling period used, which can affect correlations more generally.

We estimate the following "difference-in-difference" regression:

$$Comvmt_{ij,t} = \alpha_{ij} + \beta \times Finlink_{ij,t-1} + \gamma \times Tradelink_{ij,t-1} + Crisis_t + \omega \times Finlink_{ij,t-1} \times Crisis_t + \lambda \times Tradelink_{ij,t-1} \times Crisis_t + \varepsilon_{ij,t}, \quad (3.1)$$

in which $Comvmt_{ij,t}$ is the growth rate correlation between countries i and j in period t; $Finlink_{ij,t-1}$ and $Tradelink_{ij,t-1}$ denote the (lagged) bilateral financial and trade linkages, respectively, between countries i and j; and $Crisis_t$ is a dummy variable equal to 1 during the crisis period.

Table 3.5. Multiperiod Financial Linkages and International Comovement

	(1)	(2)
Financial Linkages	–0.40***	–0.39***
	(–5.43)	(–4.35)
Crisis	0.27	
	(0.56)	
Financial Linkages × Crisis	0.47***	0.35***
	(4.73)	(3.59)
Country-Pair Fixed Effects	Yes	Yes
Time-Fixed Effects	No	Yes
Observations (*N*)	24,835	24,835
R Squared (within)	0.71	0.71

Note: The table reports panel (country-pair) fixed-effect coefficients estimated over the period 1978:Q1–2012:Q4, using all country pairs. The dependent variable (GDP synchronization) is minus one times the absolute value of the difference in the growth rate of GDP between countries *i* and *j* in quarter *t*. Financial linkages are measured by the log of the share of the stock of bilateral assets and liabilities between countries *i* and *j* in the previous quarter relative to the sum of the two countries' external assets and liabilities in the entire world in the previous period. The crisis indicator variable equals 1 in all quarters between 2008:Q3 and 2009:Q2 (and zero everywhere else). *t* stats for robust errors are reported. *** denotes significance at the 1 percent level.

For the multiperiod version of the regression using the full sample period (from 1978 to 2012), the estimates are in line with the results reported in the main text (Table 3.5). The effect of finance during normal times is negative, but it is positive during crisis periods. Including or excluding time dummies does not affect these results.

The economic impact of financial linkages is highly significant. The coefficient of –0.4 during normal times implies that a rise in bilateral integration from the 25th percentile to the 75th percentile of the distribution, which is similar to the increase in integration between Italy and Portugal during our sample period, is followed by an average decrease in output synchronization of 1 percentage point—that is, on average, the difference in their growth rates increases by 1 percentage point more than before. But during crisis periods and for the same pair, the effect of banking integration on output synchronization turns positive, with a 0.8 percentage point increase in synchronization (that is, on average the difference in their growth rates declines by 0.8 percentage point). Given that the median degree of synchronization is 4 percent in terms of GDP growth rate differences, these are significant effects.

The effects are also sizable from the perspective of changes. The actual average increase in synchronization is 2 percentage points during the global financial crisis. Thus, our estimates on financial linkages can explain two-fifths of the actual change in output comovements during the crisis. The estimated crisis effect of financial linkages is higher when we do not control for the direct effect of the crisis itself, since most of the impact

in that case is attributed to transmission via financial linkages. In this case, we can explain up to three-fifths of the actual increase in comovement during the crisis period, and the remainder is explained by the commonality of the shock.

Appendix 3.3. Growth Regressions

Empirical Methodology

The statistical techniques used to assess the output spillover impact of country-specific shocks, and the role of trade and financial linkages in transmitting these shocks, is standard and follows the approach used by Romer and Romer (2010), among others.

We use two econometric specifications: one to establish whether these shocks materially impact other countries and the other to determine whether the effects vary with the strength of linkages. In the first specification, we estimate the *average* response of real GDP growth in other countries to current and past shocks originating in one of the major economies (China, euro area, United States). Including lags allows for a delayed impact of country-specific shocks on output in other countries.

The first regression specification we estimate is as follows:

$$\Delta y_{it} = \alpha_i + \beta t + \varphi_1(l)Shock_i^m + \varphi_2(l)Global_t + \varepsilon_{it}, \quad (3.2)$$

in which the subscript i denotes the ith country, the subscript t denotes the tth quarter, the superscript m (with m different from i) denotes the country where the shock originated, y is the log of real GDP, and *Shock* is the country-specific shock examined. The specification includes a full set of country dummies (α_i) to account for differences in countries' long-term growth rates, a time trend to take account of a common trend in growth rates across countries, and a set of global factors, including oil prices and global financial uncertainty (*Global*). A similar approach has been used by Ilzetzki and Jin (2013) to assess the dynamic impact of U.S. fiscal and monetary policy shocks on economic activity in other countries.

In the second specification, we allow the output response to vary with the strength of trade and financial linkages between each country and the country where the shock originated. In particular, the set of explanatory variables is augmented to include the linkages between country i and country m and the interaction of these linkages with the shock in country m:

$$\Delta y_{it} = \alpha_i + \beta t + \varphi_1(l)Shock_t^m + \varphi_2(l)Global_t + \varphi_3(l)Shock_t^m Link_{imt} + \varphi_4(l)Link_{im,t} + \varepsilon_{it}, \quad (3.3)$$

in which the coefficient φ_3 represents the difference in the spillover effect on an economy with stronger (trade or financial or both) linkages versus an economy with weaker linkages. Linkages have been demeaned from the average country's linkage to keep the interpretation of φ_1 consistent across the two specifications (Balli and Sørensen, forthcoming). The equation is alternatively estimated using a full set of time dummies to take account of unobserved global and country-specific shocks.

Finally, we also assess whether country-specific shocks have different effects on other countries during periods of crisis.[35] To do so, we estimate the flowing regression:

$$\Delta y_{it} = \alpha_i + \beta t + \varphi_1^C(l)Shock_t^m D_t + \varphi_1^{NC}(l)Shock_t^m(1 - D_t) + \varphi_2(l)Global_t + \gamma D_t + \varepsilon_{it}, \quad (3.4)$$

in which D takes a value of 1 during the U.S. recession (2008:Q3–2009:Q2) and zero otherwise.

The regression equations are estimated on quarterly data for an unbalanced panel of 34 advanced economies and 29 emerging market and developing economies over the period 1978:Q1–2012:Q4 (see Appendix 3.1).

