Western Hemisphere Department

WHO'S DRIVING WHOM?

Analyzing External and Intra-Regional Linkages in the Americas

Martin Mühleisen, Shaun K. Roache, and Jeromin Zettelmeyer
Editors

INTERNATIONAL MONETARY FUND

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Preface

This book summarizes much of the analysis conducted by a working group on intra- and interregional economic and financial linkages in the Americas. The working group consisted of economists and research assistants of the IMF's Western Hemisphere Department (WHD), headed by Martin Mühleisen and Jeromin Zettelmeyer under the supervision of David J. Robinson. The work was performed under the leadership of Director Anoop Singh, whose vision of a new way of doing cross-country work inspired the creation of this group.

In addition to the authors of the chapters in this book, significant contributions to the working group were provided by Natalia Berrera, Cleary Haines, Magda Kandil, James P. Walsh, and especially Kristian Hartelius, Padamja Khandelwal, and Álvaro Piris.

The authors of the chapters of this book wish to thank a large number of colleagues, both in WHD and elsewhere in the Fund, as well as discussants and participants in a departmental seminar on November 26, 2007, for their comments and inspirations.

Pär Österholm and Jeromin Zettelmeyer are especially grateful to Caroline Atkinson, Eduardo Borensztein, Ben Clements, Alejandro Izquierdo, Chris Jarvis, Eduardo Levy Yeyati, Ernesto Talvi, and seminar participants at the LACEA 2007 Annual Meetings for valuable comments and discussions, and Priya Joshi for outstanding research assistance.

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A special thanks goes to Gloria Bustillo, Myadali Soe-Lin, and particularly Maria S. Gutierrez, who ensured the smooth operation of the working group with much efficiency and enthusiasm, and whose input was essential when it came to the construction of the website and the organization of the departmental seminars.

We are also grateful to Marina Primorac of the IMF's External Relations Department and her team for their guidance through the publication process and support in securing editorial assistance. Claudia Ghersi and Eugen Tereanu showed great skill in arranging the charts and tables for this volume, and Andrea Aquino provided valuable assistance in the typesetting process.

We are particularly indebted to Joy Villacorte, who worked tirelessly with editors, proofreaders, and authors to get each individual chapter ready for publication. She made this project her own, and the book would not have been published without her great dedication and excellent word-processing skills.

The Editors

Chapter 1

Introduction and Summary

Martin Mühleisen, Shaun K. Roache, and Jeromin Zettelmeyer

In a global economy beset by concerns over a growth recession, financial volatility, and rising inflation, many countries in the Western Hemisphere have been among the few bright spots in recent years. Not that these countries were immune to the shocks that hit around the globe, especially the challenge posed by rampant food and energy price increases. Overall, however, economic growth has been resilient, balance sheets have remained strong, and financial institutions have been largely isolated from the turbulence that has affected their brethren in the industrialized world.

These developments fly in the face of traditional views of the "if the United States sneezes, Latin America catches a cold" type. However, they have not come as a surprise to those following the significant progress achieved by many countries in recent years, both in macroeconomic management and on the structural and institutional front. A decline in export commodity prices may yet test the resilience of these achievements—a fact not lost in recent debates of whether the glass of economic reforms in Latin America is half full or half empty—but there seems to be a strong consensus that economic and financial linkages between Latin America, the United States, and other important regions of the world economy have undergone profound change.[1]

The papers compiled in this book analyze these "linkages" from many different angles. They reflect the outcome of what began as a stock-taking exercise in the IMF's Western Hemisphere Department in late 2006. Given the mandate to strengthen the institution's work on cross-country and regional issues, a working group of about 15–20 economists set out to have a fresh look at some of the questions that researchers (and policymakers) in both North and South America have grappled with for decades, for example:

- How do changes in global economic conditions affect countries in the Western Hemisphere? Are countries different in their response to external shocks, and what could account for such differences?
- What role do factors such as external demand, global interest rates, risk appetite, remittance flows, or commodity prices play in the propagation of shocks?
- To what extent are countries still dependent on the United States as a growth locomotive and provider of capital? Have financial markets become more integrated, and what is the role of capital flows in transmitting financial volatility, or even crises?

The results are presented in three sections, focusing in turn on (1) business cycle linkages, (2) commodity price shocks and inflation, and (3) financial linkages. Literature surveys on each topic are presented separately at the end of the book. Many of the papers were discussed during the Western Hemisphere Department's 2007 Annual Research Seminar, the proceedings of which are available online.[2]

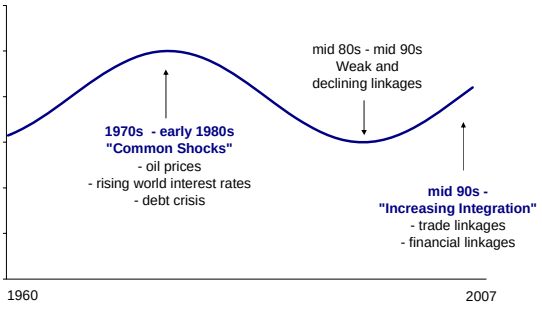
[1] For a debate on the sustainability of Latin America's current fortunes, see IDB (2007) and Zettelmeyer (2007).

[2] See www.imf.org/external/np/seminars/eng/2007/whd/index.htm.

Business Cycle Linkages

Survey work suggests that trade and financial integration have again strengthened Latin America's business cycle linkages with the outside world. This process began in the mid-1990s; however, the degree of business cycle synchronization is still considered to be below the peaks of the 1970s and early 1980s (see Figure 1.1). During this earlier period, linkages were strong because countries faced common shocks, including global oil supply disruptions and, subsequently, a rise in world interest rates and the emergence of the regional debt crisis. Today, different factors are at work. Although world commodity prices are on the rise once again, common shocks are now playing a less important role. Trade liberalization, increasing openness, and the globalization of capital markets, including for foreign direct investment, currently explain much of the region's rising sensitivity to external factors.

Figure 1.1



Another key finding has been that the exposure to external cyclical factors varies widely across the region. The relative importance of the United States as an export market has declined, but the overall increase in openness means that exports to the United States have risen relative to GDP in most countries since the early 1990s. U.S. linkages are strongest within NAFTA, followed by those between the United States and Central America. While rising, linkages between South America and the United States, and within South America itself, remain weaker. Instead, trade and investment linkages to other regions have been growing, particularly with Europe (e.g., Brazil, Chile) and Asia. World Bank studies have found that the emergence of China as a trading partner has so far had a small overall impact on Latin America, although it has triggered some shifts in production from low-wage to high-wage sectors.[3]

An empirical model presented by Par Österholm and Jeromin Zettelmeyer (Chapter 2) sheds light on the relative contribution of external shocks to output fluctuations in Latin America between 1994 and 2007. The authors estimate that external factors account for at least half of the medium-term variance of Latin American GDP growth. The overall impact of an export-weighted world growth shock on Latin America is estimated to be roughly one-for-one, and commodity prices and borrowing spreads (the Latin EMBI, or U.S. high-yield spread) are also found to play an important role. Standardized shocks to commodity prices and spreads—equivalent to about 5 percent and 75–100 basis points, respectively—each contribute to a change in the Latin American growth rate of at least ½ percentage point. This said, there is reason to believe that the resilience of Latin America to the U.S. financial shocks has increased relative to the sample period. The transmission mechanism for these shocks during the 1994–2007 typically involved Latin American borrowing spreads. Recently, however, the response of these spreads to financial shocks in the U.S. has been far more muted.

A particular focus of the work on business cycle linkages has been on two regions that were expected to have particularly strong linkages with the United States—the NAFTA countries and Central America. In Chapter 3, Andrew Swiston and Tam Bayoumi explore business cycle synchronization and economic growth spillovers in an environment of increasing trade integration within NAFTA. They found that linkages between Canada and the United States have been high and stable over time: about 75–80 percent of a U.S. growth shock are passed on to Canada. In contrast, linkages between Mexico and the United States have strengthened following the

[3] See Lederman, Olarreaga, and Perry (2006).

implementation of NAFTA, in part because the external anchor appears to have lowered domestic instability, and now the Mexican growth response to a U.S. shock is even greater than one-for-one.

Shaun Roache analyzes the Central American angle (Chapter 4). The economies of this region are relatively open and geographically close to the United States, and cyclical fluctuations are being transmitted through several transmission channels, including trade, the financial sector, and migrant worker remittances. The paper indeed finds that the Central American business cycle is dominated by the United States. However, output growth does sometimes diverge, and the model suggests that region-specific shocks, including civil conflicts, terms of trade shocks, and poor policy responses—rather than a unique regional business cycle—in the past have played an important role.

Commodity Price Shocks

One of the most important economic developments in recent years has been the rise in global energy and commodity prices. Nkunde Mwase and Guy Meredith in Chapter 5 present a timely analysis of how higher world oil prices were passed through to retail prices in the Latin America and the Caribbean during 2003-07. For the region as a whole, they find that there has been low pass-through on average during this period, although there was significant variation across the region, with higher pass-through generally observed for the oil-importing countries.

Taking a broader perspective of inflation, Rita Babihuga and Ana Corbacho show that world commodity price shocks have had a clear impact on inflation across the region (Chapter 6). Their empirical analysis suggests that world commodity prices typically explain about 30 percent of the variation in headline inflation, with food price pass-through much higher than for energy. They estimate that the 30 percent increase in world food prices during 2006-07 has raised annual headline inflation rates by an average of 1 percentage point, equivalent to the increase in inflation in the whole region during 2007. In contrast, the 50 percent rise in world fuel prices over the same period would have raised inflation by 0.3 percentage points.

Financial Linkages

Our literature surveys also have found ample evidence for the transmission of financial shocks from global markets to the region. Monetary policy "surprises" in the United States—which are most widely studied—have had an important impact on local equity markets and sovereign credit spreads. These effects were generally found to be stronger for countries with a pegged exchange rate than for countries with a flexible rate. The intensity of equity market spillovers also seemed to be positively linked to the degree of openness and liquidity of financial markets, and the degree of financial and real integration. While these spillovers have increased over time, the literature found that—outside a crisis period—their impact on the business cycle is usually superseded by other shocks.

Not surprisingly, there is evidence of anomalous shock propagation during crises, suggesting that financial relationships change fundamentally during such times. Volatility in capital flows, including sudden stops, has been particularly high in Latin America. Possible reasons include small tradable sectors in Latin America (e.g., compared to Asia), as well as low scores on indices of corporate and macroeconomic transparency, both of which tend to be associated with a higher crisis probability. However, to the extent that fundamentals in Latin American countries have improved, the region may have reduced its vulnerability to shocks.[4]

One of the fundamental changes that may have supported greater resilience has been the development of domestic financial markets that

[4] This finding has been confirmed by a simulation exercise (not reported in this book) that found the increase in the Latin America risk premium to be somewhat lower than predicted by a sovereign spreads model. Although probably still within the margin of error of such models, this suggests that the market had little reason to question the still-strong fundamentals of countries in the region.

have attracted a larger amount of foreign investment to Latin America. Ravi Balakrishnan and Fernando Goncalves analyze the impact of financial flows from the United States to regional economies (Chapter 7). Using a comprehensive dataset, they find external factors, such as global risk aversion and U.S. interest rates, still tend to be more important than domestic fundamentals in driving capital flows from the United States to Latin America. However, the link from capital flows to domestic financial conditions is quite weak and superseded by other factors, including global measures of risk aversion. This suggests that financial shocks are largely transmitted through prices rather than flows.

Roberto Benelli and Srideep Ganguly study day-to-day spillovers of shocks from U.S. financial markets to regional stock, bond, and currency markets, with a particular focus on periods of higher global market volatility (Chapter 8). They find that the sensitivity of Latin American financial markets to U.S. shocks is higher during periods of global market turbulence. For example, the amount of volatility in regional stock markets explained by U.S. factors during turbulent times is, on average, double that for periods of relative tranquility. One key result is that currency markets in Latin America have exhibited a decrease in linkages with the United States, which could be explained by the rising degree of exchange rate flexibility in the region.

Finally, the book returns to the relation between Canada and the United States—possibly the two countries with the closest economic and financial relationship in the Western Hemisphere. In Chapter 9, Vladimir Klyuev considers three transmission channels to assess the impact of tighter U.S. financial conditions on Canada: (i) trade, (ii) the cost of capital for firms in Canadian markets, and (iii) the amount of capital raised by Canadian firms in U.S. markets. The analysis shows that U.S. financial conditions are important for Canada—a 1 percentage point increase in the U.S. short-term interest rate leads to a decline in real Canadian GDP growth of up to 1¼ percentage points. The main impact comes through the financial channel, first and foremost through the cost for Canadian firms to rely on funding through U.S. markets, and secondly through the lingering effects emerging of tighter conditions in Canadian financial markets.

Conclusions

For most emerging market and developing countries in the Western Hemisphere, the integration with the global economy and financial markets has continued to deepen since the mid-1990s. Besides studying the linkages that increasingly tie these countries to the rest of the world, the papers presented in this volume also provide clues as to whether the benefits of globalization will come with the cost of increased vulnerability to external shocks. For much of the region, however, the answer is "probably not."

There is relatively strong evidence that financial linkages have been the most important transmission mechanism for external shocks. In the past, external shocks were amplified through capital markets movements that reacted to rigid economic policies. Such movements have been quite rapid, as underlined by the finding that prices—rather than capital flows which typically reverse with some lag—provide the key transmission mechanism.

As economic policies have become more flexible—supported by higher credibility of central banks and sounder fiscal policies—this amplification effect appears to have weakened. Most strikingly, while food and energy price shocks have been quickly passed through to domestic inflation, stresses in developed credit markets and the rise in global commodity prices in 2007 and 2008 have not led to an uptick in regional economic and financial volatility comparable to that experienced in past cycles.

Yet, it is also important to remember that many countries have benefited from positive terms of trade shocks and, hence, the new paradigm of stability remains to be tested by a sustained decline in the price of export commodities. In general, however, the result of the papers confirm the importance of good economic policies—flexible exchange rates, low inflation, and a responsible fiscal

stance tend to produce better outcomes and lower degrees of vulnerability.

In summary, a combination of stronger external linkages and more flexible policies suggest that the region may receive the benefits of globalization without necessarily increasing its vulnerability to external shocks. As the English proverb goes, the region may be able to have its cake and eat it, too.

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Part I

Business Cycle Linkages

Chapter 2

The Effect of External Conditions on Growth in Latin America

Pär Österholm and Jeromin Zettelmeyer

Following the economic crises of the late 1990s and early 2000s, Latin America has enjoyed an extraordinary recovery. From 2004 to 2007, the region grew at an average annual rate of more than 5 percent, making this period the longest and most vigorous expansion since the late 1970s. Furthermore, public and private overconsumption, which have tended to accompany similar expansions in the past, have been largely absent. Inflation has generally been low and falling, public debt has declined, and primary fiscal balances and external current accounts reached record surpluses in 2006. Some strains and policy slippages—inflation pressures, and a decline in the fiscal surplus—began to emerge in 2007, but compared to its historical record, the macroeconomic position of Latin America remains strong (IMF, 2006a and 2007).

Though improved macroeconomic policy frameworks no doubt deserve some credit, Latin America watchers are quick to point to out that the region's extraordinary improvement in macroeconomic fundamentals has occurred in the context of an external environment that has been just as extraordinary, with high world growth, ample private financing, historically low emerging market risk premiums, and high commodity prices (Talvi, 2007; and Calvo and Talvi, 2007). This observation leads to the main questions of this chapter. Can Latin America's current growth be expected to continue if external conditions deteriorate? What impact would external shocks—both real and financial—have on Latin America's growth performance? More specifically, how is the ongoing slowdown in U.S. growth, and tightening in credit conditions of lower-rated borrowers, likely to affect Latin America?

This chapter addresses these questions using a novel technique, namely, a Bayesian vector autoregressive (BVAR) model with "informative priors" on *steady state* values. As is standard in BVAR models, we place priors on the dynamic behavior of the model as a step toward addressing the loss in estimation precision caused by the generous parameterization of VARs. In addition, however, our approach exploits outside information about the steady state of variables such as GDP growth. Incorporating such information into the model estimation makes it more likely that forecasts will converge to levels judged sensible by the forecaster; this convergence should improve out-of-sample forecasting performance (see, for example, Villani, 2005; and Adolfson and others, 2007). The efficiency gain is likely to be especially important for the questions addressed in this chapter, because structural changes in Latin America between the mid-1980s and the mid-1990s—external opening, liberalization, and stabilization from hyperinflation in several large countries—restrict the useable sample to about a dozen years. Indeed, our model is shown to outperform both a classical VAR and a conventional BVAR in terms of forecasting performance at most horizons.

The main results are as follows:

- External shocks—financing shocks, external growth shocks, and commodity price shocks—explain more than half of the forecast error variance of the growth rate of an aggregate Latin American output index at standard medium-term horizons. Of these shocks, financing shocks turn out to be the most important, explaining more than half of the contribution of external shocks.

- The impulse responses in the model deliver some rules of thumb on the dynamic impact of various external shocks on Latin American growth. In particular, the overall impact of a world shock on Latin America is roughly one-for-one over time. One standard deviation shocks for commodity prices and the Latin EMBI (Emerging Markets Bond Index)—namely, changes of about 5.5 percent and 110 basis points, respectively, within one quarter—are both estimated to lead to a change in Latin American growth of about 0.4 percentage point. The effect of a standard deviation shock in the U.S. high-yield bond spread (67 basis points) is estimated to be even higher (0.7 percentage point).
- Conditional forecast exercises suggest that Latin American growth would be fairly resilient to a moderate slowing of external growth as envisaged in the IMF's October 2007 *World Economic Outlook* projection. The reason is that even with such a slowing, Latin America's external environment would still remain relatively favorable—sustained, in particular, by continuing high commodity prices and relatively low external financing premiums. However, this environment could change if the U.S. economy enters a recession in 2008. The combination of a 2008 U.S. recession and a credit crunch in advanced financial markets—captured in our model by a rise in the U.S. high-yield bond spread to more than 700 basis points—could reduce Latin American growth by as much as 2 percentage points below the baseline forecast.

Notably, these results reflect the average behavior of Latin American economies over the 1994–2007 sample period. In the meantime, many Latin American economies may have undergone structural changes—most dramatically, a large reduction in currency mismatches. Consequently, the results may overstate Latin America's current vulnerability to external shocks, particularly financing shocks. This said, our conditional forecasting framework helps address this problem by allowing us to impose specific paths of variables (such as the Latin EMBI) if we have reason to think that these may behave differently in the future compared to typical past behaviors. Comparing these conditional forecasts with forecasts that allow the Latin EMBI to respond endogenously gives a sense of the sensitivity of growth forecasts to alternative assumptions about financial transmission channels.

This chapter contributes to a large and diverse literature on the effect of external factors on growth in Latin America; see Cuevas, Messmacher, and Werner (2003); Canova (2005); Kose and Rebucci (2005); and IMF (2007, Chapter 4) for some contributions, and Chapter 10 for a survey. The chapter is most closely related to a recent study by Izquierdo, Romero, and Talvi (2008), who likewise examine the effects of financial, commodity price, and external growth shocks on Latin American growth at the business cycle frequency. However, the empirical methodologies and focus of the two papers are different, with Izquierdo, Romero, and Talvi interested mainly in the role of external factors in the most recent expansion, while we are interested in assessing the robustness of the expansion to a number of adverse external scenarios.

The Model

Methodology

Although VAR models are a common tool in empirical macroeconomics—used both in forecasting and for analyzing the dynamic impact of shocks to the economy—they have some drawbacks. One problem is their heavy parameterization; in combination with small or moderate samples, this can result in poor forecasting performance, particularly at longer horizons, because the levels at which forecasts converge are a function of the estimated parameters of the model. As a potential solution to this problem, Villani (2005) suggests a Bayesian VAR approach with an "informative prior" on the steady state of the process.

To see the benefits of this approach, consider first the standard BVAR model:

$$\mathbf{G}(L)\,\mathbf{x}_t = \boldsymbol{\mu} + \boldsymbol{\eta}_t \qquad (1)$$

where $\mathbf{G}(L) = \mathbf{I} - \mathbf{G}_1 L - \ldots - \mathbf{G}_p L^p$ is a lag polynomial of order p, $\mathbf{x}_t$ is an n x 1 vector of stationary macroeconomic variables, and $\boldsymbol{\eta}_t$ is an n x 1 vector of identically indepedently distributed error terms fulfilling $E(\boldsymbol{\eta}_t) = \mathbf{0}$ and $E(\boldsymbol{\eta}_t \boldsymbol{\eta}_t') = \boldsymbol{\Sigma}$. It is typically difficult to specify a prior distribution for $\boldsymbol{\mu}$ in equation (1), and therefore the solution has often been to employ a noninformative prior for these parameters. However, the difficulty of specifying a prior for $\boldsymbol{\mu}$ is related to the chosen specification. Consider the alternative parameterization of the model suggested by Villani (2005):

$$\mathbf{G}(L)(\mathbf{x}_t - \boldsymbol{\psi}) = \boldsymbol{\eta}_t \qquad (2)$$

where $\mathbf{G}(L)$, $\mathbf{x}_t$, and $\boldsymbol{\mu}_t$ all are defined as above. This model—while nonlinear in its parameters—has the feature that $\boldsymbol{\psi}$ immediately gives us the steady state of the series in the system. Hence, the forecaster often has an opinion regarding the parameters of $\boldsymbol{\psi}$ and an informative prior distribution can accordingly be specified.

In this chapter, we follow Villani (2005) in estimating model (2), with the prior on $\boldsymbol{\Sigma}$ given by $p(\boldsymbol{\Sigma}) \propto |\boldsymbol{\Sigma}|^{-(n+1)/2}$, the prior on $\mathbf{vec}(\mathbf{G})$—where $\mathbf{G}=(\mathbf{G}_1 \ldots \mathbf{G}_p)'$—given by $\mathbf{vec}(\mathbf{G}) \sim N_{pn^2}(\boldsymbol{\theta}_\mathbf{G}, \boldsymbol{\Omega}_\mathbf{G})$, and the prior on $\boldsymbol{\psi}$ given by $\boldsymbol{\psi} \sim N_n(\boldsymbol{\theta}_\psi, \boldsymbol{\Omega}_\psi)$. That is, the prior on $\boldsymbol{\Sigma}$ is noninformative, while the priors on the vectors of dynamic coefficients $\mathbf{vec}(\mathbf{G})$ and steady state parameters $\boldsymbol{\psi}$—which are characterized by normal distributions centered on particular values—will generally be informative. We will return to and discuss the parameters of these priors below. The priors are then combined with the data through the likelihood function. The conditional posterior distributions of the model are derived in Villani and the numerical evaluation is conducted using the Gibbs sampler with the number of draws set to 10,000.[1]

Empirical Implementation

External conditions that might be relevant for Latin America comprise (at a minimum) three sets of factors: external demand, commodity prices, and global financial conditions. In our model, external demand is proxied by GDP growth of Latin America's trading partners, weighted using export shares. We refer to this index as world GDP growth; note, however, that the weights are different from the usual purchasing power parity (PPP) GDP-based weights (in particular, U.S. growth is weighted with about 0.55 rather than its weight of about 0.2 in the world economy). Commodity prices are captured using a net export share-weighted index, and external financial conditions are captured using U.S. treasury bill rates and the high-yield corporate bond spread in the United States.[2] A weighted index for Argentina, Brazil, Chile, Colombia, Mexico, and Peru—referred to as the "LA6" in the remainder of this section—was used to measure Latin American growth.[3] In addition, the model included the Latin America subcomponent of JPMorgan's Emerging Market Bond Index, which is influenced by both external financing conditions and domestic fundamentals in Latin America.[4] Hence:

$$\mathbf{x}_t = (\Delta y_t^{world} \quad i_t^{US} \quad \boldsymbol{HY}_t \quad \Delta y_t \quad \Delta c_t \quad \boldsymbol{EMBI}_t)' \qquad (3)$$

where y_t^{world} is the logarithm of export-share weighted world GDP, i_t^{US} is the three-month treasury bill rate,

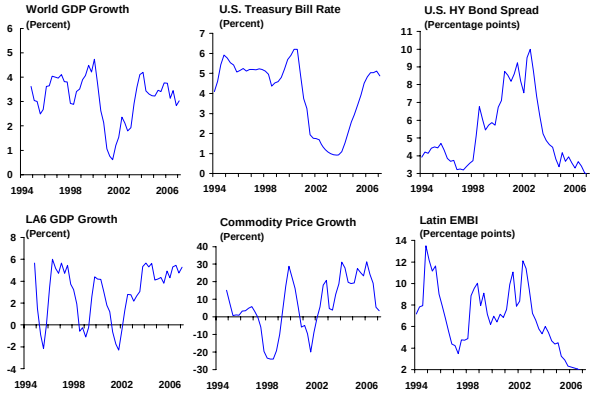
[1] See, for example, Tierny (1994). The chain is serially dependent, but there has been no thinning of it.

[2] The U.S. high-yield bond spread is sometimes interpreted as reflecting risk aversion; see Levy Yeyati and Gonzáles Rozada (2005). An alternative measure, the Chicago Board of Trade "Volatility Index" (VIX), yields very similar results (not reported but are available upon request).

[3] This index represents the largest economies in the region (except for Venezuela, which was excluded from the index because of its different economic structure), accounting for almost 90 percent of Latin American output.

[4] Initially, a real effective exchange rate index for the region was also included, but it had no effect on the results.

Figure 2.1. Data



Source: See Appendix.
Note: Growth rates are given as percentage changes with respect to the same quarter in the preceding year; HY = high-yield; LA6 = Argentina, Brazil, Chile, Colombia, Mexico, and Peru; EMBI = Emerging Market Bond Index.

$\boldsymbol{HY}_t$, is the high-yield corporate bond spread in the United States, $\boldsymbol{y}_t$ is the logarithm of aggregate real GDP for the LA6 countries, $\boldsymbol{c}_t$ is a (net) export commodity price index for these countries, and $\boldsymbol{EMBI}_t$ is the JPMorgan Emerging Market Bond Index spread for Latin America.[5]

World growth and U.S. financial variables are treated as block exogenous with respect to the Latin American variables.[6] The model was estimated on quarterly data, from 1994Q2 to 2007Q2, after defining prior distributions for both the $\mathbf{vec}(\mathbf{G})$ and $\boldsymbol{\psi}$ parameter vectors. Figure 2.1 shows our data (see the appendix for sources).

Slightly modified "Minnesota priors" (Litterman, 1986) were used for the dynamic coefficients, $\mathbf{vec}(\mathbf{G})$. Based on the assumption that a univariate random walk with drift is a good starting point for modeling GDP and commodity prices in levels, prior means on the first own lag for variables modeled in first differences were set equal to zero. Accordingly, the prior means for all higher order lags and for all cross-coefficients—that is, coefficients relating a variable to another variable in the system—were also set to zero.[7] However, prior means on the first own lag of variables modeled in levels were set to 0.9. The reason for this is that a traditional Minnesota prior—that is, a prior mean on the first own lag equal to 1—is theoretically inconsistent with the mean-adjusted model (2), because a random walk does not have a well-specified unconditional mean.

Steady state priors are shown in Table 2.1 (first column) and can be justified as follows:

- Priors for world growth were based on medium-term projections from the IMF's *World Economic Outlook*.
- Following standard convention, the prior for the U.S. three-month treasury bill rate was based on a U.S. inflation target and an equilibrium real interest rate of approximately 2 percent each. These values are in line with Taylor (1993) and Clarida, Galí, and Getler (1998).
- The steady state prior for Latin American growth, centered on 4.25 percent, was based on econometric studies of the impact of economic reforms on long-run growth in Latin America; see Loayza, Fajnzylber, and Calderon (2004) and Zettelmeyer (2006) for a survey.
- For the U.S. high-yield bond and EMBI spreads, we did not have guidance from either theory or the previous literature. Consequently, we did not impose strong priors, and instead defined wide distributions in line with the observed

[5] We tested for unit roots using the Augmented Dickey-Fuller (ADF) test (Said and Dickey, 1984) and KPSS test (Kwiatkowski and others, 1992). (See Table A1 in Österholm and Zettelmeyer, forthcoming.) For the log commodity price index, both tests support the presence of a unit root in levels, while for the other variables the evidence for a unit root in levels is mixed (in particular, stationarity in levels cannot be rejected using the KPSS test). We hence take model commodity prices, world GDP, and Latin American GDP in first differences. The remaining variables are modeled in levels.

[6] This is achieved using an additional "hyper-parameter," which is used to shrink the parameters on $\boldsymbol{y}_t$, $\boldsymbol{c}_t$, and $\boldsymbol{EMBI}_t$ in the equations for y_t^{world} and i_t^{US} and HY_t to zero; see Villani and Warne (2003). Intuitively, this modeling approach amounts to imposing a tight prior distribution centered on zero for the parameters in question. This is somewhat less restrictive than imposing exogeneity directly, because it would allow an estimated nonzero posterior if the data strongly disagree with our prior.

[7] Lag length was set as 2 or 4. This did not make much difference. Below, results with lag length 2 are reported.

behavior of these variables since the late 1980s and early 1990s, respectively—that is, based on a somewhat longer sample period than the one used for estimation.

- Commodity prices are assumed to be reasonably well described by a random walk with a small drift component. The steady state growth rate in commodity prices is accordingly centered on 1 percent and is not particularly wide, despite the historically high variability of commodity prices.

Table 2.1 shows that the estimated posterior distributions are within, and usually narrower than, the assumed prior intervals. We also confirmed that the short-run *dynamics* of the model were not affected by the steady state priors chosen.[8] Hence, the assumed steadystate priors do not prejudge the model's short-run forecasts.

Table 2.1. Steady State Prior and Posterior Distribution

	95% Probability Interval 1/	
	Prior	Posterior
World GDP growth	(3.0, 4.3)	(3.1, 3.7)
U.S. treasury bill rate	(3.0, 5.0)	(3.6, 4.9)
U.S. HY bond spread	(3.0, 6.0)	(3.7, 5.4)
LA6 GDP growth 2/	(3.5, 5.0)	(3.5, 4.6)
Commodity price growth	(-2.0, 4.0)	(-0.9, 3.9)
Latin EMBI	(2.0, 5.0)	(2.3, 4.6)

Source: Authors' estimates.
1/ Refers to a normal distribution.
2/ LA6 = Argentina, Brazil, Chile, Colombia, Mexico, Peru.
Note: Units are percentage points for Latin Emerging Market Bond Index + and U.S. HY bond spread, and in percent for all other variables.

Results

Impulse Response Functions and Variance Decompositions

A standard Cholesky decomposition of the variance-covariance matrix was used to identify independent standard normal shocks ε_t based on the estimated reduced form shocks; that is, we used the relationships $\Sigma = \mathbf{P}\mathbf{P}'$ and $\varepsilon_t = \mathbf{P}^{-1}\eta_t$, with the variables ordered as in $\mathbf{x}_t$ in equation (3). Hence, world GDP growth is assumed to be contemporaneously independent of all shocks except its own, U.S. interest rates are assumed to contemporaneously depend on only world GDP shocks, and so on.[9]

Figure 2.1 shows the response of LA6 growth to various shocks (see Österholm and Zettelmeyer (forthcoming) for a full set of impulse response functions).[10] The magnitude of standard deviation shocks is as follows: about 0.37 percentage point for world growth, 28 basis points for the U.S. treasury bill rate, 67 basis points for the U.S. high-yield bond spread, 5.5 percent for commodity prices, and 110 basis points for the Latin EMBI. These shocks are estimated to have the following effects on Latin American growth:

- Increases in world growth are passed on to Latin America about one-for-one: a 0.37 percent world growth shock leads to an increase in (four-quarter) Latin American growth by about 0.52 percentage point after four quarters. This is similar to the impulse response of world growth with respect to its own shock, which also reaches a maximum of about 0.44 (though it reaches its maximum faster; see Figure 2.2, overleaf).

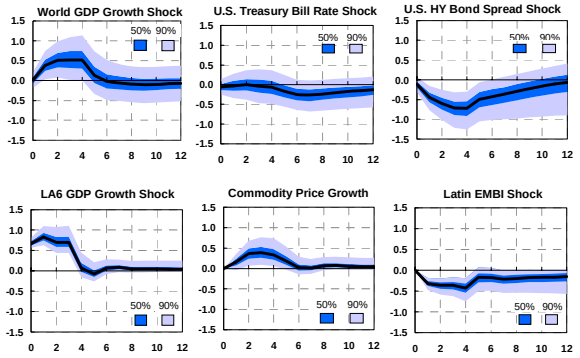
- The reaction of Latin American growth to U.S. interest rates is more muted; a hike leads to a reduction in growth, but the effect is reasonably small.

[8] Noninformative priors on the constant μ, which allow the data to influence the steady state parameters to a larger extent, produced qualitatively similar but less precise results.

[9] Note that the ordering allows commodity prices to be contemporaneously affected by Latin American GDP shocks but not vice versa. The argument for this ordering is that GDP is a sticky variable, whereas commodity prices are not. It is also unlikely that Latin American GDP contemporaneously affects commodity prices, and our results would not change if we reversed the ordering of these two variables.

[10] Österholm and Zettelmeyer (forthcoming) also contains an evaluation of the model's out-of-sample forecasting properties, which is ignored here for brevity.

Figure 2.2. Response of LA6 GDP Growth To One Standard Deviation External Shocks



Source: Authors' estimates.

- In contrast, a standard deviation (67 basis point) rise in the U.S. high-yield bond spread, interpreted as reflecting a retreat of investors from risk, has a very strong effect, leading to a decline of four-quarter growth in Latin America by about 0.7 percentage point after three quarters. Note that the U.S. high-yield bond spread also appears to have strong effects on the Latin EMBI as well as an effect on world growth (or, more strongly, on U.S. growth); both of these channels could play a role in transmitting the shock.

- A standard deviation commodity shock—which in this sample is a change of almost 5.5 percent in a quarter, illustrating the volatility of Latin American commodity prices—leads to a change in four-quarter Latin American growth of about 0.4 percentage point after three quarters.

- Finally, a 110 basis point rise in the Latin EMBI is associated with a drop in four-quarter growth by 0.4 percent after four quarters.

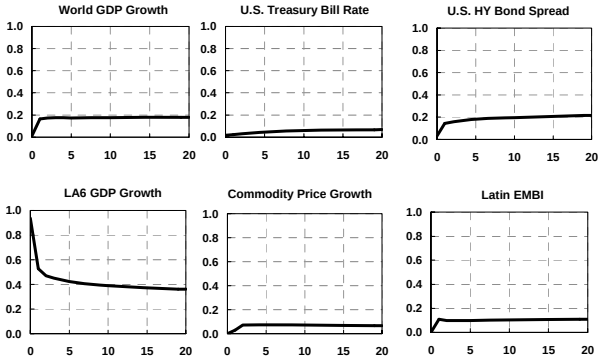
Figure 2.3 shows the variance decompositions for LA6 growth. More than half of the medium-term (10- to 20-quarter horizon) forecast error variance of Latin American GDP growth is explained by external factors: approximately 12 percent by world growth shocks, 6 percent by commodity prices, and a remarkable 34 percent by U.S. financial conditions (the combined influence of U.S. short-term interest rates and the U.S. high-yield bond spread).

Conditional Forecasts and Scenario Analysis

In addition to producing unconditional (or "endogenous") forecasts, as discussed so far, the mean-adjusted BVAR model turns out to be a convenient machinery for *conditional* forecasts; that is, forecasts based on assumptions about the future paths of some of the endogenous variables.[11] Conditional forecasts can serve two purposes. First, they are a way of incorporating extra-model information—"judgment," in Svensson's (2005) terminology—into the forecasting process. For example, assumptions about world growth or about the future path of commodity prices could be fed into the model. To the extent that these assumptions are based on information outside the model (such as commodity price forecasts based on futures prices), conditional forecasts might improve overall forecasting performance. Second, conditional forecasts can be used for scenario analysis to examine how growth would respond to specific external events. It is in this sense that conditional forecasts will be used extensively in this section.

We generate conditional forecasts as follows (see Österholm, 2006, for details). As described in the

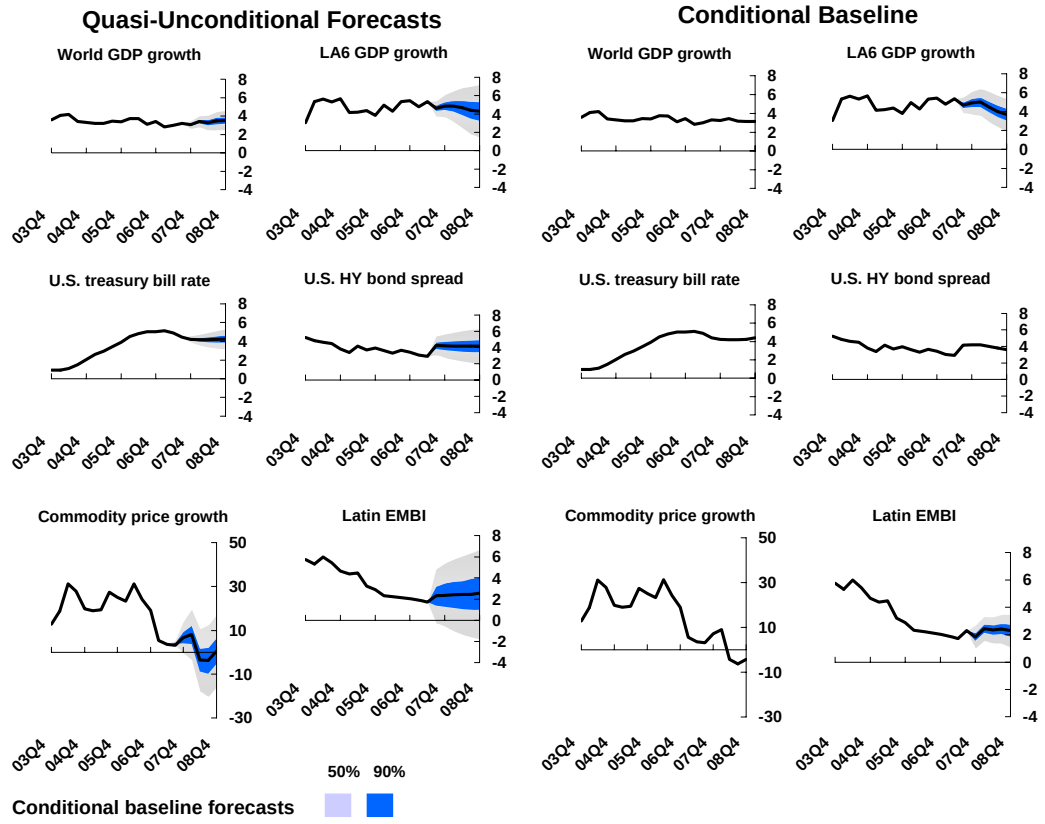
Figure 2.3. Variance Decomposition from Mean-Adjusted Bayesian VAR Model



Source: Authors' estimates.

[11] This exact imposition of particular paths has been called "hard conditions," see Waggoner and Zha (1999). It is a common approach in the VAR literature; examples include Sims (1982) and Leeper and Zha (2003).

Figure 2.4. Quasi-Unconditional vs. Conditional Baseline Forecasts



Source: Authors' estimates.
Note: Units are percentage points for Latin EMBI and U.S. HY bond spread, and percent for all other variables.

previous section, we are interested in generating a distribution of future paths of the endogenous variables. To generate each path, we require the historical data, a draw from the posterior distribution of parameters, and a sequence of orthogonal shocks ($\varepsilon_{T+1} \ldots \varepsilon_{T+H}$). These shocks are then used, together with the definition $\varepsilon_t = \mathbf{P}^{-1}\eta_t$, to generate the reduced form shocks and hence (given history and the realization of the parameters) the future data. The only difference between the unconditional and conditional forecasting exercises is that in the unconditional case, the entire vector ε_{T+h} is generated randomly at each horizon through independent draws from a normal distribution. In contrast, in the conditional case, only the orthogonal shocks belonging to a subset of the endogenous variables are created randomly; the shocks of the conditioning variables are implied by the assumed conditioning path. For a given set of randomly generated orthogonal shocks of the variables that have not been conditioned upon and a given path of the conditioning variables, the implicit shocks of the conditioning variables and the forecasts for all variables are generated sequentially, one horizon at a time.

Figure 2.4 shows two conditional forecasts based on the model estimated through the second quarter of 2007. The first forecast is a "quasi-unconditional" forecast that conditions on only the realizations of financial and commodity price variables in the third quarter—which by now are observable—and an estimate for third quarter external growth, and after that projects all variables endogenously. The second forecast contains "baseline"-conditional-forecast-based world growth and commodity price paths projected by the October 2007 *World Economic Outlook* (WEO), as well as interest rate paths consistent with that outlook. In particular, following a weak fourth quarter, output in the United States is assumed to gradually recover in 2008 in the

conditional baseline scenario, leading to a moderate increase in short-term interest rates and a moderate decline in the high-yield bond spread from levels observed at the beginning of the fourth quarter. In the figure, these conditioning paths can be recognized by the lack of probability "fans" around them.