Description of Shocks

The shocks considered in the analysis include (1) growth surprises for the United States, euro area, China, and Japan; (2) financial shocks for the United States and the euro area; (3) fiscal policy shocks for the United States and the euro area; and (4) U.S. monetary policy shocks.[36]

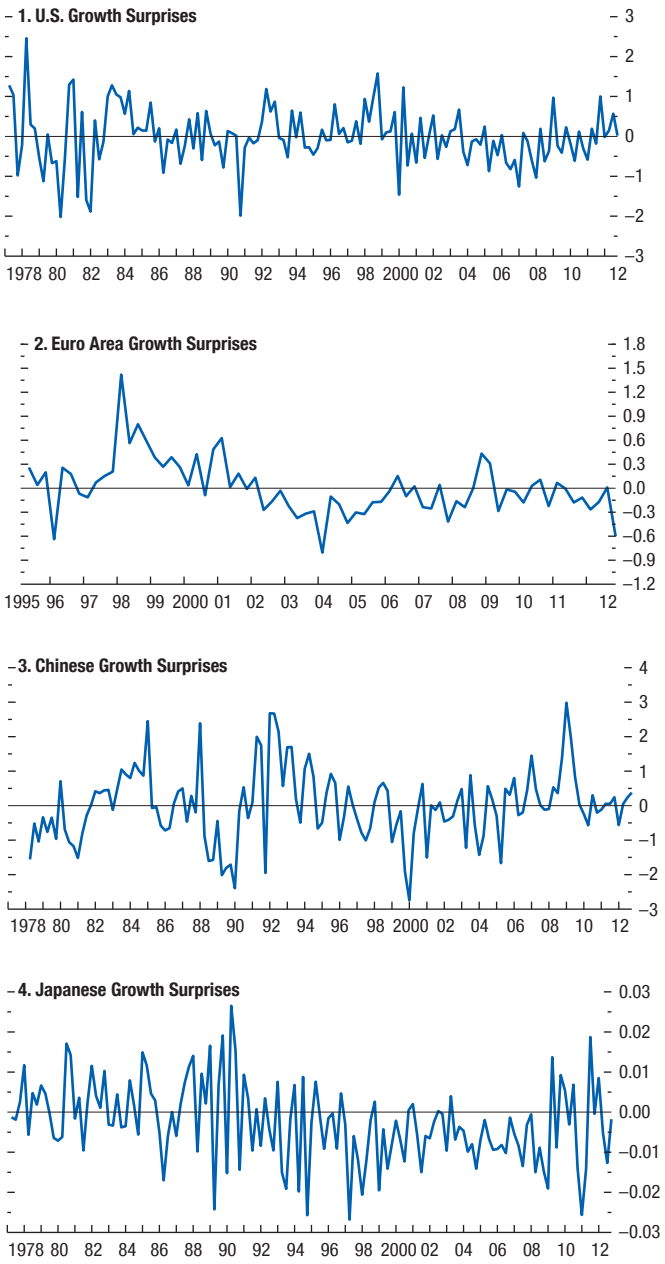
Growth surprises for the United States, the euro area, China, and Japan (Figure 3.15a) are identified for a given country-quarter as the deviation from the average growth for that country over the entire period and from average growth for all countries in the sample in that quarter. In particular, following Morgan, Rime, and Strahan (2004), growth surprises are identified as the residuals ($\hat{\varepsilon}_{it}$) of the following regression:

$$\Delta y_{it} = \alpha_i + \gamma_t + \varepsilon_{it}, \quad (3.5)$$

[35]The analysis focuses only on financial shocks, because data for policy shocks are available only before the crisis.

[36]We analyze monetary policy shocks only for the United States because these are the only ones for which we have exogenous measures.

Figure 3.15a. Growth Surprise Shocks
(Percent)



Source: IMF staff calculations.

in which y is the log of real GDP and α_i and γ_t are country- and time-fixed effects, respectively.

The *financial shocks* considered in the analysis are (1) the Lehman Brothers bankruptcy, (2) a measure of banking sector credit default swap (CDS)-spreads-based risk for the United States and the euro area, and (3) the excess bond premium of U.S. corporate bonds (Gilchrist and Zakrajšek, 2012).

The Lehman Brothers bankruptcy is identified as a dummy that takes a value of 1 in 2008:Q3 and zero otherwise.[37] The measure of banking sector risk for the United States (the euro area) is obtained by extracting the first principal component of the 6 (45) largest U.S. (euro area) banks' CDSs and considering innovations in the first principal component that are orthogonal to past and expected current output growth. In detail, innovations are obtained as the residuals ($\hat{\nu}_t$, Figure 3.15b, panels 2 and 3) of the following equation:

$$P_t = \alpha + \rho(l)P_{t-1} + \theta_1 E_{t-1}\Delta y_t + \theta_2(l)\Delta y_{t-1} + \nu_t, \quad (3.6)$$

in which P_t is the first principal component of U.S. (euro area) banks' CDSs, Δy_{t-j} are past real GDP growth rates, and $E_{t-1}\Delta y_t$ is the expected current output growth proxied by *World Economic Outlook* growth forecasts.[38] Finally, the excess bond premium of Gilchrist and Zakrajšek (2012) is the unpredictable component of U.S. corporate bonds (Figure 3.15b, panel 4). As argued by Gilchrist and Zakrajšek (2012), an increase in the excess bond premium represents a reduction in the effective risk-bearing capacity of the financial sector and therefore a contraction in the supply of credit.