As can be seen from Figure 2.4, the conditioning paths turn out to be close to the quasi-unconditional forecasts for most variables. The largest difference is with respect to world GDP growth, where the quasi-unconditional forecast envisages a modest rebound in 2008, to 3.5 percent growth on average, while the WEO forecast implies a slight decline. Hence, the comparison of the quasi-unconditional and conditional baseline forecasts gives a sense of the effects of the moderate slowing of the world economy—without a further deterioration of financial conditions—on Latin America. The main result is that Latin America would slow only slightly, by about 0.3 on average in 2008 relative to the quasi-unconditional forecast, and by about 0.6 percent relative to the expected 2007 outturn. The conditional point forecast for average annual growth in 2008 is 4.4, about in line with the October 2007 WEO projection for the LA6 countries (4.2).

We next examine how this conditional forecast changes in a number of scenarios that represent particular risks to the external environment and may have an impact on Latin American growth.

A U.S. recession and credit crunch

The most obvious external risk looming over Latin America today is the possibility that a deepening U.S. housing crisis may trigger a U.S. recession in 2008, as consumer confidence collapses and financial market turbulence begins to affect corporate credit conditions. For illustrative purposes, we assume a scenario in which U.S. growth declines sharply in the fourth quarter of 2007 and remains about zero in the first half of 2008, before beginning a slow recovery in the second half. Average annual growth in 2008 would be reduced from just less than 2 percent in the baseline to about 0.8 percent. The Federal Reserve is assumed to cut interest rates aggressively to prevent a deeper and longer downturn, leading to a decline in the U.S. treasury bill rate to about 2 percent by the end of the second quarter. At the same time, corporate credit is likely to decline, and credit spreads for subinvestment-grade borrowers would likely rise sharply, to more than 700 basis points, in line with previous U.S. recessions.

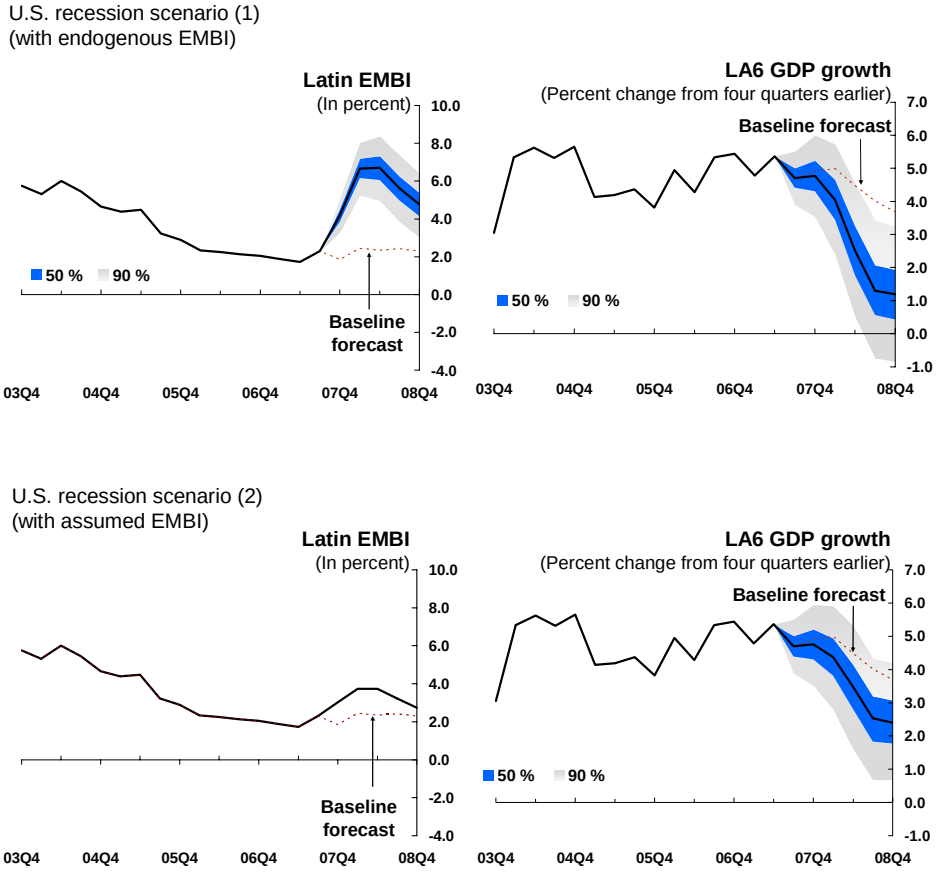
Slower U.S. growth and tighter credit market conditions are likely to spill over to industrial growth outside the United States. In line with Bayoumi and Swiston (2007), for each one-point reduction in U.S. growth we assume a reduction of about 0.4 to 0.5 percent in the growth of major non-U.S. importers of Latin American goods. Given the high weight of the United States in Latin American exports, this reduction implies an overall reduction of export demand by about 0.8 percentage points below baseline, on average, in 2008.

We make no assumption about the price path of commodities, and so commodity prices are left endogenous. Not surprisingly, the model predicts that commodity prices would fall in reaction to the assumed U.S. and world slowdown by about 22 percent by mid-2008, before recovering slightly (see Figure 2.5).

Finally, regarding the Latin EMBI, we make two alternative assumptions:

- One option is to simply leave the EMBI endogenous. Because the typical response of the EMBI to changes in the high-yield bond spread during this period was at least one-for-one during the 1994–2007 estimation period, this implies a very sharp rise, from about 230 basis points on average in the third quarter to 670 basis points by the first quarter of 2008.
- Alternatively, one can assume a path for the EMBI in line with the much more muted reactions of the EMBI to changes in the high-yield bond spread observed in recent months. In this case, the EMBI would rise by only about half the amount of the endogenous rise, to 370 basis points by the first quarter.

Figure 2.5. Effects of a U.S. Recession and Credit Crunch



Source: Authors' estimates.

Figure 2.6 summarizes the conditioning paths and compares them to the baseline paths, while Figure 2.5 contains the results.

Not surprisingly, the magnitude of the predicted slowdown depends on the behavior of the Latin EMBI—that is, on the extent of financial contagion.

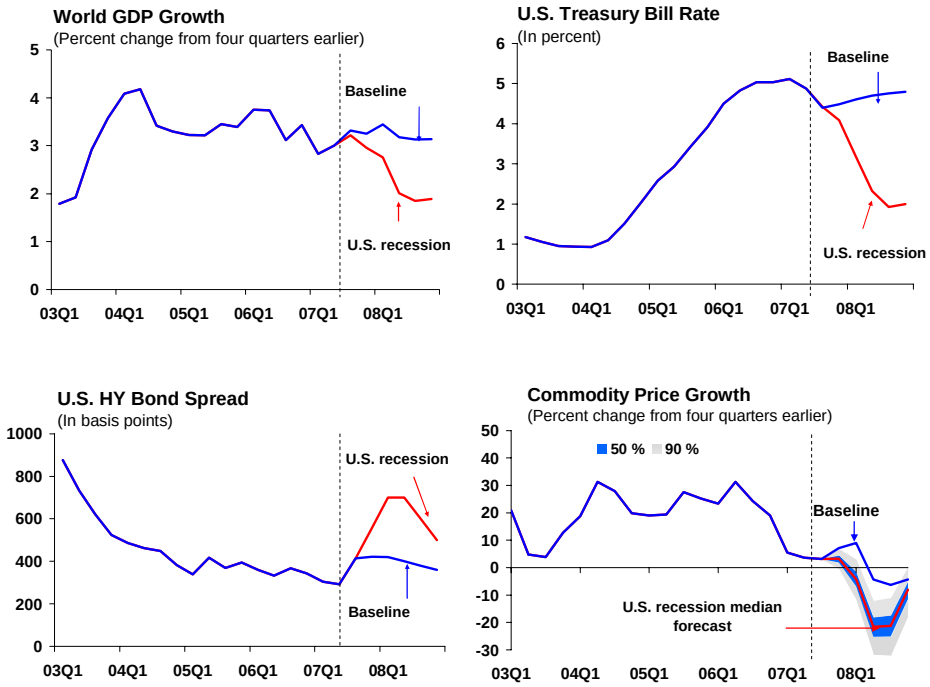
- If this follows the average pattern during the sample period, the predicted effect of a 2008 U.S. recession and credit crunch is large, with about zero growth during the first half of 2008 relative to the second half of 2007, just short of a recession. Average growth in 2008 falls by 2.1 percentage points relative to the baseline, to 2.3 percent.
- If external financing premiums in Latin America continue their partial decoupling from U.S. financial markets, the model predicts a milder slowdown to about 3.2 percent in 2008, or about 1.2 points relative to the baseline.

Note that in either case, the predicted fall of Latin American output relative to the baseline (1.2 to 2.1 percent) exceeds the assumed fall in external demand (0.8). The reason for this fall is that the scenario consists of a *combined* demand and financial shock, given the assumed sharp rise of the U.S. high-yield bond spread. Even in the more muted scenario, the financial transmission channel has not been shut down completely, and the commodity price channel is also at work in both variants of the scenario.

Declines in commodity prices

As discussed, declining commodity prices constitute one channel through which a slowdown in external

Figure 2.6. Conditioning Paths for Baseline and U.S. Recession Scenario



Source: Authors' estimates.

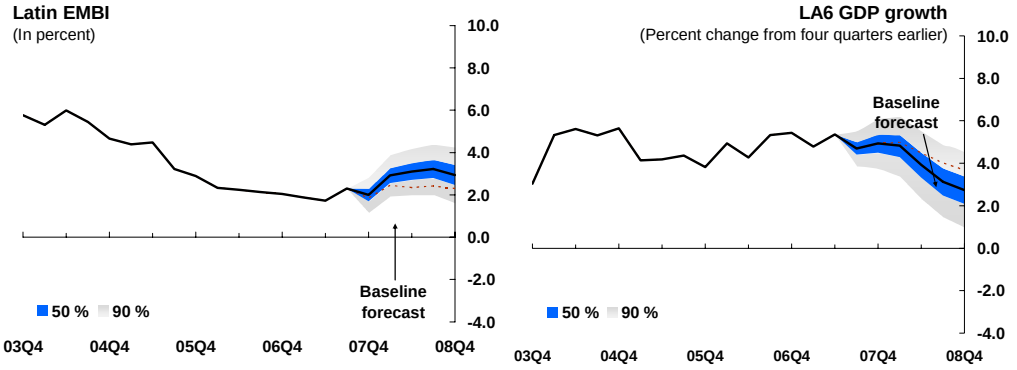
growth could hurt Latin America. It is also interesting to see how much a commodity price fall of about the same magnitude would slow Latin American growth if it occurred in isolation. This scenario can be constructed by modifying the baseline scenario to include a fall in commodity prices by 20 percent over 3 quarters, beginning in the last quarter of 2007 (see the appendix in Österholm and Zettelmeyer, forthcoming, for details). All other baseline paths are retained, and the EMBI is allowed to adjust endogenously.

The model predicts that a 20 percent fall in commodities prices in late 2007 and early 2008 would lead to noticeably lower, but still robust, 2008 growth in Latin America (Figure 2.7). Annual average growth is reduced to 3.7 percent. This partly reflects the direct effect of commodity prices on growth, but also higher external risk premiums, with the EMBI rising endogenously by about 60 to 80 basis points above the baseline (see Figure 2.7).

An emerging market financing shock

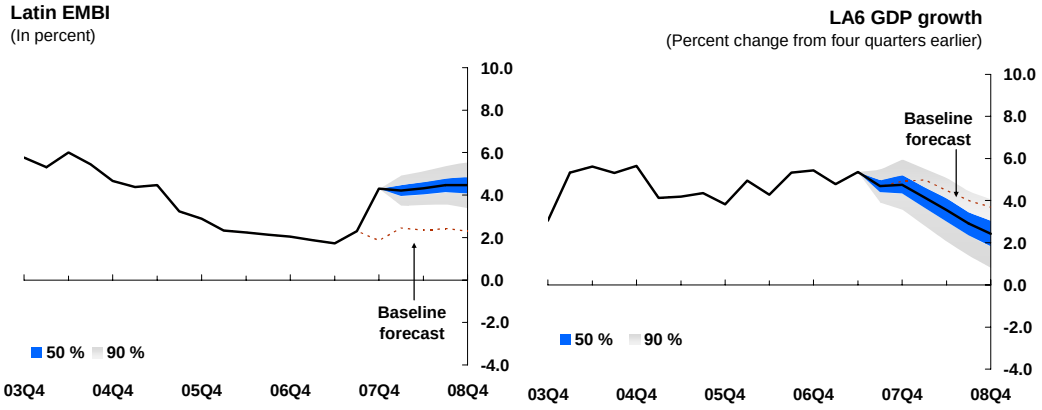
Finally, we considered a scenario illustrating much tighter emerging market financing conditions in the form of a 200 basis point shock to the Latin EMBI spread and a 100 basis point increase in the U.S. high-yield bond spread—perhaps triggered by an emerging market crisis outside Latin America, with a limited spillover effect to U.S. high-yield credit markets. To isolate the effects of a "pure" emerging market financing shock, we retained baseline assumptions for world growth, commodity prices, and U.S. treasury bill rates. The shock to the EMBI spread and the U.S. high-yield bond spread is assumed to occur in the fourth quarter, after which these variables are allowed to be endogenous.

Figure 2.7. Effects of a Decline in Commodity Prices



Source: Authors' estimates.

Figure 2.8. Effects of Emerging Market Financing Shock



Source: Authors' estimates.

The model suggests that a financing shock of this kind would significantly reduce growth in Latin America, though by less than the combined U.S. recession/credit crunch scenario considered earlier (Figure 2.8). Growth in 2008 is predicted to fall to about 3.3 percent on an annual average basis, about 1 percent below the baseline.

Conclusions

This chapter presented a mean-adjusted BVAR model of growth in Latin America for both forecasting and scenario analysis. The model outperforms plausible competitors—a classical VAR, and a conventional BVAR—as a forecasting tool, and seems to perform approximately as well as the IMF's WEO forecasts. Using impulse responses and conditional forecasts, we evaluated the sensitivity of Latin American growth to a variety of shocks, including a slowdown in external demand, a U.S. credit crunch affecting high-yield borrowers, commodity price shocks, and an emerging market financing shock.

The main result is that although Latin American growth appears to be fairly robust to a variety of moderate shocks, including a moderate slowdown in U.S. and world growth and a 20 percent reduction in commodity prices, a combined recession and credit crunch in the United States—as currently (late 2007) feared for 2008—could have a severe impact. The scenario analyses undertaken in this chapter suggest that the magnitude of the spillover from a U.S.

recession to Latin America will depend mainly on two factors:

- First, the extent to which a U.S. recession leads to a decline in commodity prices. In our model, commodity prices are an important channel for transmission of external demand shocks, with a U.S. recession and credit crunch leading to a decline of Latin American commodity export prices by 20–25 percent. This, in turn, affects Latin American growth both directly and through tighter external financing conditions.
- Second, whether financial transmission channels continue to be as critical as they were in the 1990s and at the beginning of this decade (the sample period for which our model is estimated). During these periods, a tightening of credit conditions facing subinvestment-grade corporate borrowers in the United States led to an at least one-for-one increase in Latin American external borrowing costs. However, this factor may not be as critical today, as public and private sectors in Latin America have become more resilient as a result of better-anchored inflation expectations and less reliance on foreign currency and short-term debt. Indeed, since the U.S. subprime mortgage crisis emerged in full force in July 2007, the reaction of the Latin EMBI to changes in the U.S. high-yield bond spread has been comparatively muted.

Depending in particular on the strength of the financial transmission channel, our results suggest that a U.S. recession, involving a reduction of U.S. growth by about 1.2 percent below the baseline in 2008, would lead to a baseline reduction in Latin American growth between about 1 and more than 2 percent. The latter would imply a fall of Latin American growth to nearly zero the first half of 2008.

What would it take to reduce regional vulnerabilities further? The model estimated in this chapter provides evidence for the importance of financial shocks—which account for more than 60 percent of the contribution of external factors to the variance of Latin American growth—as well as the role of financial channels in magnifying "real" shocks, such as commodity price shocks. It also indicates that commodity prices remain an important determinant of short-term fluctuations. This suggests that policies that lower public debt, make budgets more flexible, strengthen financial systems, diversify export structures, and reduce fiscal dependence on commodity revenues would help reduce regional vulnerabilities.

Appendix. Data Sources

- World GDP: Haver Analytics and the IMF's World Economic Outlook database (export-weighted index created using export shares of the LA6 countries to the rest of the world, export shares taken from the IMF's *Direction of Trade Statistics*).
- Latin American (LA6) GDP: Haver Analytics, weighted using WEO PPP-GDP weights.
- U.S. three-month treasury bill rate and U.S. consumer price index: Haver Analytics.
- U.S. high-yield corporate bond spread: Bloomberg.
- Latin Emerging Market Bond Index (EMBI) Spread: JPMorgan.
- Commodity price indices: Calculated based on United Nations Commodity Trade Statistics (UNCOMTRADE) Database trade share and IMF commodity price data.

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Chapter 3

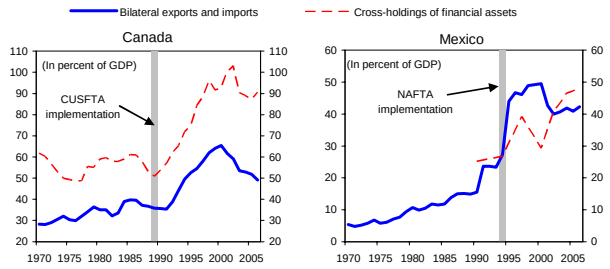
Spillovers Across NAFTA

Andrew Swiston and Tamim Bayoumi

The past two decades have witnessed an acceleration in globalization, as trade and cross-border holdings of financial assets have grown more quickly than economic activity in most regions of the world. In North America, free trade agreements implemented between Canada and the United States (CUSFTA) in 1989 and both those countries and Mexico (NAFTA) in 1994 preceded an especially dramatic rise in interconnectedness, despite the high degree of integration that was already prevailing.

From 1988 through 2006, the sum of U.S.-Canada exports and imports expanded from 37 percent of Canadian GDP to 49 percent, while cross-border holdings of financial assets increased from 53 percent of Canadian GDP in 1988 to more than 90 percent (Figure 3.1). Mexico-U.S. trade jumped from 23 percent of Mexican GDP in 1993 to more than 40 percent in recent years. Some of the increase was a result of the 1994/95 economic crisis, but the implementation of NAFTA also hastened a rising trend, as Mexico-U.S. trade had been less than 10 percent of Mexican GDP before 1980. Financial integration has also advanced, with cross-border holdings nearing 50 percent of Mexican GDP, up from 25 percent in 1990.

Figure 3.1. Measures of U.S. Integration with Canada and Mexico



Sources: Haver Analytics; IMF, *Direction of Trade Statistics*; Bank for International Settlements; Coordinated Portfolio Investment Survey; U.S. Treasury International Capital System; and IMF staff calculations.
Note: CUSFTA = Canada-United States Free Trade Agreement; NAFTA = North American Free Trade Agreement.

The rapid tightening in integration between the United States and its NAFTA partners provides an opportunity to examine business cycle synchronization and spillovers of economic activity across countries in an environment of increasing globalization. The question is one of empirics, as economic theory provides no clear answer to the effects of either higher trade intensity or tighter financial linkages on output comovement.[1]

The main challenge in determining the size and source of spillovers across countries is identifying the sources of comovement in real growth. Business cycle synchronization could come from similar responses to common shocks, domestic factors that are correlated over the sample period but are unrelated across countries, or true spillovers—the response of growth in one country to conditions emanating from another.

Given the long history of substantial international business cycle fluctuations, the importance of common or global factors in national output fluctuations is widely recognized (see, for example, Bordo and Helbling, 2004). Consequently, a large body of literature has sought to measure the contribution of common factors to national business cycle fluctuations. Dynamic factor models have been the preferred approach in recent studies because these models reduce common variations across individual countries to a small number of significant but unrelated factors (see Gerlach, 1988; Gregory, Head, and Raynauld, 1997; Kose, Otrok, and Whiteman, 2003; and Stock and Watson, 2005).

[1] See Calderón, Chong, and Stein (2007) or Kose, Prasad, and Terrones (2004) for discussions of the impact of integration on business cycle comovement.

The common factors in such studies, however, are typically difficult to interpret, because basic factor model decompositions are atheoretical and lack a structural identification scheme. The common factor could reflect global shocks, spillovers from one country to others, or idiosyncratic shocks that happen to be correlated across countries.[2] This type of analysis leaves unanswered questions such as whether U.S. shocks account for a significant share of common output fluctuations.[3]

This chapter uses an approach introduced in Bayoumi and Swiston (2007) to solve this identification issue. We construct an aggregate of several countries, which we call "the rest of the world," to proxy for global shocks. The rest of the world contains a set of countries that is varied in terms of both geography and industrial structure. Given the diversity of the constituent countries, any shock to this aggregate is a strong candidate for a global disturbance. Spillovers from the rest of the world to other regions can be regarded as a reasonable measure of the impact of global shocks, provided that none of the individual economies involved are likely to have significant direct effects on the economies under analysis.

This method is able to accurately identify the effects on Canada and Mexico of global shocks and of those emanating from other regions. We find that a positive shock of 1 percentage point to U.S. GDP growth brings about a ¾ percentage point rise in Canadian growth, with little variation across subsamples. For Mexico, the response since 1996 is 1½ percentage points; previous periods are dominated by idiosyncratic domestic factors. Neither country is highly sensitive to shocks from the euro area or Japan, though global shocks have been increasing in importance for both countries in recent decades.

We also use this identification scheme to identify the major channels through which spillovers are propagated—trade, commodity prices, and financial markets. Trade and financial market linkages both contribute to U.S. spillovers, with the latter becoming increasingly important for both countries. For Canada, financial markets transmitted about a quarter of spillovers from the United States before 1989 and more than a half since then, while the contribution of trade has declined modestly, from 50 to 40 percent. Trade accounted for 60 percent of U.S. spillovers to Mexico over the 1970–2007 period, but has decreased to 40 percent since 1996, mirrored by a rise in the contribution of financial spillovers to 60 percent from 40 percent.

Identifying Spillovers in a Vector Autoregression

As explained above, examining the dynamic response of growth across countries in a vector autoregression (VAR) requires identification of the size and geographic location of shocks to growth. To estimate impulse response functions, the errors across individual equations are typically orthogonalized using a Cholesky decomposition, which assumes that all of the correlations between errors are assigned to the equation that is earliest in the ordering. For example, in a three-variable VAR, all of the correlation between the residuals in the first equation and the second and third ones is assigned to the first, while any remaining correlation between the errors in the second and third equations is assigned to the second. This approach works well if there is a relatively clear ordering for the Cholesky decomposition, but such strong assumptions are unlikely to hold in a VAR containing growth across countries.

This chapter uses a quasi-Bayesian approach to identification within a VAR framework, introduced

[2] See, for example, Canova and Dellas (1993). There are other problems as well. For example, if countries respond differently to some common shock (for example, because of differences in economic structure), the estimated common factors may or may not capture the effects of these common shocks, depending on the stringency of the restrictions on the dynamic structure of the underlying model.

[3] Stock and Watson (2005) allow for lagged spillovers of country-specific shocks, but this still leaves contemporaneous shocks unidentified.

in Bayoumi and Swiston (2007).[4] They average results across a number of "plausible" Cholesky orderings, which acts as a mechanism for assigning priors to the direction of causality. The probability that spillovers originate in country A as opposed to country B is equal to the proportion of Cholesky orderings in which A is before B. These probabilities are then modified by the variance-covariance matrix of the errors in the VAR to arrive at an estimate of the magnitude of spillovers between the two countries. Note that this updating depends only on the parameters of the variance-covariance matrix and not on the full probability distribution, which is used in traditional Bayesian methods.[5]

The underlying approach can be illustrated using a two-variable VAR. Consider the matrix A that transforms the estimated errors e from such a VAR into orthogonalized errors ε. Mathematically, $\varepsilon = Ae$. For the two possible Cholesky decompositions, the matrix A is

$$A = \begin{pmatrix} 1 & -\frac{\sigma_{12}}{\sigma_{11}} \\ 0 & 1 \end{pmatrix} or \begin{pmatrix} 1 & 0 \\ -\frac{\sigma_{12}}{\sigma_{22}} & 1 \end{pmatrix} \qquad (1)$$

where σ_{ij} is the relevant entry in the estimated variance-covariance matrix of the equation errors (for example, σ_{11} is the variance of the error on the first variable in the first equation). The zeros in the lower left cell of the first matrix and the upper right cell of the second indicate that in each of these decompositions, contemporaneous feedback between the two variables flows in only one direction.

By putting weight on both decompositions, however, this procedure allows contemporaneous spillovers in both directions. The user assigns a weight of α to the first Cholesky decomposition and $1 - \alpha$ to the second. The matrix that orthogonalizes the equation errors becomes

$$A = \begin{pmatrix} 1 & -\alpha\frac{\sigma_{12}}{\sigma_{11}} \\ -(1-\alpha)\frac{\sigma_{12}}{\sigma_{22}} & 1 \end{pmatrix} \qquad (2)$$

Although the weight α defines the prior probability on the source of contemporaneous correlation between the two error terms, this prior is modified by the estimated parameters of the variance-covariance matrix of errors (σ_{11}, σ_{12}, and σ_{22}). Mathematically,

$$\frac{a_{12}}{a_{21}} = \frac{\alpha}{(1-\alpha)}\frac{\sigma_{22}}{\sigma_{11}} \qquad (3)$$

where a_{ij} is the relevant entry of the matrix A. The relative importance assigned to each possible direction of causation, and thus the estimated magnitude of spillovers, depends on both the prior (α) and on the variances of the equation errors (σ_{11} and σ_{22}), which are not affected by the ordering of the variables.

The intuition of this example can be generalized to the *n*-variable case, with the complication that adding variables to the VAR makes it more difficult to define the errors in each equation (the e's), because correlations with errors from a greater number of equations must be taken into account. Once this has been done, the rest of the logic of this two-variable case holds.

It is also possible to calculate how uncertainty across Cholesky orderings adds to the variance around the impulse response functions, over and above the standard error associated with the parameter uncertainty of the VAR. Sticking with the two-variable example, let $\overline{x}_t$ represent the average impulse response for period *t* across the two decompositions (so that $\overline{x}_t = \alpha\overline{x}_{1t} + (1-\alpha)\overline{x}_{2t}$).

[4] The discussion here closely follows that paper.

[5] For approaches that use Bayesian techniques to update forecasts across models, see Leamer (1978) and Sala-i-Martin, Doppelhofer, and Miller (2004). See Wright (2003) for a discussion and application of Leamer's Bayesian model averaging technique.

The variance of the impulse response function can be written as

$$
\begin{aligned}
E(x_{ijt} - \bar{x}_t)^2 = \\
&\alpha^2 E(x_{1jt} - \bar{x}_{1t})^2 \\
&+ 2\alpha(1-\alpha)E(x_{1jt} - \bar{x}_{1t})(x_{2jt} - \bar{x}_{2t}) \\
&+ (1-\alpha)^2 E(x_{2jt} - \bar{x}_{2t})^2 \\
&+ \alpha^2 E(\bar{x}_{1t} - \bar{x}_t)^2 \\
&+ (1-\alpha)^2 E(\bar{x}_{2t} - \bar{x}_t)^2
\end{aligned}
\qquad (4)
$$

where subscript *i* on the left-hand side indicates the different orderings (1 and 2). Variation across orderings produces the final two terms in equation (4), which we call specification uncertainty. Subscript *j* indexes the individual observations represented in the sample from which the standard errors are calculated. This generates the first three terms in equation (4), reflecting the familiar uncertainty associated with each individual identification scheme, coming from the imprecision with which the VAR coefficients are estimated.

Given that the individual identification schemes differ only in their assumptions about the ordering of the variables, the errors across individual orderings are likely to be highly correlated. Accordingly, we assume that the correlation across different orderings is unity. Under this assumption, the first line of equation (4) can be approximated by taking the weighted average of the variances of each of the decompositions. The second line of equation (4) reflects the uncertainty due to variation in the response across orderings and is simply the variance of the response across these decompositions.

Hence, the uncertainty associated with identification can be approximated by simply adding the variance of the impulse responses across identification schemes to the variance associated with parameter uncertainty. Given our assumption of a perfect correlation of errors associated with parameter uncertainty across orderings, this is an upper limit for the true value of this variance. This procedure can again be generalized to the *n*-variable case.

Where Do Shocks to Canada and Mexico Originate?

This section uses a VAR containing quarterly real GDP growth, with four lags, to isolate the geographic sources of disturbances to growth in Canada and Mexico.[6] Estimation starts in 1970, beginning with the availability of estimates for the euro area real GDP from Fagan, Henry, and Mestre (2005). The data extend through the second quarter of 2007. Results are also presented for subsamples corresponding with periods of greater integration with the United States. For Canada, the sample break date is set at 1989, when the CUSFTA came into effect. The sample break date for Mexico is 1996—two years after the implementation of NAFTA, in order to exclude the effects of the Tequila crisis of 1994–95.

The regions included are the United States, the euro area (EA), Japan (JP), and the rest of the world aggregate (ROW). That aggregate includes seven or eight industrial countries—Australia, Canada, Denmark, New Zealand, Norway, Sweden, Switzerland, and the United Kingdom—and three or four emerging markets—Korea, Mexico, South Africa, and Taiwan Province of China (Canada or Mexico is dropped when that country is under analysis). The rest of world growth rate is formed by weighting each country's growth rate by its GDP at purchasing power parity. The countries included are based on availability of quarterly real GDP dating back to 1970. Results were similar using only the industrial countries, and for equally weighted aggregates.

The priors on the correlation of Canadian and Mexican VAR residuals with those of other regions are formed by averaging results across the following eight orderings for the Cholesky decomposition:

[6] Conventional tests indicated a shorter number of lags (which varied across specifications), but four lags were chosen; in addition to being a natural choice for quarterly data, this is consistent with the specifications used in Stock and Watson (2005) and Perez, Osborn, and Artis (2006).

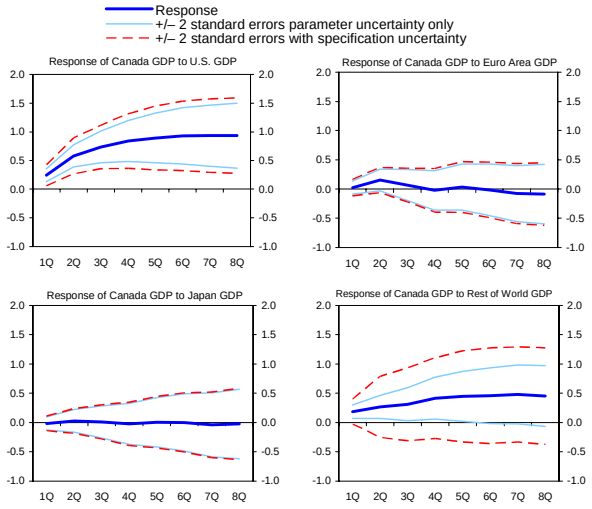
1. US, EA, JP, ROW;
2. US, JP, EA, ROW;
3. US, EA, ROW, JP;
4. US, JP, ROW, EA;
5. ROW, US, EA, JP;
6. ROW, US, JP, EA;
7. EA, ROW, JP, US;
8. JP, ROW, EA, US.

In numerical terms, the above priors give, for example, a 50 percent probability that the correlation between Canadian, U.S., and rest of world shocks is driven by the United States, and 50 percent that it is driven by the rest of the world. The other probabilities are 75:25 U.S.–euro area and U.S.-Japan, and 50:50 euro area–Japan, rest of world–euro area, and rest of world–Japan. In all cases, Canada or Mexico is ordered last, assuming that any contemporaneous correlation between their residuals and those of the major regions is driven by the larger economies. Given this "small country" assumption, results are not shown for the impact of Canada or Mexico on the other regions.[7]

Size of Spillovers to Canada

Figure 3.2 contains impulse response functions (IRFs) showing the impact on Canadian GDP of shocks to the United States, euro area, Japan, and rest of world for the 1970–2007 period. The figure includes the average response across the eight Cholesky orderings given above, with ± two standard error bands that only account for coefficient uncertainty and an additional set of bands incorporating the specification uncertainty discussed above.

Figure 3.2. Canada: Spillovers Across Eight VARs



Source: IMF staff calculations.

Spillovers from the United States are large and statistically significant drivers of the Canadian business cycle. Canada's initial response to a typical U.S. shock is ¼ percentage point and rises to almost a full percentage point after two years. With innovations to U.S. GDP averaging more than 1 percentage point in this period, the response of Canadian growth is fully 75 to 80 percent as large as the original shock. This lines up with the findings of a number of other authors, including Stock and Watson (2005); Perez, Osborn, and Artis (2006); and, with different methodologies, Perez, Osborn, and Sensier (2007); and Ambler, Cardia, and Zimmermann (2004).[8] There is almost no influence on Canada of shocks to the euro area or Japan. Canada's response to rest of world growth is just below ½ percentage point. Although the initial impact of global shocks is on par with that from U.S. shocks, their effects accumulate less over time than U.S. spillovers do.

The estimated response of the Canadian economy to U.S. shocks is remarkably robust to uncertainty across the Cholesky orderings, as evidenced by the narrow gap between the two sets of standard error bands in Figure 3.2. Variation across orderings is most noticeable in the response of Canadian GDP to global shocks. Spillovers are higher when the rest of the world is ordered before the United States and are statistically significant, but are only statistically significant for one quarter when the United States is given primacy in the ordering. The effects of rest of world spillovers are not sensitive to the relative position of the euro area, despite a high correlation between the shocks of the two regions.

[7] Canada or Mexico could theoretically affect other regions through the lagged impact of their shocks, but we found that their impact (including on each other) was never statistically significant. For more detail on the size of shocks and IRFs across the major regions, see Bayoumi and Swiston (2007).

[8] Other estimates range from 0.5 (IMF, 2007b, and Klyuev, 2008) to 1.0 (Schmitt-Grohé, 1998) percentage point.

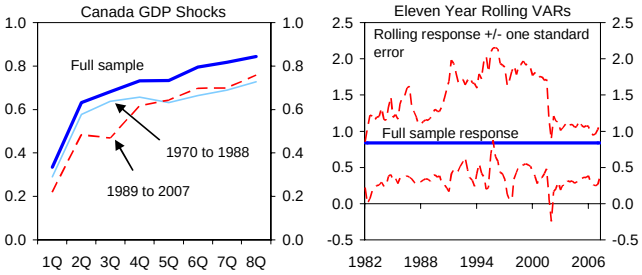
The uncertainty over Canada's response to the rest of the world stems almost entirely from the high correlation between global and U.S. shocks in the volatile 1970s and early 1980s (Figure 3.3, overleaf). For the 1970–88 subsample, the impact of global shocks on Canadian GDP was statistically significant for the first two to three quarters only when the rest of the world was ordered ahead of the United States. The post-1988 results are insensitive to the ordering—the response is significant for one year after impact before fading. The finding of statistically significant spillovers from the rest of the world also validates the use of the aggregate as a proxy for global shocks, because none of these countries by themselves would be expected to have a significant effect on the Canadian economy. Spillovers from the euro area are close to zero in all periods, whereas for Japan there is the counterintuitive finding of significant negative spillovers since 1989, although the idiosyncratic behavior of the Japanese business cycle over this period may explain this result without implying causality.

Results by subsample indicate that spillovers from the United States are stable over time once the volatility of U.S. shocks is taken into account. The response of Canadian GDP has been nearly halved since CUSFTA implementation, from 1.1 to 0.6 percentage points (Figure 3.3). However, the entire reduction can be attributed to the decline in U.S. volatility; the magnitude of U.S. shocks has fallen from 1.5 to 0.8 percentage points, while the 70 to 80 percent response of Canadian GDP to U.S. shocks has remained broadly stable before and after CUSFTA implementation (Figure 3.4)[9]. The size of the reduction in U.S. disturbances is unique among the major regions, as shocks to the euro area and rest of world did not vary much across the subsamples while the decline in Japanese shocks was less pronounced. Meanwhile, the magnitude of Canadian shocks has been steady at 0.6 to 0.8 percentage points over a one- to two-year horizon.

Rolling regressions confirm the stability of the Canadian response to U.S. shocks. We estimated the same eight VARs described above, over 11-year rolling windows. The right panel of Figure 3.4 shows the ± one standard error bands of the impulse response function at an eight-quarter horizon averaged across these VARs, with the estimation window ending in the period indicated on the horizontal axis. All shocks are normalized to 1 percentage point, and the full sample response across eight VARs, 0.84, is shown for comparison. There is no visible trend in the rolling estimates. They indicate a response above the full sample average in windows ending from 1991 to 2001, and below-average spillovers before and after, but no statistically significant breaks, as even the ± one standard error bands encompass the full sample response in all periods except one.

Figure 3.4. Canada: Response to U.S. GDP Shocks by Subsample

(Response of Canada GDP to one percentage point U.S. GDP shock)

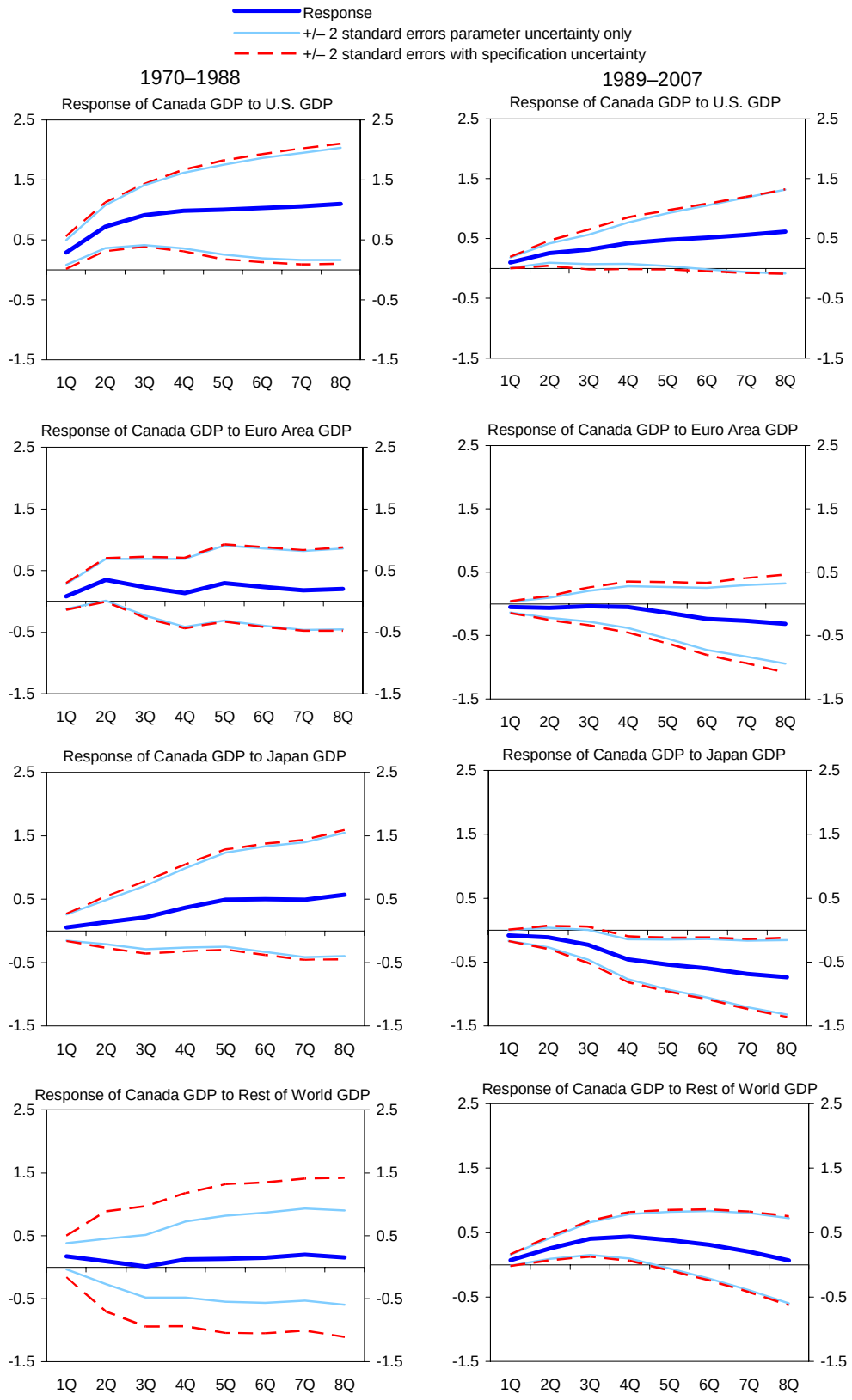


Source: IMF staff calculations.

Lower output volatility in the United States over the past two decades explains the entire decrease in spillovers to Canada. This explanation points to the importance of the great moderation in U.S. output in reducing volatility in Canada. The effects of increased integration, then, appear to be slight, or offset by still other factors, because the Canadian response as a proportion of U.S. shocks has been steady.