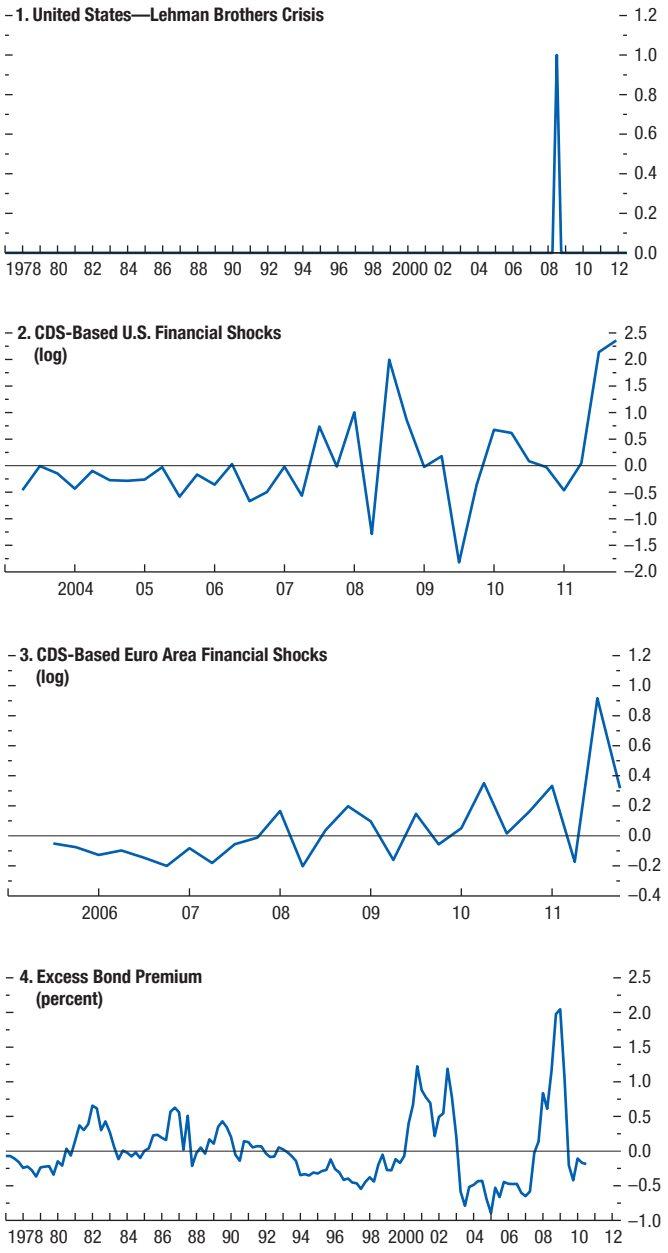
Fiscal policy shocks (Figure 3.15c, panel 1) for the United States consist of legislative tax changes, identified by Romer and Romer (2010) using narrative records such as presidential speeches and congressional reports, that are unrelated to countercyclical actions and factors that may affect output in the near future. Fiscal policy shocks for the euro area are computed by aggregating the tax-based consolidation measures identified by Devries and others (2011), using a similar narrative approach.

[37]Similar results are obtained when we let the dummy take value 1 during the period 2008:Q3–2009:Q2, and zero otherwise.

[38]We consider the forecasts in the April *World Economic Outlook* reports for output growth in the last two quarters of the same year and the forecasts in the October reports for output growth in the first two quarters of the following year.

Figure 3.15b. Financial Shocks

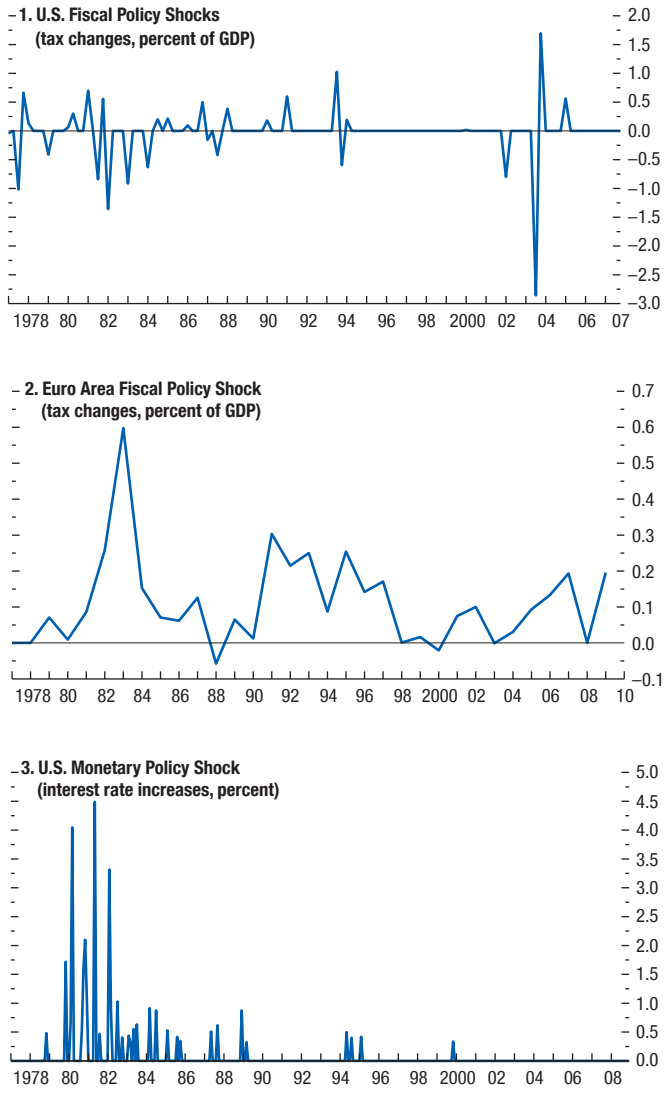
(Percent)



Sources: Bloomberg, L.P.; Gilchrist and Zakrajšek (2012); and IMF staff calculations.
Note: CDS = credit default swap.

Figure 3.15c. Policy Shocks

(Percent)



Sources: Coibion (2012); Romer and Romer (2010); and IMF staff calculations.

Monetary policy shocks (Figure 3.15c, panel 3) are exogenous innovations in the U.S. federal funds rate identified by Coibion (2012) as the residuals from an estimated Taylor rule with time-varying parameters.[39] The approach is similar to the one originally proposed by Romer and Romer (2004), but it allows a distinction between innovations to the central bank's rule (policy shocks) and changes in the rule itself. In this approach, random innovations to the rule are classified as monetary policy shocks, but policy changes such as regime changes or changes in the inflation target or GDP growth target are captured by the time-varying parameters of the rule and are therefore not classified as shocks.

Robustness checks

Our series of shocks reflects events and policies that are essentially unrelated to other factors likely to influence foreign economic activity in the short term. Thus, there is no reason to expect systematic correlation between these shocks and other determinants of foreign output growth. From an econometric point of view, this implies that the series of shocks is unrelated to the error term in equation (3.1) and that ordinary least squares estimates of ϕ_1 are in principle unbiased. Here, we assess how our baseline results are affected by adding lagged foreign output growth as a control:

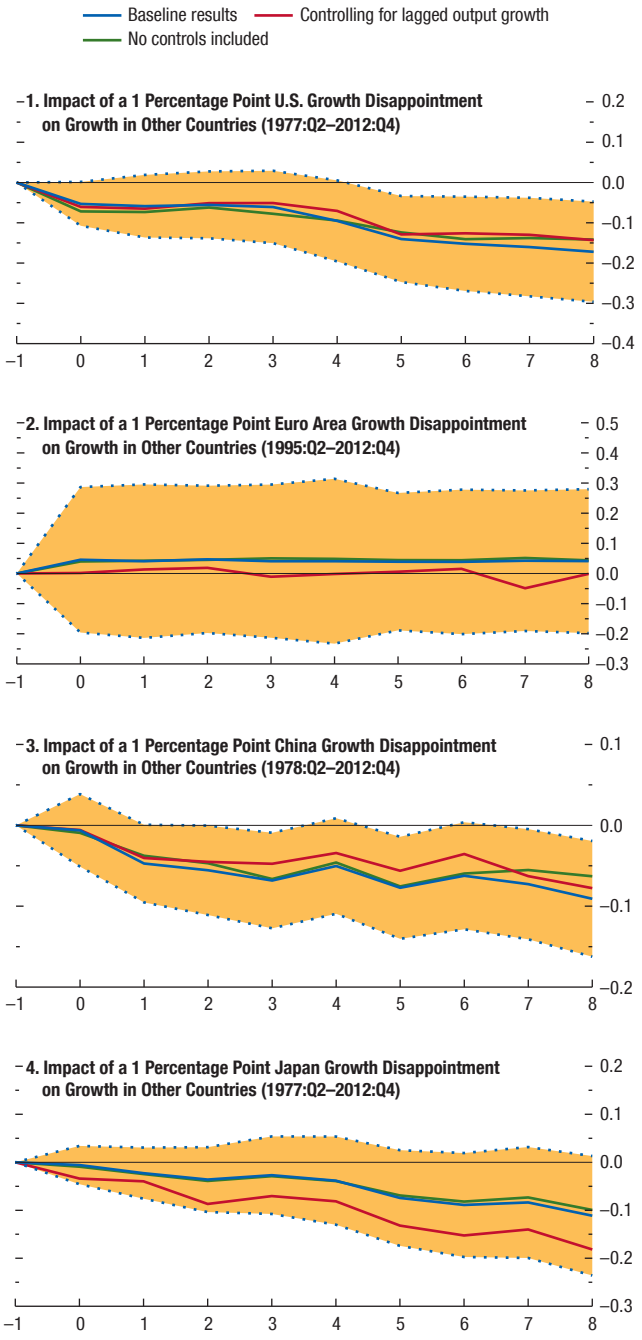
$$\Delta y_{it} = \alpha_i + \beta t + \rho(l)\ \Delta y_{it-1} + \varphi_1(l) Shock_t^m + \varphi_2(l) Global_t + \varepsilon_{it}. \qquad (3.7)$$

Including lagged output growth helps control for the normal dynamic of output. Because determinants affecting output growth are typically serially uncorrelated, it also helps control for various factors that may influence output growth in the near term.

Figures 3.16a–c show the results obtained by estimating equation 3.2 (blue lines) and equation 3.7, which control for lagged output growth (red line). The impulse response function from equation 3.7 now includes not only the direct impact of shocks on foreign output, but also the effects propagated through past growth. The figure shows that controlling for lagged output growth has almost no effect on the results. The two sets of impulse response functions are very close to each other, and the

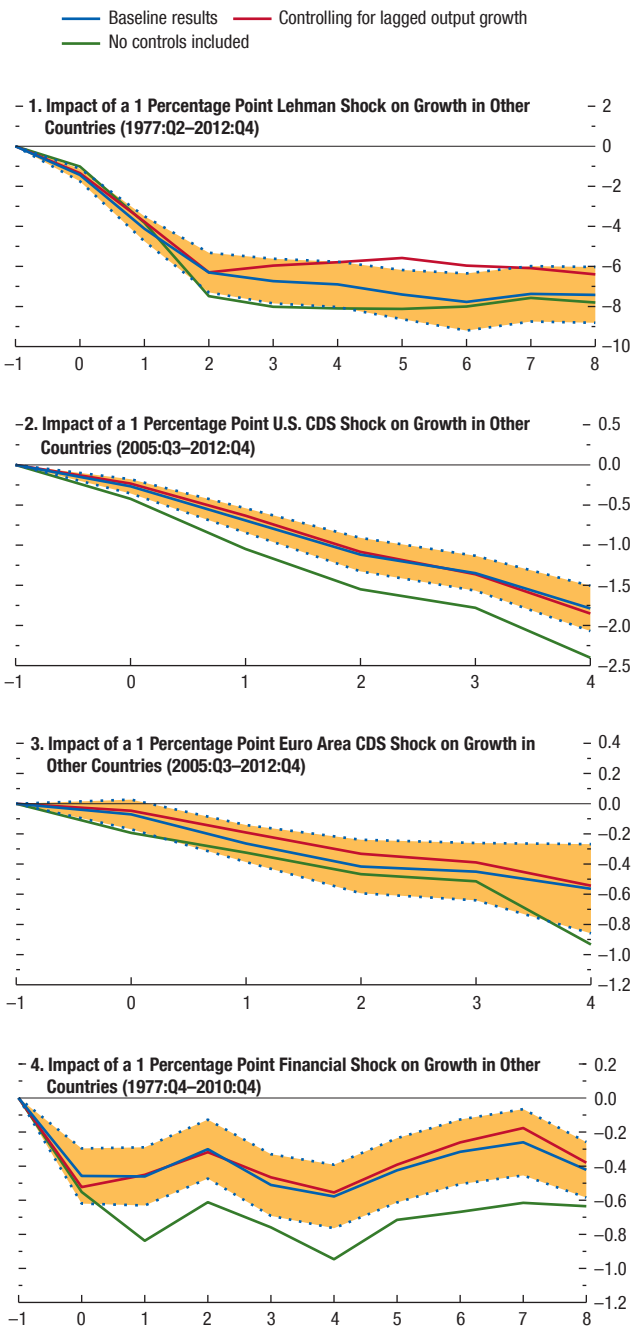
[39]In order to limit possible measurement errors associated with the monetary policy shocks, in the analysis we focus on interest rate increases greater than 30 basis points, which corresponds to the average size of exogenous increases in U.S. monetary policy. It is worth noting that the effect for smaller monetary shocks is not statistically significantly different from zero.