[9] Bayoumi and Swiston (2007) show the detailed shocks experienced in the United States and other major regions over roughly the same sample periods.

Figure 3.3. Canada: Spillovers Across Eight VARs by Subsample



Source: IMF staff calculations.

Size of Spillovers to Mexico

Given that the variance of idiosyncratic shocks to the Mexican economy swamps that coming from abroad before the 1990s, this section briefly analyzes the full sample results before concentrating on the 1996–2007 period, when the identification of spillovers becomes more clear because the role of external factors in Mexican growth is more precisely estimated. However, even those estimates need to be interpreted with some caution, given that they cover only one full business cycle. In this section, the rest of world aggregate includes Canada and excludes Mexico.

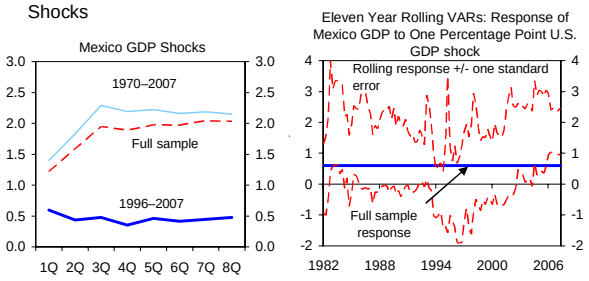
The full sample results in Figure 3.5 (overleaf) show a moderate positive response of Mexican GDP to activity in the United States, euro area, and Japan over the full sample, with a zero average response to global shocks—perhaps because global oil shocks that were negative for the rest of the world had some positive elements for Mexico. There are no statistically significant spillovers for the average across eight orderings, although shocks from each of the first three regions are mildly significant when given primacy in the ordering. Results for the 1970–95 subsample (not shown here), are quite similar. Both sets of results illustrate the difficulty of identifying the effects of external shocks in the presence of a high degree of domestic volatility, because the standard error bands are quite wide.

Moving to the postcrisis period, the response of Mexican growth to external fluctuations is more precisely estimated, despite the reduction in degrees of freedom coming from a smaller sample size (Figure 3.5). Since 1996, the typical one standard deviation shock to U.S. GDP has resulted in a 1¼ percentage point response of Mexican GDP. The impact starts small, at ⅓ percentage point, and builds over the first year and a half after impact to become more than 1½ times the size of the U.S. shock. The greater than one-for-one response is also found in Österholm and Zettelmeyer (2007) for GDP; Chiquiar and Ramos-Francia (2005) for manufacturing production; and Bergin, Feenstra, and Hanson (2007) for *maquiladora* assembly industries.

In contrast to the increased spillovers from the United States, linkages to other regions remain low. The average response to the euro area and Japan is minimal, and the response to global disturbances peaks at ½ percentage point. Variation in the results across Cholesky orderings is minor: Mexico's response to U.S. shocks is robust across all specifications, while euro area and rest of world spillovers are mildly significant in early quarters when their shocks are ordered first.

The rise in spillovers from the United States has occurred amidst a stark decline in shocks to Mexican GDP (Figure 3.6). The typical domestic shock was an order of magnitude larger than those of any major economies for the period 1970–95, but has fallen by a factor of four since 1996. The size of Mexican GDP distrubances has been roughly similar to those in the United States and Japan over the last decade. With this decline in domestic volatility, fluctuations in the Mexican economy have more closely paralleled those in the United States.

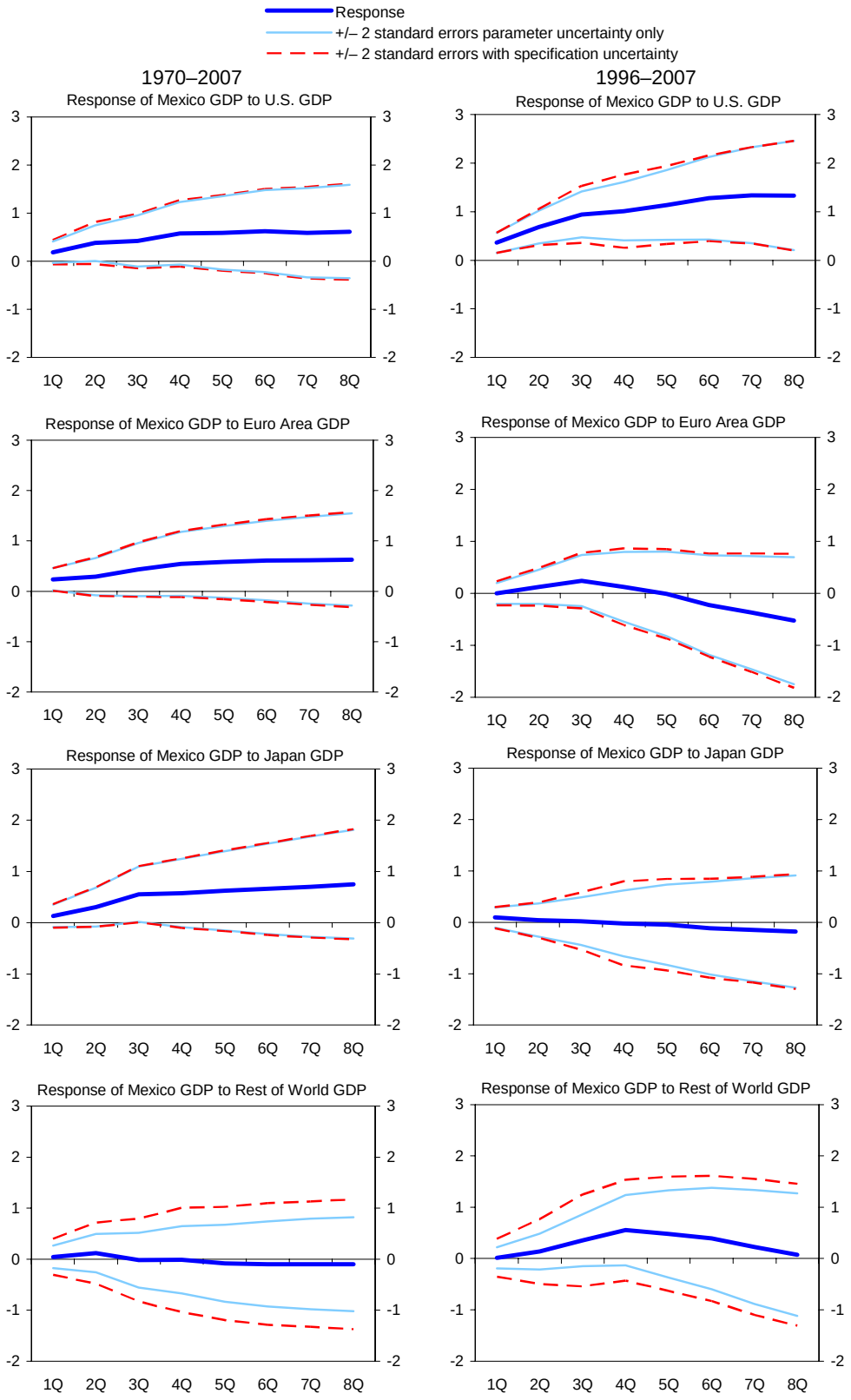
Figure 3.6. Mexico: Domestic Shocks and Response to U.S. GDP Shocks



Source: IMF staff calculations.

Rolling VARs confirm the upward shift in the sensitivity of the Mexican economy to U.S. shocks. The right panel of Figure 3.6 reports the response of Mexican GDP after eight quarters, ± one standard error, to a 1 percentage point shock in the United States. The estimation window is 11 years, so that the final runs roughly match the postcrisis period. There is a definite upward break and narrowing of the standard errors once the 1994–95 crisis drops

Figure 3.5. Mexico: Spillovers Across Eight VARs by Subsample



Source: IMF staff calculations.

out of the sample, but the graph also highlights the brief period of time over which the result holds. Thus, the estimated post-NAFTA spillovers from the United States to Mexico are tentative, pending the confirmation of this stronger link with further data.

Variance decompositions also underscore the rising importance of external factors in driving the Mexican cycle (Table 3.1). For the full sample and period before 1996, variation in Mexican GDP is dominated by domestic factors. Since 1996, external factors have accounted for more than 60 percent of Mexican fluctuations. Spillovers from the United States have been responsible for 30 percent, twice the share attributed to either the euro area or the rest of the world. This increased relative importance of U.S. spillovers is another piece of evidence that growing cross-border linkages have tightened business cycle comovements between the two countries.

Table 3.1. Mexico: Variance Decompositions of Real GDP

(Average across eight orderings)

Share Explained by	Sample Period	
	1970–95	1996–2007
United States	4.0	30.7
Euro area	6.5	14.5
Japan	7.3	3.0
Rest of world	3.3	15.9
Mexico	78.9	35.9

Source: IMF staff calculations.

By What Channels Are Spillovers Transmitted?

This section builds on the analysis of the geographic provenance of spillovers by estimating the linkages by which these spillovers are transmitted across borders. Three potential channels are considered—trade, commodity prices, and financial conditions. This procedure is more applicable to identifying spillovers across countries than the sources of fluctuations in a domestic economy, which can be driven by additional factors, such as consumer confidence or fiscal policy. Therefore, no attempt is made to decompose the sources of Canadian or Mexican domestic shocks.

The five-variable VAR in the previous section is augmented by adding each of the above channels as exogenous variables in separate VAR runs. The response of GDP to foreign activity in the augmented VAR can be thought of as the size of the spillover excluding the channel that is present as an exogenous variable. The individual channel's contribution to spillovers, then, equals the difference between this response and the one from the original VAR, as follows:

$$c_{i,j} = r_i - r_{i,j} \tag{5}$$

where $c_{i,j}$ is the contribution of channel j in period i. The response from the VAR with only GDP is r_i, and $r_{i,j}$ is the response of domestic GDP to foreign GDP shocks from the VAR with channel j included. The sum of the spillovers coming from the individual sources is not constrained to equal the overall spillover estimated in the base VAR, so it provides an alternative estimate of the size of spillovers that can be used to verify the main results.

For the full sample, all four major regions were included, while spillovers by subsample were decomposed using a VAR containing only the United States, rest of world, and Canada or Mexico (with the appropriate reductions in exogenous variables), to conserve degrees of freedom.

Measuring the Channels

To identify trade spillovers, we use the contribution of exports to real GDP growth. Because imports are a function of domestic demand, contemporaneous movements in a country's imports and its output are likely to capture domestic factors in addition to the effects of foreign activity on income. Fluctuations in exports, however, are mainly a function of foreign income, and their contemporaneous correlation with domestic demand can generally be considered weakly exogenous to home country factors. If the effects of shocks to foreign growth on domestic activity are accounted for by movements in

domestic exports, then there is evidence of spillovers through trade. Similarly, if a shock to a major economy's exports affects its GDP, and in turn this feeds through into growth in another country, this is a trade spillover. This justifies including the export contributions of the major regions along with those of Canada or Mexico. The contribution for the rest of world aggregate is excluded, however, because these countries are proxying for global shocks, and thus it is not clear that their exports can be considered to be exogenous to the global economy. The lag structure should be short to prevent reverse causality from GDP shocks to exports in future periods from contaminating the estimates. Therefore, the contemporaneous and only one lagged value are included, to allow for differences in the timing of the inclusion of one country's exports in another country's imports, and hence GDP.

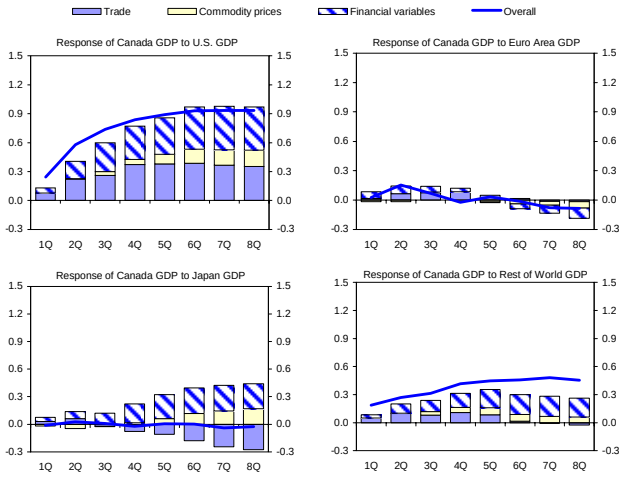
Spillovers from financial channels are captured by including short-term interest rates (the yield on three-month government securities), long-term interest rates (the yield on 10-year government securities), and equity prices for the United States, euro area, and Japan.[10] The interest rates are expressed in levels, because yields approximate a random walk. Equity prices were deflated by the country's GDP deflator, then expressed in quarterly percent changes. Because of the possibility of collinearity among the three variables, they enter as a group in a single VAR rather than individually. The contemporaneous value and first lag of each variable are included, in order to be comparable with the trade channel and to allow for transmission lags. The effects of foreign financial conditions on home country growth, either directly through financing raised abroad or indirectly through the impact on home country financial conditions, are encompassed in the estimate of the spillover to home country growth. Therefore, financial conditions are not included for Canada or Mexico.

The commodity prices used are the average petroleum spot price (APSP) for oil and the non-energy component of the Goldman Sachs Commodity Index, a broad measure with weights based on global production. Both express prices in U.S. dollars; they are converted into real terms using the U.S. GDP deflator and entered into the VAR in quarterly percent changes. The contemporaneous value and four lags are used to allow for transmission lags.

Sources of Spillovers to Canada

The full sample results in Figure 3.7 show that both trade and financial linkages between the United States and Canada are strong. The two channels are responsible for the transmission of one-third and one-half, respectively, of U.S. spillovers, with commodity prices contributing 15 percent. Klyuev (2008) uses a structural VAR and also finds that the effects on the Canadian economy from shocks to U.S. financial markets were larger than those from trade. Global shocks are more likely to affect

Figure 3.7. Canada: Decomposition of Spillovers



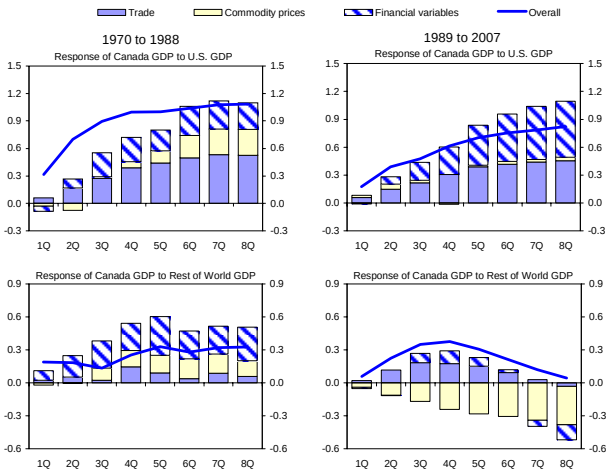
Source: IMF staff calculations.

[10] Rest of world financial conditions are not included. Given that the data already include the largest financial markets, and those in other major economies are highly correlated with the regions included here, a rest of world financial conditions variable would be unlikely to add a significant amount of information. Bayoumi and Swiston (2007) found sizable financial spillovers from rest of world growth shocks even in the absence of a specific measure of the region's financial conditions.

Canada through the financial channel, which explains about half the spillover, compared to a third for trade and commodity prices together at their peak. The sum of spillovers across channels also verifies the estimate from the base VAR, except in the case of Japan.

The importance of U.S.-Canada financial linkages has increased over time, as they accounted for only a quarter of spillovers before 1988 but have accounted for more than half since 1989 (Figure 3.8). The contribution of commodities has fallen, with that of trade remaining diminishing slightly. The decomposition of Canada's response to the rest of the world shows more variation by subsample, owing to both changes in the breakdown across channels and a less consistent overall response to the global GDP shock.

Figure 3.8. Canada: Decomposition of Spillovers by Subsample



Source: IMF staff calculations.

Sources of Spillovers to Mexico

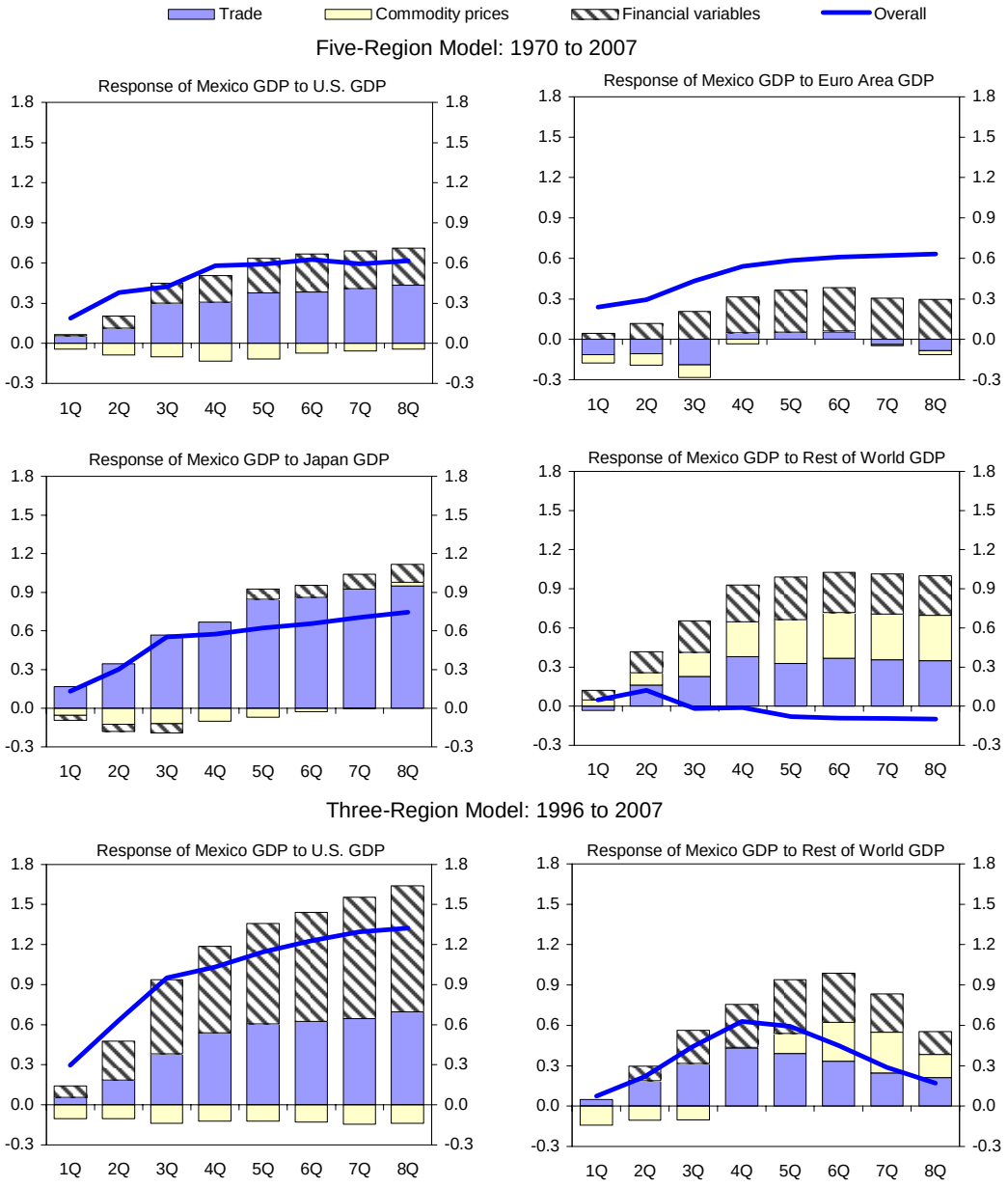
Because of the lack of precision in the estimates of the magnitude of spillovers before 1995, the analysis on the sources of spillovers will focus on the full sample results and the period since 1996. For the full sample, the sum of spillovers across channels is broadly consistent with the direct estimate from the base VAR, except for the rest of the world, which shows sizable contributions from all three channels even though Mexico's response to global shocks is about zero (Figure 3.9). Sixty percent of spillovers from the United States came through trade and 40 percent through financial conditions. Spillovers from the euro area were transmitted mostly through the financial channel and those from Japan were transmitted largely through trade. Despite Mexico's status as an oil exporter, commodity price shocks did not transmit much of the impact of growth shocks from these three regions. It could be the result of the fall in the magnitude of global commodity shocks in recent decades, or it could reflect supply shocks, as the drag on foreign growth from higher commodity prices offsets the positive impact on Mexico's terms of trade and leaves Mexico's GDP response roughly balanced.