Figure 3.16a. Cross-Border Impact of Growth Surprises in the United States, Euro Area, and China on Growth in Other Countries



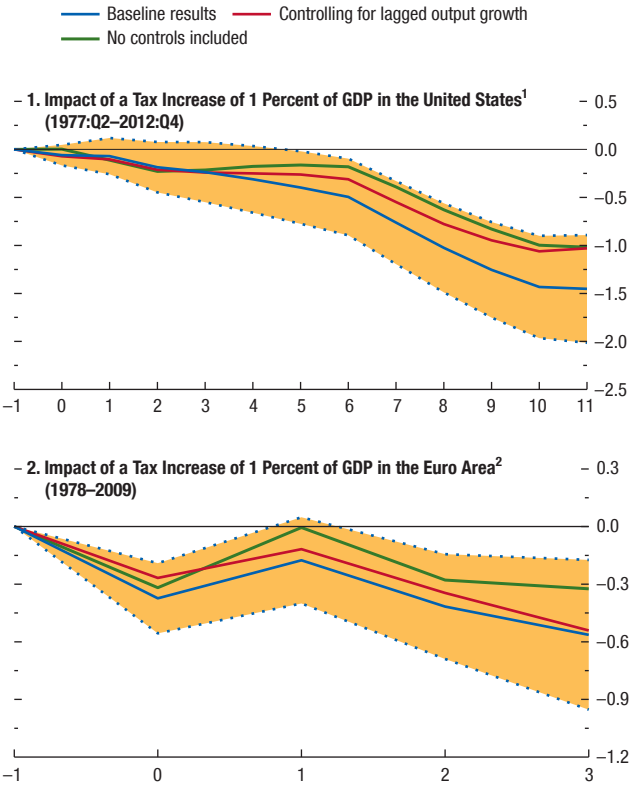
Source: IMF staff calculations.
Note: *X*-axis units are quarters; $t = 0$ denotes the quarter of the growth surprise. Dashed lines indicate the 90 percent confidence interval around the point estimate.

Figure 3.16b. Cross-Border Impact of Growth Surprises in the United States and Euro Area on Growth in Other Countries



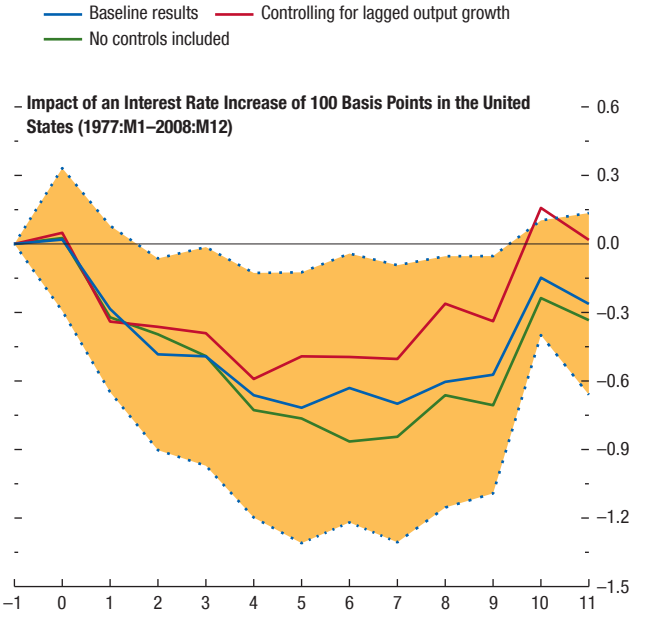
Source: IMF staff calculations.
Note: CDS = credit default swap. *X*-axis units are quarters; $t = 0$ denotes the quarter of the growth surprise. Dashed lines indicate the 90 percent confidence interval around the point estimate.

Figure 3.16c. Cross-Border Impact of Fiscal Policy Shocks on Growth in Other Countries



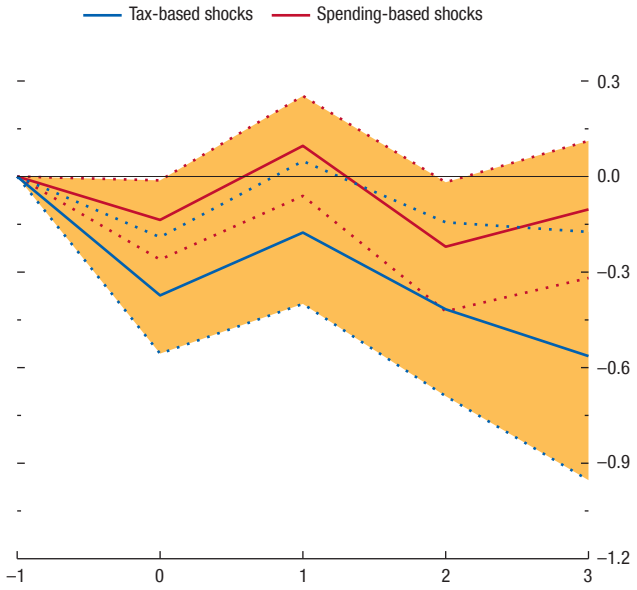
Source: IMF staff calculations.
Note: Dashed lines indicate the 90 percent confidence interval around the point estimate.
[1]The *x*-axis units are quarters; $t = 0$ denotes the quarter of the policy shock.
[2]The *x*-axis units are years; $t = 0$ denotes the year of the policy shock.

Figure 3.16d. Cross-Border Impact of Monetary Policy Shocks on Growth in Other Countries



Source: IMF staff calculations.
Note: *X*-axis units are quarters; $t = 0$ denotes the quarter of the shock. Dashed lines indicate the 90 percent confidence interval around the point estimate.

Figure 3.17. Cross-Border Output Impact of Tax- versus Spending-Based Shocks



Source: IMF staff calculations.
Note: Dashed lines indicate the 90 percent confidence interval around the point estimate. *X*-axis units are years; $t = 0$ denotes the year of the policy shock.

impulse response function obtained with lagged output growth falls within the confidence bands associated with our baseline results.

Because there is no reason to expect systematic correlation between these shocks and other determinants of foreign output growth, we should also expect that the results are robust when the set of "global" controls is excluded from the analysis. Figures 3.16a–c (yellow line) suggest that this is generally the case. Indeed, the figure shows that excluding the global controls from the analysis has almost no effect on the results. Exceptions are the results for financial shocks, which suggest that spillover effects tend to be larger when global control variables are excluded from the analysis. This, however, is not surprising giving the high correlation between financial shocks and global financial uncertainty.

Tax- versus spending-based output spillover effects

A number of studies suggest that spending-based shocks tend to have a smaller effect on domestic output than tax-based shocks.[40] A natural question is whether tax- and spending-based shocks have different spillover effects. Our results suggest that this is the case. Figure 3.17 shows the impulse response function obtained estimating equation 3.2 using euro area tax-based shocks (blue lines) and spending-based shocks (red lines) and shows that tax-based shocks tend to have large spillover effects both in the short and in the medium term.

[40]For a review, see Guajardo, Leigh, and Pescatori (forthcoming) and Ramey (2011), among others.

Box 3.1. Output Synchronicity in the Middle East, North Africa, Afghanistan, and Pakistan and in the Caucasus and Central Asia

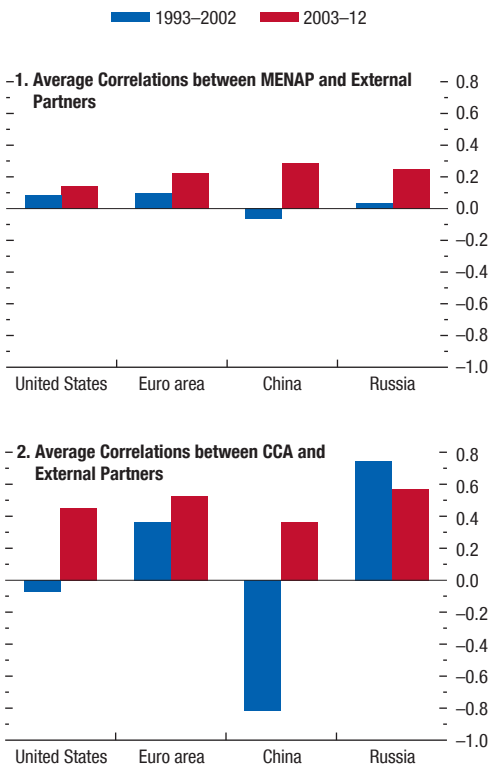
Over the past decade, growth in the Middle East, North Africa, Afghanistan, and Pakistan (MENAP) and the Caucasus and Central Asia (CCA) has become more synchronized with developments in other advanced and emerging market economies. Correlations between annual output growth in the MENAP and CCA countries and the rest of the world increased to moderate levels during 2003–12 from the low levels a decade earlier (Figure 3.1.1). The increase in output synchronicity likely reflects a number of factors, including greater trade openness of the MENAP and CCA countries, increased labor migration and remittance flows, and large shocks, such as the recent global financial crisis.[1]

One of the most striking changes has been the significant rise in output correlations between the MENAP and CCA countries and China. Although the output cycles of the MENAP and CCA economies have also become more synchronized with those in the United States and Europe (their traditional trading partners), increases in output correlations with China were much larger, in some cases turning positive from previously negative levels. Although still high, output correlations between the CCA and Russia's economy weakened over the past decade, reflecting the reorientation of the CCA trade linkages from Russia to China after the breakup of the Soviet Union.

Within the MENAP region, output cycles are not closely synchronized. Output correlations within both MENAP oil exporters and importers and between MENAP oil exporters and importers increased over the past decade but only slightly, and from low levels (Figure 3.1.2). Increased comovement within the MENAP region in 2011 was caused in part by the onset of the Arab Spring. With the rise of social unrest, several economies in the region (Egypt, Jordan, Libya, Morocco, Syria, Tunisia, Yemen) experienced disruptions in oil and non-oil production, as well as negative shocks to confidence, trade, and tourism. Other countries in the region—for example, in the Gulf Cooperation Council and Algeria—reacted to developments in the neighboring economies by also increasing public sector wages and social spending to support growth, which led to increased correlations among them. Despite these effects, average correlations in the MENAP region remain low, reflecting limited integration of the region. Correlations between the MENAP and CCA countries are also low.

Output correlations among the CCA economies declined during the past decade relative to the previous decade. After the breakup of the former Soviet Union in 1991, the CCA countries embarked on a process of socioeconomic transition. This common experience, together with the common shock of the Russian crisis in 1998, explains high output correlations of the CCA economies during 1993–2002 (see Figure 3.1.2). In the subsequent decade, the CCA economies started to

Figure 3.1.1. Output Comovements between MCD Groups and External Partners



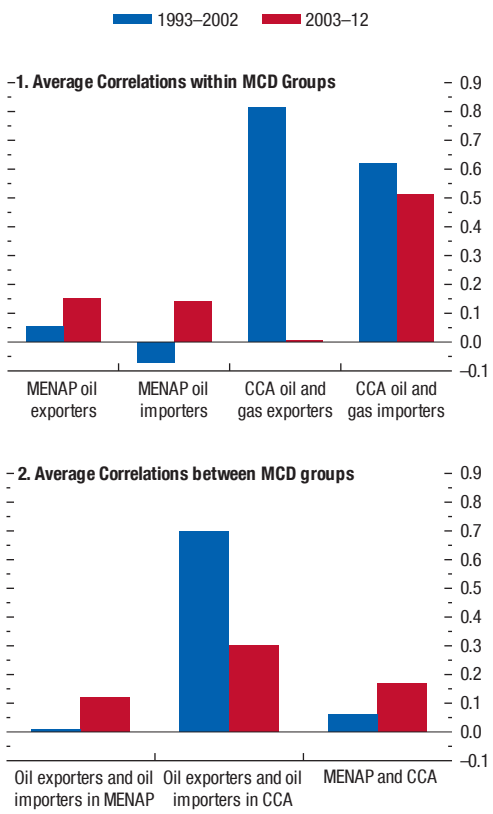
Sources: Haver Analytics; IMF, *World Economic Outlook*; Organization For Economic Cooperation and Development; and IMF staff calculations.
Note: CCA = Caucasus and Central Asia; MCD = Middle East and Central Asia; MENAP = Middle East, North Africa, Afghanistan, and Pakistan.

The authors of this box are Alberto Behar and Davide Furceri.

[1]For more details, see Box 3.3 of the November 2012 *Regional Economic Outlook: Middle East and Central Asia* (MCD REO) and Annex I of the October 2013 MCD REO.

Box 3.1 *(continued)*

Figure 3.1.2. Output Comovements in Middle East and Central Asia Country Groups



Sources: Haver Analytics; IMF, *World Economic Outlook*; Organization for Economic Cooperation and Development; and IMF staff calculations.
Note: CCA = Caucasus and Central Asia; MCD = Middle East and Central Asia; MENAP = Middle East, North Africa, Afghanistan, and Pakistan.

develop closer linkages with other countries, especially China, which caused trade and output correlations among the CCA economies to decline. The decline was much more pronounced in the CCA oil and gas exporters than in the CCA importers, where intra-regional correlations plummeted during 2003–12. Oil and gas production in these transitioning and opening economies was driven primarily by idiosyncratic factors, such as expansion of domestic productive capacity, which proceeded at an uneven pace across countries, and only weakly by common shocks reflected in global oil and gas market developments.