The United States has become a more significant driver of the Mexican business cycle since 1996, and as such the contributions to U.S. spillovers from both trade and financial conditions have increased. However, the relative importance has switched, because about 60 percent of U.S. shocks are now transmitted through financial variables and trade accounts for 40 percent of spillovers. Österholm and Zettelmeyer (2007) also find that U.S. financial market fluctuations have a more powerful impact on Mexico than do commodity price shocks. Over a two-year horizon, the decomposition of spillovers from the rest of the world assigns roughly equal weights to each of the three channels. The results for Mexico and Canada tell similar stories—the role of financial conditions in transmitting shocks from the United States has increased in importance in recent years.

Conclusions

This chapter has examined both the size and sources of spillovers from the major regions of the world to Canada and Mexico. The methodology used here allows us to identify global shocks, to estimate spillovers from contemporaneous shocks across countries, and to evaluate the sensitivity of the

Figure 3.9. Mexico: Decomposition of Spillovers



Source: IMF staff calculations.

results to changes in the assumptions made about the source of these contemporaneous shocks. We also decompose the estimated spillovers into contributions from trade, commodity price, and financial channels.

Throughout the past few decades, the Canadian business cycle has been tightly linked with that of the United States. A 1 percent shock to U.S. GDP shifts Canadian growth by ¾ of a percent in the same direction, a response that is consistent across sample periods. Thus, the decline in U.S. volatility has played a significant role in the reduction in Canadian fluctuations in recent decades. Trade channels were the largest source of spillovers in the 1970s and 1980s, but financial shocks have become the prominent transmission mechanism since the inception of the Canada–United States Free Trade Agreement. Shocks to the euro area and Japan do

not have a significant impact on growth in Canada, whereas global shocks have exerted some influence on the Canadian economy since 1989, with the effects coming largely through trade. All of these estimates are robust to the assumptions made about the source of contemporaneous correlation between the growth shocks of the major regions.

For Canada, then, tighter integration with the United States has not had a noticeable impact on the size of spillovers, but the more rapid deepening of financial linkages is seen in their increased contribution to the transmission of shocks. One issue outside the scope of this chapter is the role of Canadian macroeconomic policy in responding to U.S. fluctuations. If it has responded more vigorously to U.S. shocks in recent decades, this would offset some of the effects of tighter linkages on the size of spillovers.

The Mexican business cycle was dominated by idiosyncratic domestic factors from 1970 through 1995, as the variance of domestic shocks was more than twice as large as that of the major industrial economies. This volatility swamped any effects from international spillovers. With the stabilization of the Mexican economy since 1996, U.S. shocks have taken on a more influential role in driving the Mexican cycle. A 1 percentage point shock to U.S. growth leads to a change of 1½ percentage points in Mexican GDP—"when the U.S. sneezes, Mexico catches a cold." The U.S. economy has accounted for about one-third of the variation in Mexican GDP at business cycle frequencies since NAFTA implementation, and the spillovers have been transmitted through both trade and financial channels. There are no significant spillovers from the euro area or Japan. The impact of global shocks is only mildly significant when it is assumed to be the source of all the contemporaneous correlation in shocks across regions.

It is difficult to disentangle the effects of NAFTA on spillovers to the Mexican economy from the general macroeconomic stabilization that has occurred over the past decade; the agreement can be seen as either a cause or reflection of the country's commitment to a sound macroeconomic framework. Taken together, Mexico's integration into the global economy and domestic economic stability have caused its business cycle to become more closely linked to developments in the United States.

These results provide further evidence that higher levels of globalization have brought about increased synchronization of business cycles across countries and rising sensitivity to external shocks, as seen in Calderón, Chong, and Stein (2007) and Imbs (2006). They also underscore the importance of the great moderation in the United States for dampening economic fluctuations in other countries since the 1980s. Given the importance of financial linkages, at least some of this moderation can be attributed to a reduction in U.S. monetary policy shocks. The significant role of the financial channel in transmitting shocks also suggests that further research into the macroeconomic effects of financial market fluctuations is necessary. Finally, with the responses of Canadian and Mexican growth to U.S. shocks steady across sample periods, there is little evidence to support predictions of a decoupling of these economies from the U.S. cycle.

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Chapter 4

Central America: Regional Trends and U.S. Cycles

Shaun K. Roache

The economies of Central America share a close relationship with the United States, with considerable comovement of GDP growth over a long period of time. The open nature of the region's economies, combined with geographical proximity to the United States, has produced a number of transmission channels through which U.S. cyclical fluctuations can affect Central America. The *trade* channel is particularly important, with more than half of the region's merchandise exports over the preceding five years destined for the United States, up from around one-third in the late 1990s. Other possible channels include *financial sector linkages* and *remittance flows* from migrant workers in the United States, which accounted for about 14 percent of regional GDP during 2006.

Just how dependent is growth in the region on the United States? Is there some part of the economic cycle that is uniquely Central American? If not, what explains those periods during which certain economies appear to have decoupled from the United States? In an attempt to answer those questions, we use the common cycles method of Vahid and Engle (1993), which applies the insights of cointegration to the analysis of stationary or, in our case, cyclical economic data.

Stylized Facts

Trade Linkages

Since the early 1980s, the share of total merchandise exports from the region as a whole to the United States has averaged about 40 percent, ranging from 27 percent in Nicaragua to 53 percent in Honduras. The second-largest share of exports goes to other Central American countries, averaging about 20 percent over the same period. Do exports to the region help to diversify exposure away from the economy? The answer would be "yes" in two circumstances: either there exists a unique Central American business cycle or there is divergence in the long-run rate of trend growth between the region and the United States, an issue that will be explored below. Either possibility would have a very different implication for the behavior of exports and the overall economy, given that exports account for 20 percent of regional GDP.

Financial Linkages

Financial linkages are also important, in part because of the relatively high degree of dollarization across Central America. With many transactions taking place in U.S. dollars, financial conditions in the United States and the region should share some similarities, most obviously in terms of interest rates. However, economists have known for some time that real interest rate parity, as described in theory, has little evidence to support it despite open capital accounts.[1] Indeed, complete interest rate synchronization rarely holds between Central America and the United States, even for officially dollarized economies such as El Salvador, perhaps reflecting some frictions and other imperfections in the financial sector.

A more direct linkage with U.S. financial conditions is through external debt. The debt owed to foreign banks that report to the Bank for International Settlements (BIS) by Central American borrowers from all sectors (excluding Panama) accounted for

[1] These results are largely based on short-term interest rates. Recent work—see Chinn and Meredith (2005)—suggests that the relationship may be stronger for long-term interest rates.

about 15 percent of GDP at the end of 2006.[2] Although just over 3 percent of GDP is directly owed to U.S. banks, much of the remainder is also likely to be denominated in U.S. dollars, given the observed pattern of trade flows. Loans with a maturity of less than one year account for almost half of outstanding bank claims on Central America, suggesting considerable exposure to interest rates shifting with the prevailing global financial condition.

Foreign ownership of domestic banks—referring here to institutions from outside of the region—may also introduce spillovers. The degree of foreign ownership varies widely, ranging from less than 15 percent in Guatemala to more than 90 percent in El Salvador. Even before the large-scale entry of foreign banks in recent years, financial sector integration had gained momentum as some regional institutions expanded outside their home market (Morales and Schipke, 2005). The large-scale entry of foreign banks is a relatively new development in some countries, however, so it is not yet clear how financial sector linkages will be affected.

Remittances

Remittance flows sent to Central America by migrant workers have grown rapidly in recent years. For some countries, they now account for a significant share of GDP and rival or even dwarf foreign direct investment (FDI) as a source of external financing. Over the long term, sociodemographic and institutional factors, in both the host and recipient countries, are likely to have a dominant influence. However, in the short term, it is reasonable to presume that cyclical economic conditions in the host country would influence these remittance flows.

A number of theoretical models that describe remittance behavior have been proposed—see Rapoport and Docquier (2005) for a survey—but recent empirical evidence suggests that remittance behavior may not have been an important source of spillovers from the United States until now (Roache and Gradzka, 2007). Notwithstanding weaknesses in the remittances data, this could be due to migrant workers "smoothing" their remittance flows, for example, by sending a fixed U.S. dollar amount each month or quarter, irrespective of income fluctuations, within reason. An alternative explanation could be that immigrants attach more weight to being employed than to the wage received, and thus may be less likely to be unemployed (all other things being equal) than their native-born counterparts.

Literature Review

The relevant literature for our purposes includes Central American economic linkages and applications of the codependence methodology to business cycles. We will briefly review what little work has been done in both areas.

Central America Linkages

Although the results from global and broader regional studies indicate that Central America is one of the regions most integrated into the global economy, little work has been done specifically on Central America. One of the most comprehensive papers is Fiess (2007), which measures business cycle synchronization in Central America and sensitivity to the United States, using simple correlations of band-pass filtered GDP data from the period 1965–2002. There is evidence of a close relationship among Costa Rica, El Salvador, Guatemala, and Honduras, and between this group and the United States, suggesting that a significant portion of variability is being driven by external factors. Two other countries, Nicaragua and Panama, exhibit low or even negative correlations with the rest of the group. Controlling for the common effect of the United States causes correlations to decline, although they remain fairly high between Costa Rica and Guatemala (0.48), Costa Rica and El Salvador (0.41), and Guatemala and Honduras (0.42).

[2] Panama is excluded because of its large offshore financial sector. These figures also exclude local lending by foreign banks that have acquired a presence in domestic banking systems.

Fiess (2007) also presents coherence measures over assumed business cycle frequencies of 6 to 32 quarters for Central America using industrial production and other monthly indicators from the period 1995–2003. These results tend to confirm those from simple correlations. Business cycle synchronization was highest between Costa Rica and El Salvador (0.53), El Salvador and Guatemala (0.53), El Salvador and Nicaragua (0.51), and Honduras and Nicaragua (0.55). Comparing the Central American Free Trade Agreement (CAFTA) trade blocs to others, it was shown that intra-CAFTA coherence was lower than that seen within the North American Free Trade Agreement (NAFTA) and the European Union but similar to that within Mercosur (the Southern Cone Common Market).

Kose and Rebucci (2005) estimate country-specific vector autoregressions (VARs) for five Central American economies, the Dominican Republic, and Mexico using data over the period 1964–2003. Six shocks—three domestic and three external—are assumed to drive business cycle dynamics. The domestic variables include real GDP growth, the consumer price index (CPI) inflation rate, and the trade balance–to-GDP ratio. External variables include U.S. real GDP growth, a measure of the ex post U.S. real interest rate, and the ratio of oil to nonfuel commodity prices (a proxy for the terms of trade). External shocks accounted for one-third of output variance, with a wide range across economies from Costa Rica (67 percent) and Guatemala (55 percent) to the Dominican Republic (10 percent) and Nicaragua (18 percent).

Kose and Rebucci (2005) also present multicountry VARs using GDP growth rates for the United States, Mexico, and the same six regional economies above, assessing the importance of regional shocks. The block recursive structure placed the United States and Mexico in the first block, five Central American countries in the second, and the regional economy of interest in the final block. With this setup, NAFTA shocks explained an average of 22 percent of output variance for regional economies, with Honduras (34 percent), Costa Rica, and El Salvador (both at 26 percent) showing most sensitivity. Regional shocks were more important, explaining on average one-half of output variance, with the range across countries much tighter. Domestic shocks explained the remainder (24 percent), with the Dominican Republic and Nicaragua most affected by idiosyncratic disturbances.

Common Business Cycles

Pineda and Cerro (2002) apply the codependence approach to investigate real output trend and cycle dynamics for 11 Latin American economies using quarterly constant price GDP data from the period 1960–2000.[3] Tests indicated the existence of seven common trends and four common cycles, allowing for decomposition into trend and cycle components. The correlations of the cyclical components show that correlations across the region peaked in the 1970s, declined through the 1980s, but have been rising since then. Although intraregional correlations appear high compared to the results from other studies (often above 0.5), there was little evidence that either Chile or Mexico were influenced by the common regional cycle.

Hecq, Palm, and Urbain (2006) test for the presence of comovements in annual GDP series for five Latin American countries—Brazil, Argentina, Mexico, Peru, and Chile—for the period 1950–99. The main purpose of this study is to develop a test for strong- and weak-form reduced rank structures, with the first referring to the existence of common cycles within first-differenced data and the latter within first differences adjusted for long-run effects. They find evidence for two to three cointegrating vectors and three codependent vectors (of both kinds, strong and weak), depending on the specification, indicating linkages across the economies. The reduced-form restrictions implied by a common cycle structure also appear to improve model accuracy, on the basis of root mean-squared errors.

[3] Countries include Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay, and Venezuela.

Hecq (2005) uses annual GDP data from the period 1950–2002 for six Latin American countries (Brazil, Chile, Colombia, Peru, Mexico, and Venezuela), and finds three common trends and three common cycles. This chapter provides an innovation by using an iterative approach to improve the performance of the Johansen test in small samples, and concentrates more on the method than the results.

Data and Methodology

Data

We use annual real GDP from 1950 to 2006 for six Central American countries—Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama (Table 4.1)—and the United States. The data are taken from the IMF's *International Financial Statistics* and, for earlier periods, the Penn World Tables. For advanced economies, much use has been made of quarterly data; this is usually preferable for analyses of business cycles, but it remains difficult to obtain data at this frequency that is both comparable across countries and available with a sufficient history for the Central America region.

Table 4.1. Real GDP Growth Summary Statistics

	1951-2006				1995-2006			
	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
Costa Rica	5.4	4.1	18.4	-7.3	4.8	2.7	8.4	0.9
El Salvador	3.3	4.0	12.0	-11.8	3.1	1.4	6.4	1.7
Guatemala	3.9	2.5	9.5	-3.5	3.5	0.9	4.9	2.4
Honduras	3.8	4.0	17.9	-8.6	3.6	2.1	6.0	-1.9
Nicaragua	3.2	6.4	15.0	-26.5	4.2	1.7	7.0	0.8
Panama	4.7	4.8	18.7	-13.4	4.5	2.6	8.1	0.6

Sources: Heston, Summers, and Aten, 2006; IMF, *IFC*; and national authorities.

As the literature shows, there are many methods available to assess linkages and common cycles across economies. The focus in this chapter is on two of those methods: simple correlations, using a variety of cyclical decompositions; and the common cycles approach first described by Engle and Kozicki (1993). These methods are intuitive and provide a clear description of the common forces that drive business cycle fluctuations. The results are easy to interpret, can be compared against those of other well-known methods of business cycle analysis, and allow for the testing of hypotheses.

As with any methodology, there are drawbacks and the most important of these is the emphasis on association rather than causation. These methods have little or nothing to say explicitly regarding the underlying economic forces that drive synchronization. Some interpretation can be imposed upon the results, but this will be more conjecture than firm conclusion.

The Common Cycles Method

The common cycles technique is an extension of the cointegration framework outlined by Johansen (1988). Cointegration implies that one or more linear combinations of nonstationary variables can remove a trend from the data. As shown by Stock and Watson (1988), for n variables, the existence of r cointegrating vectors implies the existence of $n - r$ common stochastic trends. For economic output series, one interpretation of this result could be that, over the long run, common forces drive the underlying growth process.

An analogous indicator of comovement among nonstationary series is codependence. A strong form of codependence is the serial correlation feature as described by Engle and Kozicki (1993). In this case, there exist some linear combinations of the variables that remove correlations, and hence predictability, based on the set of past values. These linear combinations are defined as *cofeature vectors* and may be compared to cointegration vectors for stationary data. The approach briefly described below borrows from Vahid and Engle (1993), where full technical details of the theory are presented.

Let $\mathbf{y}_t$ denote the (7 x 1) vector of log GDP series for the economies in our sample. As confirmed by standard tests, these data are I(1) while their first differences $\Delta\mathbf{y}_t$ are I(0). As a result, $\Delta\mathbf{y}_t$ has a Wold representation

$$\Delta\mathbf{y}_t = \mu + \mathbf{C}(L)\boldsymbol{\varepsilon}_t \qquad (1)$$

where $\boldsymbol{C}(L)$ is a matrix polynomial in the lag operator and ε is an (7 x 1) vector of stationary innovations. Assuming that $\mu = 0$ for algebraic convenience, the Beveridge-Nelson decomposition allows the original I(1) series to be expressed as the sum of a trend (T) and a cyclical (C) component:

$$\mathbf{y}_t = \mathbf{C}(1)\sum_{s=0}^{\infty}\boldsymbol{\varepsilon}_{t-s} + \mathbf{C}^*(L)\,\boldsymbol{\varepsilon}_{t-s} = T_t + C_t \quad (2)$$

Stock and Watson (1988) showed that a number of common trends r may be shared among the variables in vector $\mathbf{y}$. In this case, the matrix $\mathbf{C}(1)$ may be decomposed into the product of an (n x ($n - r$)) matrix of rank $n - r$(A) with an (($n - r$) x n) matrix of rank $n - r$(B) as follows:

$$\mathbf{y}_t = \mathbf{AB}\sum_{s=0}^{\infty}\boldsymbol{\varepsilon}_{t-s} + \mathbf{C}^*(L)\,\boldsymbol{\varepsilon}_{t-s} = \mathbf{AZ}_t + \mathbf{C}_t \quad (3)$$

where $\mathbf{A}$ is a (n x ($n - r$)) matrix of factor loadings with full column rank. Analogously, the vector $\mathbf{y}$ may also share common cycles. If common cycles exist, then there must exist linear combinations of the $\mathbf{y}$ vector that do not contain the cycle and for which history has no predictive power. This would imply that the following condition, for some set of linearly independent vectors $\boldsymbol{\alpha}^*$ known as cofeature vectors, will hold:

$$\boldsymbol{\alpha}^{*\prime}\mathbf{C}_t = 0 \quad (4)$$

When applied to $\Delta\mathbf{y}$, the cofeature transformation $\boldsymbol{\alpha}^*$ eliminates all the positive powers of the lag operator; in other words, it removes the serial correlation of first differences. This same transformation, when applied to the levels, removes the common cycles.

We test for the existence of common cycles using the canonical correlation procedure outlined in Vahid and Engle (1993). The first step is to estimate a vector error correction model to recover the error correction series, otherwise known as the long-run relationship:

$$\Delta\mathbf{y}_t = \boldsymbol{\Phi}\mathbf{y}_{t-1} + \sum_{s=1}^{p}\boldsymbol{\Gamma}_s\Delta\mathbf{y}_{t-s} + \boldsymbol{\varepsilon}_t \quad (5)$$

Then, defining two (7 x 1) random vectors $\boldsymbol{\varrho}_t$ and $\boldsymbol{\eta}_t$, which are linear combinations of the (7 x 1) vector $\Delta\mathbf{y}_t$ and the ((7p + r) x 1) vector of lags and error correction terms (which will be termed $\mathbf{x}_t$):

$$\begin{aligned}\boldsymbol{\rho}_t &= \mathbf{A}'\Delta\mathbf{y}_t \\ \boldsymbol{\eta}_t &= \mathbf{B}'\left[\Delta\mathbf{y}_{t-1} \quad \cdots \quad \Delta\mathbf{y}_{t-p} \quad \boldsymbol{\beta}\mathbf{y}_{t-1}\right] = \mathbf{B}'\mathbf{x}_t\end{aligned} \quad (6)$$

The (n x n) matrix $\mathbf{A}$ and the (n x (np + r)) matrix $\mathbf{B}$ are chosen such that four conditions hold. The first two state that the individuals elements of both $\boldsymbol{\varrho}_t$ and $\boldsymbol{\eta}_t$ have unit variance; the third condition states that the ith element of $\boldsymbol{\varrho}_t$ and the jth element of $\boldsymbol{\eta}_t$ are uncorrelated; and the final condition states that the elements of $\boldsymbol{\varrho}_t$ and $\boldsymbol{\eta}_t$ are ordered in such a way that

$$1 \geq \lambda_1 \geq \cdots \geq \lambda_n \geq 0 \quad (7)$$

where the correlation r_i is known as the ith canonical correlation between the two vectors $\boldsymbol{\Delta}\mathbf{y}_t$ and $\mathbf{x}_t$. The canonical correlations and the values of $\mathbf{A}$ and $\mathbf{B}$ can be calculated from the covariance matrices of $\boldsymbol{\Delta}\mathbf{y}_t$ and $\mathbf{x}_t$ through eigenvalues and eigenvectors. The test statistic is analogous to the trace statistic from the Johansen procedure, with the null hypothesis that the dimension of the cofeature space is at least s (or equivalently that there are at most $n - s$ common cycles) is

$$C(p,s) = -(T - p - 1)\sum_{i=1}^{s}\log\left(1 - \lambda_i^2\right) \quad (8)$$

where the λ^2's are the s smallest squared canonical correlations between $\boldsymbol{\varrho}_t$ and $\boldsymbol{\eta}_t$. Under the null, this statistic is chi-squared with $s^2 + snp + sr - sn$ degrees of freedom.