Box 3.2. Spillovers from Changes in U.S. Monetary Policy

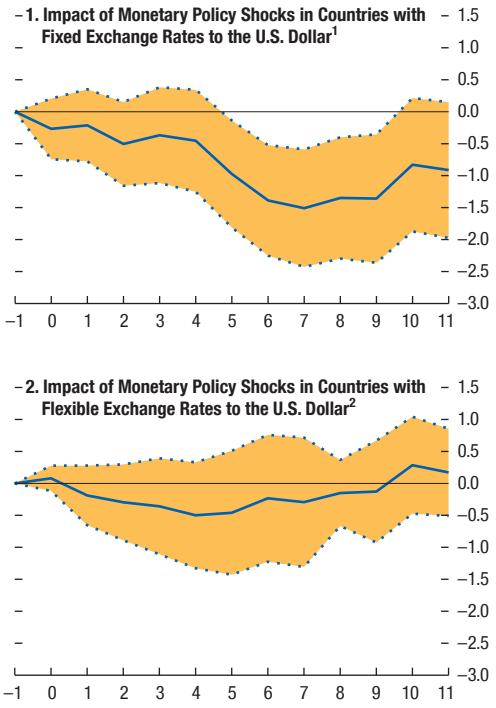
The issue of spillover effects from U.S. monetary policy is especially important in light of the possibility that interest rate normalization in the United States may proceed faster than expected. Even though current times are exceptional from a historical point of view, a look at how past U.S. monetary policy shocks have affected output in other countries may help us understand their potential effects and transmission channels. The approach here assesses how monthly movements in the U.S. policy rate (the federal funds rate) affect output and the short-term interest rates of a group of advanced economies and a group of emerging market and developing economies for which data are available.[1]

Figure 3.2.1 shows that the output effect of a U.S. monetary policy shock varies with the exchange rate regime. In particular, while an increase of 100 basis points in the federal funds rate reduces output by about 1½ percent after six months in countries with an exchange rate regime pegged to the U.S. dollar—compared with an output contraction in the United States of about 2 percent—it has no significant effect for countries that float their currency against the dollar. A plausible explanation of the difference is that a country that pegs its currency to the dollar "imports" the U.S. monetary policy stance, with implications for its domestic short-term rates and, thus, its domestic economy. In practice, however, not all peggers allow perfect capital mobility; therefore, how much a country's interest rate is affected by changes in U.S. monetary policy is an empirical question that we investigate.

Our results show a wide range of interest rate reactions to changes in the U.S. policy rate (Figure 3.2.2); among the largest reactions are those in countries with histories of pegging against the dollar (Hong Kong SAR, Israel, Korea). But the rate reaction in Canada, a floater, is also among the largest, which exemplifies the possibility that, in the presence of common shocks (or a well-synchronized business cycle), what we label interest rate spillovers may instead represent underlying comovements.

For example, if the United States and Canada have synchronized business cycles—perhaps because of geographical proximity—then Canadian rates are highly likely to move with the U.S. policy rate. However, this could simply reflect synchronized economic fluctuations faced by the U.S. and Canadian central banks. To mitigate this complication, we instrument movements in the federal funds rate with the nonsystematic unexpected component of the U.S. monetary policy—specifically, with the exogenous monetary policy shocks constructed by Coibion (2012).[2] Instrumenting

Figure 3.2.1. Impact of Monetary Policy Shocks
(100 basis points)



Source: IMF staff calculations.
Note: Dashed lines indicate the 90 percent confidence interval around the point estimate.
[1]The *y*-axis is the cumulative impact on the level of industrial production. *X*-axis units are months; $t = 0$ denotes the month of the policy shock.
[2]The *x*-axis units are months; $t = 0$ denotes the month of the policy shock.

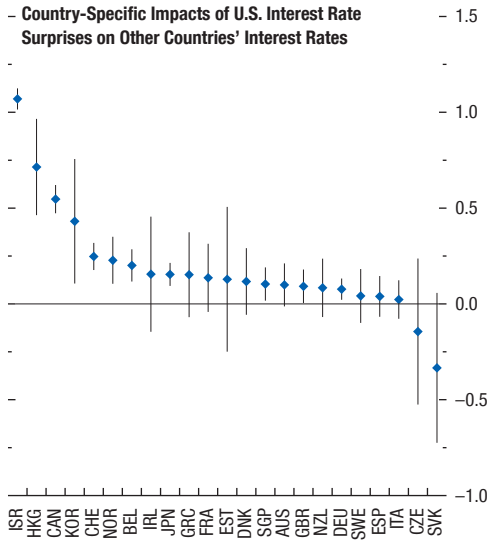
The author of this box is Andrea Pescatori.

[1]The sample period covers January 1977 to December 2008. The data are monthly and the panel is unbalanced. Our preferred definition of the short-term interest rate was monthly averages of either the policy rate or an overnight interest rate; when one of those was not available, government Treasury bill rates were used. Because of the monthly frequency, industrial production is used as the measure of output.

[2]Coibion (2012) extends the series of monetary policy shocks derived in Romer and Romer (2004). This series is constructed by first using a narrative approach to extract measures of the change in the Federal Reserve's (Fed's) target interest rate at each

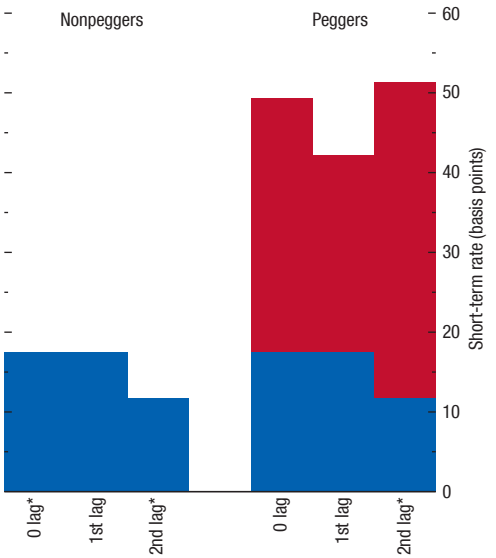
Box 3.2 *(continued)*

Figure 3.2.2. Monthly Percent Increase on Short-Term Rates



Source: IMF staff calculations.
Note: AUS = Australia; BEL = Belgium; CAN = Canada; CHE = Switzerland; CZE = Czech Republic; DEU = Germany; DNK = Denmark; ESP = Spain; EST = Estonia; FRA = France; GBR = United Kingdom; GRC = Greece; HKG = Hong Kong SAR; IRL = Ireland; ISR = Israel; ITA = Italy; JPN = Japan; KOR = Korea; NOR = Norway; NZL = New Zealand; SGP = Singapore; SVK = Slovak Republic; SWE = Sweden. Changes in short-term interest rates are regressed on changes in the federal funds rate and controls at monthly frequencies. A random coefficient model allows for heterogeneous slopes. Black vertical lines represent 95 percent confidence bands.

Figure 3.2.3. Response to Federal Funds Rate Shocks



Source: IMF staff calculations.
Note: Impact coefficients of current and lagged federal funds surprise changes for nonpeggers and peggers. Changes in short-term interest rates are regressed on changes in the federal funds rate instrumented by federal funds rate shocks, a peg dummy, and interaction terms.
* means the bar is statistically significant at the 5 percent level.

the U.S. rate changes with monetary policy surprises, and introducing a dummy for pegging vis-à-vis the U.S. dollar allows us to test whether the magnitude of U.S. interest rate spillovers varies with the exchange rate regime.[3]

For all countries, peggers or not, a surprise increase of 100 basis points in the U.S. policy rate results in a statistically significant rise in interest rates of at least 18 basis points in the same month. Over the entire quarter following a U.S. surprise, all countries see a statistically significant increase of at least 30 basis points (Figure 3.2.3).

The interaction terms are also significant, supporting the view that the exchange rate regime plays an important role.[4] Countries that peg their currency to the dollar have an additional impulse of at least 40 basis points, for a total of about 70 basis points. Statistically, we cannot reject the possibility that the interest rate of a pegging country reacts one to one to movements in the federal funds rate, as theory would predict for a perfectly credible peg. Even when the exchange rate is free to adjust, interest rates are affected by U.S. monetary policy. This result may help us reconcile the fact that the output response of floaters to U.S. monetary policy shocks is not significantly different from zero. In fact, a 10 basis point surprise increase in the U.S. policy rate causes the dollar to appreciate by

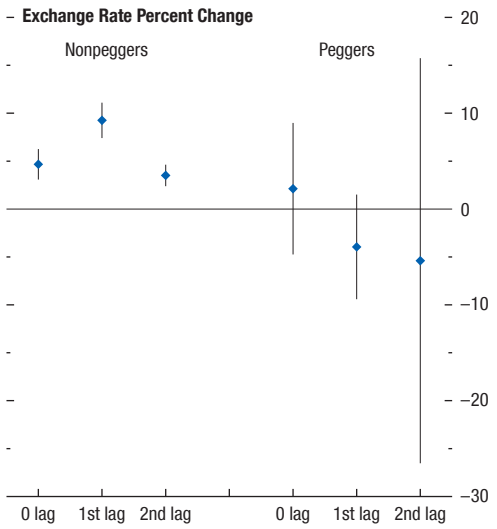
Federal Open Market Committee meeting between 1969 and 2007. This measure of policy changes is then regressed on the Fed's real-time forecasts of past, current, and future inflation; output growth; and unemployment. The residuals from this regression constitute the series of monetary policy shocks used to instrument federal funds rate changes in our analysis.

[3]The exchange rate flexibility measure comes from Lane and Shambaugh (2010).

[4]While capital controls may also affect the spillover effect of U.S. monetary policy, with the expectations that more open countries will be more affected, previous studies typically find weak evidence in support of this hypothesis (di Giovanni and Shambaugh, 2008).

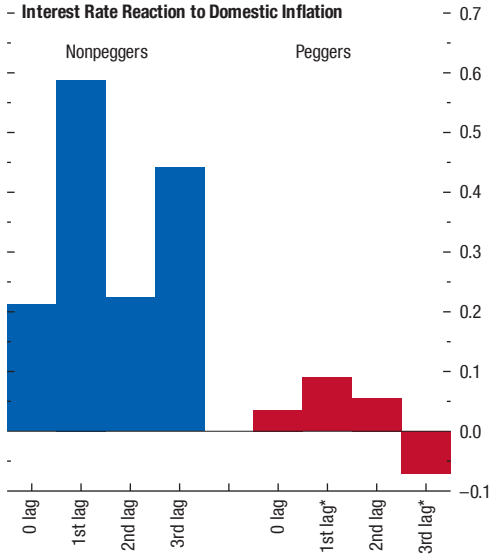
Box 3.2 *(continued)*

Figure 3.2.4. The Exchange Rate Response to Federal Funds Rate Surprises



Source: IMF staff calculations.
Note: Current, first, and second month impact coefficient of a 10 basis point federal funds rate surprise change on the change in the exchange rate (local currency per U.S. dollar) of advanced economies divided, at times, into peggers and nonpeggers. Exchange rate log differences are regressed on country-fixed effects and three lags of federal funds rate changes instrumented by surprises. Regressions are run separately for peggers and nonpeggers. Standard errors are robust, and confidence bands are shown at the 5 percent level.

Figure 3.2.5. Monetary Policy Autonomy



Source: IMF staff calculations.
Note: Impact coefficients of current and lagged federal funds rate surprise changes for nonpeggers and peggers. Changes in short-term interest rates are regressed on changes in the federal funds rate instrumented by federal funds rate shocks, a peg dummy, and interaction terms.
* means the bar is statistically significant at the 5 percent level.

4 percent in the current month and by a cumulated 18 percent during the quarter, stimulating exports to the United States and thus output (Figure 3.2.4). This beneficial effect, however, is probably offset by the partial increase in domestic interest rates.

The question is nonetheless still open as to why floaters are affected by U.S. monetary policy shocks. We propose two possible explanations. First, it is still possible that we are not able to perfectly control for common factors. However, this explanation seems unlikely since surprises in the federal funds rate should be orthogonal to common factors, to the extent that these influence inflation and output gaps. Moreover, this result is robust to domestic output and domestic inflation as control variables. Second, and more likely, it is possible that no country completely disregards its exchange rate with the dollar. In this case, the magnitude we found gives some idea of the trade-off that a central bank faces between stabilizing the exchange rate and responding to domestic economic conditions.

Responding to changes in U.S. policy rates should result in a loss of monetary policy autonomy because it would reduce the space available for domestic monetary policy to respond to domestic economic conditions. This is the open-economy trilemma: an open economy can pursue only two of three goals: fixed exchange rates, domestic monetary autonomy, and capital mobility. Analyzing this question empirically, we find, as expected, that when a country pegs its exchange rate, it is less likely to react to domestic inflation (Figure 3.2.5).

Finally, when the same analysis is performed on a sample of emerging market and developing economies, the results are obscured by the various episodes of high inflation in those economies during the sample period. However, once we exclude these episodes, the results are qualitatively similar to those for advanced economies although statistical significance declines.

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