Suppose there are s linearly independent cofeature vectors; in this case, the (s x n) matrix of cofeature vectors that has full column rank. Vahid and Engle (1993) suggest that these equations may be regarded as s pseudo-structural equations for the first s terms of the vector $\Delta\mathbf{y}$:

$$\tilde{\boldsymbol{\alpha}}'\Delta\mathbf{y}_t = \mathbf{v}_t \quad (9)$$

In other words, there are s linearly independent combinations of the elements of $\Delta\mathbf{y}_t$ that have no dependence on the relevant past, such that the residual term is stationary, analogous to cointegration. The system is completed by including the unconstrained reduced-form equations for the remaining ($n - s$) elements of the (n x 1) vector:

$$\begin{bmatrix} \mathbf{I}_s & \tilde{\boldsymbol{\alpha}}^{*\prime} \\ \mathbf{0}_{(n-s)\times s} & \mathbf{I}_{n-s} \end{bmatrix} \Delta\mathbf{y}_t = \begin{bmatrix} \mathbf{0}_{s\times(np+r)} \\ \boldsymbol{\Pi}_1^*, \ldots, \boldsymbol{\Pi}_1^* \beta^* \end{bmatrix} \begin{bmatrix} \Delta\mathbf{y}_{t-1} \\ \\ \Delta\mathbf{y}_{t-p} \\ \tilde{\boldsymbol{\alpha}}'\mathbf{y}_{t-1} \end{bmatrix} + \mathbf{v}_t \quad (10)$$

This system may then be estimated using maximum likelihood or other estimation procedures, such as iterative three-stage least squares.

Results

Growth Correlations

Surprisingly, correlations of GDP growth rates are neither particularly high, nor statistically significant, in many cases (Table 4.2). A cluster of economies—Costa Rica, El Salvador, and Guatemala—correlate fairly closely, but the links do not appear to be too strong. Even to the United States, correlations appear to be low and, for some economies, have not risen in the latest decade or so.

One possible interpretation is that the linkages are weak. A second, more plausible alternative, given the stylized facts presented above, is that GDP growth rates are a combination of changes in the trend and cycle and that the linkages of both components differ.

Four Common Trends and Three Common Cycles

The first step in the common cycle approach is to select the lag order of the system by identifying the vector autoregression—using nonstationary level data—with the lowest Aikake information criteria (AIC).[4] A system with five lags was selected by the AIC and other criteria. If the series are cointegrated, this implies an error correction representation with four lags, which was used as the basis for the cointegration tests.

The cointegration tests, run with different lag specifications for robustness, suggest the presence of three cointegrating vectors, which in turn implies four common trends among the GDP series. This result should be interpreted with care, however, given the well-known weakness of the Johansen methodology regarding small samples and overparameterization (see Cheung and Lai, 1993; and Ho and Sørensen, 1996; among others). Often, the likelihood ratio tests lead to an overestimate of the number of cointegrating vectors r, and this bias is magnified as the lag length increases.

The test for common cycles is based on calculating the canonical correlations of the (7 x 1) vector $\Delta\mathbf{y}_t$ and its lagged values and the first lag of the three error correction terms. In this test, the null hypothesis that there are four common cycles among the GDP series could not be rejected at the 5 percent level. This conclusion was insensitive to the number of cointegrating relationships.

Trends and Cycle Decomposition

The test also found that the combined number of cointegration and cofeature vectors in our data sample added up to the number of variables, that is, $r + s = n$. This special case allows us to decompose each GDP series into permanent (trend) and transitory (cyclical) components. This Beveridge-Nelson decomposition can be done for each country, as shown by Vahid and Engle (1993) and extended in Gonzalo and Granger (1995).

[4] Although the AIC possesses a nonzero limiting probability of overfitting a VAR model—that is, selecting too many lags—Gonzalo and Pitarakis (2001) have shown that this bias is a decreasing function of the system dimension and that the AIC outperforms other criteria in large dimensional systems. Also, Hecq, Palm, and Urbain (2006) have shown that the inefficiencies of overfitting a common cycles model tend to be small.

Table 4.2. Central American GDP Growth Correlations, 1950–2006 and 1995–2006 1/

	Correlation of GDP Growth Rates Including the United States						Correlation of GDP Growth Rates Controlling for the U.S. Effect 2/					
	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama
						1950–2006						
El Salvador	**0.54**						**0.47**					
Guatemala	**0.38**	**0.39**					**0.36**	**0.37**				
Honduras	0.12	**0.26**	**0.44**				0.01	0.15	**0.42**			
Nicaragua	0.13	**0.33**	0.10	-0.21			0.13	**0.34**	0.10	-0.24		
Panama	0.21	0.13	0.09	-0.07	0.23		0.23	0.14	0.09	-0.07	0.23	
United States	**0.34**	**0.37**	0.13	**0.35**	0.05	0.00						
						1995–2006						
El Salvador	0.47						0.30					
Guatemala	**0.63**	**0.79**					**0.58**	**0.68**				
Honduras	-0.23	0.06	0.06				-0.32	0.16	0.02			
Nicaragua	0.09	0.26	0.04	-0.25			-0.10	-0.05	-0.10	-0.42		
Panama	**0.71**	0.16	0.49	0.32	0.07		**0.60**	-0.19	0.39	0.10	0.02	
United States	0.49	0.21	0.32	0.01	**0.59**	**0.63**						

Source: Author's calculations.
1/ Figures in bold are statistically significant at the 5 percent level.
2/ These correlation coefficients use residuals from a regression of country *i*'s growth rate on a constant and the U.S. growth rate, over the same sample period.

The first step in recovering these components is to estimate the system described by equation (10). This was estimated using iterative three-stage least squares, which accounts for endogeneity of some regressors and provides efficiency gains over the two-stage procedure owing to the existence of common exogenous shocks—for example, the oil price—on output.

To see how these estimates may be used to recover the trends and cycles, recall that a cointegrating combination of I(1) variables eliminates the trend from the data, leaving only the cycle. By analogy, a codependent combination of the same variable eliminates the cycle, leaving only the trend. As a result, the following terms describe the trend and cyclical factors, respectively:

$$\begin{aligned} \tilde{\boldsymbol{\alpha}}'\mathbf{y}_t &= \tilde{\boldsymbol{\alpha}}'\mathbf{C}(1)\sum_{s=0}^{\infty}\boldsymbol{\varepsilon}_{t-s} \\ \boldsymbol{\alpha}'\mathbf{y}_t &= \boldsymbol{\alpha}'\mathbf{C}^*(L)\boldsymbol{\varepsilon}_{t-s} \end{aligned} \qquad (11)$$

where $\tilde{\boldsymbol{\alpha}}$ is the (n x s) matrix of cofeature vectors and $\boldsymbol{\alpha}$ is the (n x r) matrix of cointegrating vectors. The trend and cycle for each series can then be recovered using the following expression, where the (n x s) matrix $\tilde{\boldsymbol{\alpha}}^{-}$ and (n x r) matrix $\boldsymbol{\alpha}^{-}$ are formed from the partition of the inverse of the matrix $\left[\tilde{\boldsymbol{\alpha}}' \quad \boldsymbol{\alpha}'\right]'$:

$$\mathbf{y}_t = \tilde{\boldsymbol{\alpha}}^{-}\tilde{\boldsymbol{\alpha}}'\mathbf{y}_t + \boldsymbol{\alpha}^{-}\tilde{\boldsymbol{\alpha}}'\mathbf{y}_t = trend + cycle \qquad (12)$$

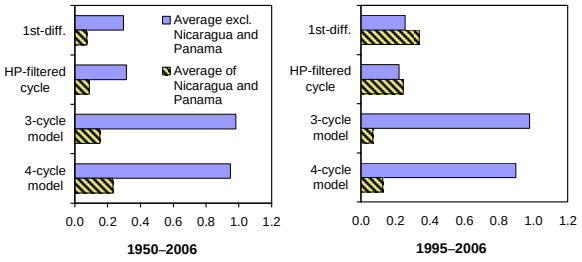
One cautionary note regarding the common cycle model is the relatively high volatility of the trend component, a tendency also seen in the original application to U.S. consumption by Vahid and Engle (1993). Trend or underlying, GDP growth is often assumed to be smooth over time, with a lower frequency of perturbations.

As a robustness check, the model was also run assuming four shared cycles and three shared trends. The results were not qualitatively different, although for some countries, the cycle tended to be somewhat more volatile. This is particularly true for Guatemala, for which the low volatility of the official GDP series tends to imply a very shallow cycle with this model.

Cyclical Correlations

The results of our model indicate that correlations of the cyclical part of GDP are much higher than for both the annual growth rate and the Hodrick-Prescott filter cycle (Figure 4.1). This finding is true for almost all the countries in our sample. This result is not an inevitable outcome of the methodology—recall that there are three common cycles, and although it is conceivable that some economies would have exposure to some cycles but not to others, this has not been found to be the case here. The ranking of countries is also similar to the one found when analyzing correlations of growth rates. Costa Rica, El Salvador, and Honduras appear to be the most sensitive to the U.S. business cycle.

Figure 4.1. Central America: Average Correlation of Cyclical GDP Component to the United States—Comparison of Methods 1/



Source: Author's calculations.

1/ The methods include first-differenced log values, the first difference of the cyclical component from the Hodrick-Prescott (HP) filter, and the first difference of the common cycle factor recovered from the Vahid and Engle (1993) decomposition.

Cyclical and Trend Elasticities to the United States

In our sample, we assume that we have one truly exogenous cycle, that of the United States (ignoring, for now, the possibility of common exogenous shocks, which could characterize the 1970s oil supply disruptions). Although correlations show that the cycles in most Central American countries and the United States tend to move in the same direction, it does not tell us anything about elasticities; that is, how much growth in Central America would respond to a cyclical shock in the United States. Assuming one-way causality from the United States to Central America allows us to use very simple methods to estimate elasticities, without running into interpretation and estimation problems related to endogenous regressors.

The cyclical contribution to GDP growth is approximated by the first difference in the cyclical series extracted above. For each Central American country, the first-differenced cycle was estimated as the sum of a constant γ (which should be zero in the long run); the first-differenced U.S. cycle and the elasticity ε^{USC}, the first-differenced U.S. trend and the elasticity ε^{UST}, and a residual e that could reflect country-specific factors or linkages with other economies in the sample. Given our exogeneity assumption, this relationship may be estimated using ordinary least squares:

$$\Delta y_{it}^{C} = \gamma_i + \varepsilon_i^{USC} \cdot \Delta y_{USt}^{C} + \varepsilon_i^{UST} \cdot \Delta y_{USt}^{T} + e_{it} \quad (13)$$

Recall that the codependent combination of variables eliminates the influence of past shocks. As a result, we should be able to discard autoregressive terms or lags of the U.S. cycle. If such variables were incorrectly omitted from equation (13), the result would likely be strong serial correlation of the residuals, which can be tested using well-known procedures.

We again find that Central America is very cyclically sensitive to the United States, with elasticities highly significant for four countries. (Guatemala's elasticity is somewhat lower than the others, owing mostly to the low volatility of the historical GDP series.) In contrast, long-run trend shocks in the United States have a lesser impact, indicating that trends are determined much more by regional developments. Running diagnostics for each of these estimations confirms that the model is well behaved and supports our earlier assertions that this simple functional form captures the true cyclical elasticities (Table 4.3).

Table 4.3. U.S. GDP Growth Elasticities in Central America 1/

	Elasticity of the Cycle to		Elasticity of the Trend to	
	U.S. cycle	U.S. trend	U.S. cycle	U.S. trend
Costa Rica	0.90 ***	0.02	0.00	0.41 *
El Salvador	1.07 ***	0.06	-0.23	0.44
Guatemala	0.17 ***	0.01	-0.05	0.11
Honduras	0.59 ***	0.00	0.00	0.66 **
Nicaragua	0.41	0.36	-0.35	-0.86
Panama	0.10	0.03	-0.10	-0.35

Source: Author's calculations.
1/ Elasticity of the cyclical and trend component of growth in each economy to the cycle and trend in the United States, with ***, **, and * implying significance at the 1, 5, and 10 percent levels, respectively.

Variance Decomposition by Factor

How much of the variation in GDP is due to the trend and how much to the cycle? Previous research answered this question using a VAR approach (see Vahid and Engle, 1993; and Pineda and Cerro, 2002). Generally, it was found that one type of shock tends to dominate variance and, using the same methods, similar results are obtained using this sample. However, the specific shock that is found to dominate is very sensitive to the ordering of the VAR. Without strong priors from theory to suggest which shock should be ordered first—for example, cyclical or trend shocks—we have a powerful incentive to identify a new decomposition method.

We use an application of the portfolio risk contribution. To describe this method, first recall that in our case, there are three common cycles and four common trends, which are scaled up by the factor loadings to yield the level of GDP. This implies that it is possible to write GDP as a factor model, where the (n x 1) vector $\mathbf{f}$ contains r cycles and s trends:

$$\mathbf{y}_t = \mathbf{A}\mathbf{f}_t \qquad (14)$$

For any individual country, this can be written as

$$y_{it} = a_{i1} f_{1t} + a_{i2} f_{2t} + \cdots + a_{in} f_{nt} \qquad (15)$$

The variance in this case can be written as

$$\text{var}(y_i) = \sum_{j=1}^{n}\sum_{k=1}^{n} a_{ij} a_{ik} \,\text{cov}(f_j, f_k) \qquad (16)$$
$$\forall \;\; j,k = 1,\ldots,N$$

Our results indicate that for most Central American countries, the cycle contributes most to changes in GDP. One exception is Honduras, for which the trend is more important and more closely linked to the U.S. trend than other countries. The other exception is Guatemala, where the cycle tends to dampen changes in the trend; this can occur owing to the inclusion of covariance terms in equation (16). Once again, as with the estimated elasticities, the curiously low volatility of the historical GDP series may be playing a role in this result.

Conclusions

Cyclical Linkages: Stronger Than Expected

Almost all of the countries in our sample—including the United States—share a common business cycle. Clearly, the United States is the dominant economy and, as a result, we have evidence of a powerful cyclical linkage running from the United States to Central America, a linkage that is stronger than simple regressions of GDP growth rates would imply.

Indeed, growth elasticities using GDP suggest a much weaker cyclical relationship. This is due to the weak links between long-run growth shocks in Central America and the United States, the most important of which are related to armed conflicts in particular countries but also involve common terms of trade shocks and poor policy responses (see Macías, Meredith, and Vladkova Hollar, 2007). If the long-run component of Central America's GDP growth is not stripped out, estimated cyclical linkages with the United States will seem lower than they really are, which could complicate the policy response.

How Will Linkages Evolve?

The cyclical linkages between Central America and the United States are unlikely to weaken in the absence of a significant diversification of exports and investment. CAFTA, the most important economic change in recent years, may play the

pivotal role in determining how external linkages develop.

Most obviously, CAFTA may encourage more integration with the United States through trade, but also through investment flows and the financial sector. This would tend to strengthen cyclical linkages. For example, Mexico's experience under NAFTA suggests that trade flows between Central America and the United States could increase rapidly as a result of CAFTA, while FDI from the United States would rise (Kose, Rebucci, and Schipke, 2005).

However, it is also conceivable that CAFTA would have an externality effect that could weaken the dependence of Central America upon the U.S. cycle. It seems reasonable to assume that CAFTA could have a positive effect on productivity growth through higher investment and technology transfer. This effect, in turn, could encourage investment from new sources that have not been a strong presence in the region, such as Asia. Improved competitiveness may also increase the region's penetration in other markets. In other words, CAFTA could have positive externalities beyond the obvious linkages with the agreement's members. Other bilateral trade agreements, including those currently being negotiated with the European Union, could also encourage cyclical diversification (Desruelle and Schipke, 2007).

The more difficult question is how long-run trend growth, which has been responsible for long periods of decoupling with the United States, will evolve across the region. The diversification of exports, with a greater share now destined for neighboring countries in the region rather than the United States, suggests that Central America may be experiencing its own growth dynamic. Perhaps this is the early stage of the positive externality process from CAFTA mentioned earlier. How could this process provide some insulation against cyclical fluctuations in the United States? First, it may encourage linkages with new markets beyond CAFTA. Second, and less likely, it may build the region's critical economic mass to the point that it could generate its own economic cycle.

Policy Implications

Whether a rise (or fall) in economic growth is due to the cycle or to long-run structural factors should influence the public policy response. The clearest example is fiscal policy. Evidence suggests that government tax revenues in the region rise by more than one-for-one with growth in the economy.[5] For example, if GDP growth over a year is 5 percent, tax revenues will grow by more than 5 percent, causing the tax-to-GDP ratio to rise (and vice versa for a decline).[6]

The decision to save or spend this additional income is a straightforward application of the permanent income hypothesis. If the rise in growth is due to permanent structural factors, the optimal response would be for the government to fully spend it, either through higher expenditure or lower taxes. If the rise in growth is cyclical, and by definition temporary, it would be optimal to save most of it and spread the benefits of temporarily higher income over time. In other words, governments would be well advised to adjust their spending to the structural level of revenues, that is, to the level explained by potential or long-run growth.

Appropriate policy settings rely on a good understanding of the nature of growth. A simple trend-cycle analysis incorporating major trading partners cannot provide all the answers, but it does provide some important clues. For Central America, the message seems to be that if regional growth is picking up (or falling) at the same time as it is in the United States, then it is reasonable to presume that some significant portion of that improved growth performance is attributable to cyclical factors.

[5] For instance, Cubero and Sowerbutts (forthcoming) find that, in the case of Costa Rica, the elasticity of tax revenues with respect to GDP is about 1.1 (and much higher than that for income taxes).

[6] Over the long run, the tax-to-GDP ratio should be expected to stabilize at some level, given an unchanged tax structure.

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Part II

Commodity Price Shocks and Inflation

Chapter 5

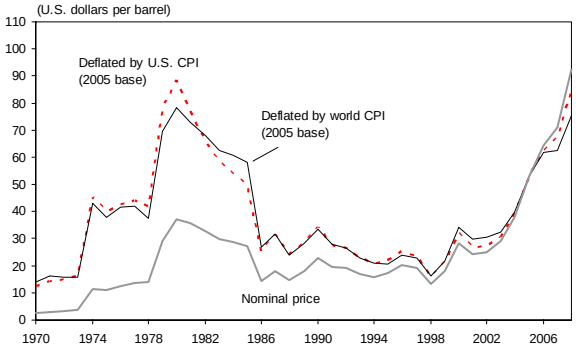
Oil Price Pass-Through in Latin American and Caribbean Countries

Nkunde Mwase and Guy Meredith

World crude oil prices roughly tripled during the period from late 2002 to late 2007, and the world wholesale price of refined products rose by about the same proportion (Figures 5.1 and 5.2). The dramatic increase in crude and refined oil prices presented a significant shock to both oil-consuming and oil-producing countries via movements in their terms of trade, real incomes, and fiscal balances. From a household perspective, one of the most immediate influences was upward pressure on pump prices of refined products, notably gasoline. Not surprisingly, then, policies toward the magnitude and timing of pump price increases became an important issue in many countries. Those with direct government regulation of retail petroleum prices clearly needed to make explicit decisions on the degree of "pass-through" of world oil prices to domestic prices. But even in countries with market-determined retail prices, pressures were frequently brought to bear to adjust tax or other policies to cushion the impact of higher world prices.

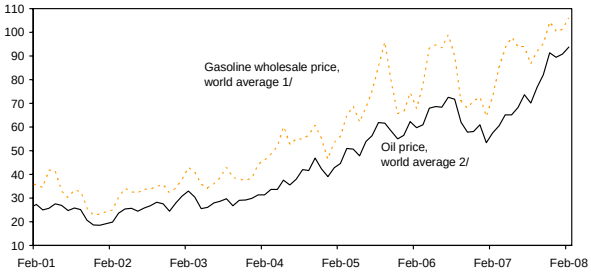
This chapter assesses the extent to which higher world oil prices were in fact passed through to higher retail prices in the Latin America and Caribbean (LAC) region during 2003–07.[1,2] The results provide a measure, albeit imperfect, of the extent to which governments offset the direct impact on consumers of higher oil prices, with effects on government revenues and/or the incomes

Figure 5.1. World Oil Price, 1970–2008 1/
(U.S. dollars per barrel)



Sources: Bloomberg; and IMF staff estimates.
1/ Simple average of WTI, Dated Brent, and Dubai Fateh crude spot prices (f.o.b.). Data for 2008 are January and February 2008 averages.

Figure 5.2. World Oil and Gasoline Prices, December 2001–February 2008
(U.S. dollars per barrel)



Source: Bloomberg.
1/ Average of premium gasoline f.o.b. spot prices in New York, U.S. Gulf Coast, Los Angeles, Rotterdam, and Singapore.
2/ Average of WTI, Dated Brent, and Dubai Fateh crude spot prices, f.o.b..

of other economic agents (e.g., distributors). In addition to the effects on income distribution and inflation, policies toward price pass-through are also of interest for their effects on resource allocation, because a lack of pass-through reduced incentives to economize on oil use and increased fiscal risks, through forgone revenues or subsidies.

In general, any factor that affects retail margins—defined to include taxes, transportation and distribution margins, and retail profits—will affect measured pass-through of world oil prices to retail gasoline prices. In countries with domestic refining capacity, changes in refining margins will also affect

[1] Due to limited data on other petroleum products, such as diesel fuel, the analysis focuses on retail gasoline prices.
[2] The Latin America and Caribbean region includes all 32 countries in Central and South America and the Caribbean, and Mexico.

measured pass-through—often the result of government policy given pervasive public sector involvement in refining activities. There are three main factors that could induce significant variations in pass-through coefficients across countries and over time:

- *Gasoline pricing mechanisms*: Pricing regimes that are market-based, or regulated based on an automatic formula, generally result in retail prices adjusting fully in response to increases in world prices. However, if the adjustment process includes a smoothing policy and/or occurs with a lag, the calculated pass-through would be expected to be high, but less than one-for-one, during the period in which oil prices are changing.[3] Where the pricing regime is regulated and prices are adjusted on an ad hoc basis, pass-through will depend on the frequency and size of the adjustments. If retail prices are fixed, pass-through would be zero, or possibly negative if they are fixed in nominal terms, and thus the real price falls over time.
- *Tax regimes*: Specific taxes (that is, taxes expressed as a fixed value per unit of gasoline) do not vary as world wholesale prices change, and in this sense are consistent with full pass-through.[4] Ad valorem taxes, in contrast, rise as the wholesale price increases, leading to a larger absolute increase in retail gasoline prices than in wholesale prices. Regardless of whether taxes are specific or ad valorem, changes in tax rates will affect measured pass-through if they occur in conjunction with changes in world wholesale prices. For example, taxes in most Eastern Caribbean Currency Union (ECCU) countries, until recently, were calculated as a residual between fixed pump prices and a varying landed import price as part of the policy to keep retail prices stable. This has resulted in periods when retail gasoline prices were subsidized by the government.
- *Costs that affect distribution margins*: If other, nontax costs embodied in domestic margins change significantly in real terms this would also affect measured pass-through. For example, if transportation costs increase at a higher pace than general inflation, measured pass-through would be greater than one-for-one. Conversely, if margins rise at a lower rate than inflation, less than full pass-through would result. Similarly, countries that compress distributors' margins as part of a policy to hold down retail prices would be expected to have less than full pass-through.

The next section of the chapter describes the methodology used to compute the pass-through of changes in world prices to domestic retail prices. The following section presents the results, and the last one concludes.

Methodology for Measuring Pass-Through

We define pass-through as the change in the pump price of gasoline divided by the change in the cost component owing to higher world oil prices, with a coefficient of unity indicating "full" pass-through. Algebraically, this approach can be described by decomposing the retail gasoline price at time t (PR_t) into two components: the cost of the oil input (PO_t), and "domestic margins" (PM_t), defined as all other components of the retail price (including taxes and subsidies):

$$PR_t = PO_t + PM_t \quad (1)$$

The change in the retail price from a given base period B can then be expressed as

$$PR_t - PR_B = (PO_t - PO_B) + (PM_t - PM_B) \quad (2)$$

[3] The degree of pass-through would be higher the shorter the delay in price changes or the period used for price smoothening.
[4] To be precise, specific taxes indexed to a broad price index such as the CPI are consistent with full pass-through (see next section).

Dividing by the change in the oil cost component gives the following measure of pass-through:[5]

$$\frac{PR_t - PR_B}{PO_t - PO_B} = 1 + \frac{PM_t - PM_B}{PO_t - PO_B} \qquad (3)$$

If domestic margins are not affected by changes in world oil prices, then $PM_t - PM_B$ will be zero when oil prices change, and the calculated pass-through coefficient in equation (3) will be one. If, instead, domestic margins fall when oil prices rise, the coefficient will be less than one; conversely, if they rise, the coefficient will be greater than one.

It is important to note that this definition of pass-through differs from the "percent variation" approach sometimes used in comparing domestic to international price movements. In particular, the latter measure defines pass-through in terms of the percent change in domestic prices relative to the percent change in world prices. This approach is appropriate if the measure of world price includes margins that are comparable to the domestic price measure. This is not the case when retail gasoline prices are compared with the international oil cost component, because domestic margins (taxes, distribution costs, and so forth) generally account for a large component of the retail price. Using percent changes to define pass-through would imply that these margins move proportionately to world oil prices for pass-through to be one. Yet these margins are primarily a function of domestic cost factors rather than world oil prices, making this definition of full pass-through unattractive—in practice, measured pass-through coefficients would be less than one even in countries with market-determined gasoline prices and unchanged tax structures.[6] Using this methodology, for instance, the calculated pass-through of world prices to U.S. retail gasoline prices would have been less than two-thirds over the 2004–07 period.

Several issues must still be addressed to implement the approach in equation (3). These include defining the "world" oil cost component of retail gasoline prices, choosing appropriate currency units for world oil prices and domestic gasoline prices, and making assumptions about the behavior of domestic gasoline prices in the counterfactual case where world oil prices are unchanged. Here we discuss how these issues are dealt with in this analysis.

- To proxy the world oil cost component of retail gasoline prices, we use the world wholesale price of refined gasoline products. Specifically, we use an average of the prices of refined products in the four major regional markets, while excluding the volatile Los Angeles market. This measure, then, reflects both change in the crude oil cost component as well as changes in average world refining margins. It is a proxy for the world cost component relevant for any individual country, as the latter will depend, among other items, on the country's sources of supply of crude and refined oil products, and transportation costs.
- To measure the world oil cost component, we use the U.S. dollar world price deflated by the U.S. consumer price index (CPI), as a broad measure of inflation, to abstract from general price movements. The denominator of the pass-through calculation in equation (3) is then the same for all countries, facilitating international comparisons.
- Although it would seem natural to also measure the numerator in U.S. dollars, this presents problems, because full pass-through would require that domestic retail margins *measured in U.S. dollars* remain constant. It seems more

[5] See Baig and others (2007) and Rebucci and Spatafora (2006) for other approaches to estimating pass-through.

[6] Comparing percent changes may be less problematic in the current context if the measure of world prices is taken to be the retail gasoline price in a country that is assumed to be an appropriate "benchmark" for pass-through, for instance the United States. Conceptually, the problem with this approach involves the assumption that pass-through is, by definition, unity in the benchmark country. The choice of currencies in *(continued)*

which to measure percent changes in retail prices in the benchmark and home countries can also have a significant impact on the results when there are important changes in real exchange rates, as was the case over the period considered here.

natural to define full pass-through when domestic margins remain constant relative to some general measure of domestic prices, such as the domestic CPI. The two approaches yield similar results when real exchange rates are relatively stable, but can differ significantly in the face of large real exchange rate movements. The approach we take is to express domestic margins in units of domestic currency deflated by the domestic CPI, and then convert the change in margins in the numerator of equation (3) into U.S. dollars using the base period exchange rate of the local currency versus the U.S. dollar to make the currency units of the numerator and denominator consistent.[7]

With these refinements to equation (3), the pass-through formula can be expressed as

$$1 + \frac{\left(\frac{PM_t^i}{PCPI_t^i \,/\, PCPI_B^i} - PM_B^i\right) ER_B^i}{\left(\frac{PO_t^\$}{PCPI_t^{US} \,/\, PCPI_B^{US}} - PO_B^\$\right)} \qquad (4)$$

where

$$PM_t^i = PR_t^i - (PO_t^\$ * ER_t^i) \qquad (5)$$

PM^i is the nominal price margin in country i, $PCPI^i$ is the consumer price index in country i, ER^i is price of a unit of country i's currency in terms of dollars, $PO^\$$ is the world average wholesale price of gasoline in dollars and PR^i is the retail price, and subscripts t and B reflect the current period and base period, respectively. The base period is December 2002 in the calculations presented below, which broadly corresponds to the start of the sustained upswing in world oil prices. However, because oil prices were volatile during 2003, the reported findings focus on the period since the beginning of 2004.

[7] Another way of expressing this approach is to say that the numerator and the denominator of equation (5) are both measured in U.S. dollars, but the numerator is adjusted to abstract for real exchange rate movements between the local currency and the dollar.

Empirical Findings

To illustrate heterogeneity in pass-through performance across the LAC region, countries are aggregated into groups depending on geography and their oil trade status (exporters or importers).[8] The oil importers are broken down into four subgroups: South America, Central America, the ECCU, and the non-ECCU Caribbean.[9] The oil exporters are Argentina, Colombia, Ecuador, Mexico, Trinidad and Tobago, and Venezuela. Bolivia, Brazil, and Suriname are excluded from the groups and considered separately, because their net oil trade status was ambiguous during this period. The aggregation of countries into these groups is based on purchasing power parity (PPP) weights.

As shown in Table 5.1, domestic retail fuel prices have increased significantly since 2002, and the variance across countries has also risen. By end-2007, the price per gallon stood at about US$4.3 in the group of South American oil importers, compared with a low of US$2.4 per gallon in the average of oil exporters. The highest retail gasoline prices in 2007 were observed in Brazil and Chile, at US$5.3 per gallon and US$4.9 per gallon, respectively. The lowest prices were observed in Venezuela, at US$0.1 per gallon, where they have actually declined in nominal terms since end-2002. The variance of fuel prices across countries increased to 0.5 at end-2007 compared with 0.46 at end-2002.

For the LAC region as a whole, the methodology described above indicates that, on average, there has

[8] Oil exporters are countries with positive net oil balances; importers are those with negative balances, excluding Bolivia, Brazil, and Suriname because these are basically natural gas exporters.

[9] South America is defined as Chile, Paraguay, Peru, and Uruguay; Central America as Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, and Panama; the ECCU as Antigua, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines; and the non-ECCU Caribbean as The Bahamas, Barbados, Belize, Guyana, Haiti, and Jamaica.

Table 5.1. Domestic Gasoline Retail Price
(U.S. dollars per gallon) 1/

	Dec. 2002	Dec. 2004	Dec. 2005	Dec. 2006	Dec. 2007	Change Dec. 2002–Dec. 2007	Growth (in percent) Dec. 2002–Dec. 2007	Ratio of Retail Price to World Price Dec. 2002	Ratio of Retail Price to World Price Dec. 2007
Net oil importers (by region)	**2.1**	**3.0**	**3.4**	**3.5**	**4.2**	**2.1**	**98.0**	**2.8**	**1.8**
South America	**2.2**	**3.3**	**3.7**	**3.8**	**4.3**	**1.5**	**69.7**	**2.9**	**1.9**
Chile	2.2	3.3	4.0	4.1	4.9	2.7	125.8	2.9	2.1
Paraguay	1.6	2.4	3.1	3.8	3.4	1.8	111.3	2.1	1.5
Peru	2.3	3.2	3.4	3.2	3.9	1.6	69.8	3.0	1.7
Uruguay	2.7	4.0	4.7	4.4	...	…	…	3.5	…
Central America	**1.9**	**2.5**	**3.0**	**3.1**	**3.9**	**1.2**	**61.2**	**2.6**	**1.7**
Costa Rica	2.2	2.8	3.1	3.3	3.9	1.7	79.4	2.9	1.7
Dominican Republic	1.8	2.8	3.4	3.6	4.6	2.8	158.2	2.3	2.0
El Salvador	1.8	2.2	2.8	2.8	...	…	…	2.3	…
Guatemala	2.0	2.5	2.9	2.9	3.7	1.7	86.4	2.6	1.6
Honduras	2.2	2.8	3.2	3.0	3.4	1.2	55.6	2.9	1.5
Nicaragua	2.0	2.4	3.0	3.1	...	…	…	2.7	…
Panama	1.8	2.1	2.4	2.5	3.2	1.4	78.5	2.3	1.4
ECCU region 2/	**2.2**	**2.4**	**3.2**	**3.3**	**3.5**	**1.1**	**49.3**	**2.9**	**1.5**
Antigua and Barbuda	2.1	2.6	3.7	3.5	3.5	1.4	67.9	2.8	1.5
Dominica	2.3	2.8	3.4	3.1	4.1	1.8	78.4	3.0	1.8
Grenada	2.3	2.3	3.4	3.4	4.0	1.7	74.0	3.1	1.8
St. Lucia	2.4	2.6	2.9	2.9	2.9	0.5	22.6	3.2	1.3
St. Kitts and Nevis	2.0	2.0	3.2	3.2	3.2	1.2	58.9	2.7	1.4
St. Vincent and Grenadines	2.1	2.3	2.5	3.5	3.5	1.5	70.5	2.7	1.6
Caribbean (non-ECCU) countries	**2.3**	**2.9**	**3.5**	**3.4**	**…**	**1.0**	**44.9**	**3.1**	**1.8**
The Bahamas	2.7	3.4	3.7	3.8	4.6	1.9	68.9	3.6	2.0
Barbados	2.6	3.1	4.0	4.1	...	…	…	3.5	…
Belize	3.5	4.2	4.5	...	...	…	…	4.6	…
Guyana	1.9	2.5	3.2	3.1	3.4	1.5	79.9	2.5	1.5
Haiti	2.2	2.8	3.4	...	...	…	…	2.9	…
Jamaica	2.1	2.4	3.3	2.9	...	…	…	2.8	…
Net oil exporters	**1.8**	**2.0**	**2.2**	**2.2**	**2.4**	**0.4**	**20.6**	**2.4**	**1.0**
Argentina	2.0	2.4	2.4	2.3	...	…	…	2.7	…
Colombia	1.3	2.1	2.5	2.7	3.3	2.1	165.4	1.7	1.5
Ecuador	1.0	1.3	1.3	1.3	1.3	0.4	37.8	1.3	0.6
Mexico	2.2	2.1	2.3	2.3	2.4	0.3	11.5	2.9	1.1
Trinidad and Tobago	1.5	1.6	1.6	1.6	1.6	0.1	9.8	1.9	0.7
Venezuela	0.2	0.1	0.1	0.1	0.1	-0.1	-38.6	0.3	0.1
Other countries	**2.1**	**3.1**	**4.0**	**4.4**	**5.3**	**2.3**	**111.3**	**2.8**	**2.3**
Brazil	2.1	3.2	4.1	4.4	5.3	3.2	154.1	2.8	2.3
Bolivia	1.7	1.8	1.8	1.8	1.7	0.1	3.8	2.2	0.8
Suriname	1.6	2.2	3.5	3.6	...	…	…	2.1	…
Memo:									
North America (Canada and USA) 1/	1.4	1.8	2.2	2.3	3.1	1.7	122.1	1.8	1.3
Latin America and Caribbean 1/	2.0	2.6	3.0	3.2	3.9	1.9	95.9	2.6	1.7
World prices (four-market average)	0.8	1.0	1.5	1.6	2.3	1.5	202.3	1.0	1.0

Sources: Bloomberg; IMF, *International Financial Statistics* and staff estimates; and country authorities.
1/ Regional values are PPP-weighted.
2/ ECCU - Eastern Caribbean Currency Union.

been low pass-through, averaging 0.5, during 2004–07 (Table 5.2). Taking a simple, as opposed to a weighted, average across countries yields higher coefficients, of 0.8 during 2004–07; for the weighted average, oil exporters and other energy-producers tend to dampen pass-through owing to their higher PPP weights and more regulated price regimes. The computed coefficient, based on a GDP-weighted average of country values, ranges between 0.1 and 0.8 from the beginning of 2004. This contrasts with a computed average pass-through coefficient of 1.1 for the United States and Canada, reflecting high weights and deregulated price regimes.

However, there are marked differences in fuel retail prices across countries and regions, and between oil importers and exporters, largely reflecting

Table 5.2. Pass Through: "Constant Real Margins" Approach 1/

	Jun. 2004	Dec. 2004	Jun. 2005	Dec. 2005	Jun. 2006	Dec. 2006	Jun. 2007	Dec. 2007	Jan. 2004–Dec. 2007 Average
Net oil importers (by region)	**1.6**	**2.1**	**1.2**	**1.3**	**1.1**	**1.1**	**1.3**	**1.0**	**1.1**
South America	**1.9**	**2.5**	**1.3**	**1.3**	**1.1**	**1.1**	**1.3**	**1.0**	**1.2**
Chile	2.7	2.5	1.5	1.4	1.3	1.4	1.2	1.1	1.4
Paraguay	1.5	1.7	1.0	1.4	1.1	1.4	0.7	0.7	1.1
Peru	1.2	2.4	1.1	1.2	0.8	0.8	0.8	0.7	1.0
Uruguay	1.3	3.1	1.3	1.6	1.1	0.9	0.8	...	1.3
Central America	**1.3**	**1.7**	**1.1**	**1.2**	**1.1**	**1.1**	**1.2**	**0.9**	**1.1**
Costa Rica	1.1	2.2	1.1	1.0	0.9	1.0	1.0	0.9	1.1
Dominican Republic	1.6	2.5	1.6	1.9	1.5	1.8	1.7	1.5	1.5
El Salvador	1.3	1.3	1.1	1.3	1.1	1.0	1.1	...	1.1
Guatemala	0.6	1.1	0.8	0.9	0.8	0.7	0.9	0.8	0.7
Honduras	2.0	2.0	1.1	1.0	0.7	0.6	0.7	0.5	1.1
Nicaragua	1.4	1.1	1.1	1.2	1.2	1.1	1.1	...	1.2
Panama	1.3	1.0	0.4	0.8	0.9	0.8	0.9	0.8	0.8
ECCU region	**0.2**	**0.5**	**0.3**	**1.1**	**0.7**	**1.1**	**1.6**	**1.0**	**0.6**
Antigua and Barbuda	0.8	1.4	0.5	2.0	1.1	1.7	1.0	0.8	1.1
Dominica	1.1	1.6	1.0	1.4	1.0	0.8	1.1	1.0	1.0
Grenada	-0.3	-0.4	-0.2	1.2	0.7	1.0	1.1	0.9	0.5
St. Lucia	0.5	0.5	0.1	0.5	0.2	0.4	0.2	0.1	0.2
St. Kitts and Nevis	-0.3	-0.4	0.6	1.4	0.8	1.1	0.7	0.6	0.5
St. Vincent and Grenadines	-0.3	0.5	0.3	0.3	0.5	1.6	0.9	0.8	0.6
Caribbean (non-ECCU) countries	**0.7**	**0.8**	**0.7**	**1.0**	**1.0**	**1.0**	**...**	**...**	**0.8**
The Bahamas	2.0	2.5	0.9	1.1	1.2	1.1	1.3	1.1	1.2
Barbados	1.3	1.5	1.7	1.5	1.3	1.3	...	...	1.2
Belize	1.8	2.2	0.8	1.0	1.1	...	...	...	1.3
Guyana	1.4	1.8	1.0	1.4	1.0	1.2	0.9	0.8	1.1
Haiti	0.1	-0.6	0.4	0.5	0.8	...	...	...	0.3
Jamaica	0.2	0.9	0.4	1.4	0.9	0.7	...	...	0.6
Net oil exporters	**0.0**	**0.1**	**0.1**	**0.1**	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**
Argentina	0.2	0.2	0.1	0.0	0.0	-0.2	...	...	0.1
Colombia	1.1	2.2	1.1	1.2	0.7	1.3	1.1	1.0	1.1
Ecuador	1.0	1.2	0.4	0.4	0.2	0.3	0.2	0.2	0.6
Mexico	-0.6	-0.6	-0.2	-0.1	-0.2	-0.1	-0.1	-0.1	-0.3
Trinidad and Tobago	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Venezuela	-0.3	-0.1	-0.2	-0.1	0.0	0.2	0.2	0.4	-0.1
Other countries	**0.1**	**1.1**	**0.6**	**1.0**	**0.8**	**1.0**	**1.2**	**1.0**	**0.7**
Brazil	0.2	1.1	0.6	1.1	0.8	1.0	0.9	0.8	0.7
Bolivia	-0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2
Suriname	1.2	1.4	0.5	2.0	1.6	1.8	...	...	1.4
Memo:									
North America (Canada and USA) 1/	1.5	1.5	1.0	1.0	1.1	1.0	1.2	1.0	1.1
Latin America and Caribbean average 1/	0.3	0.8	0.5	0.6	0.4	0.6	0.6	0.6	0.5

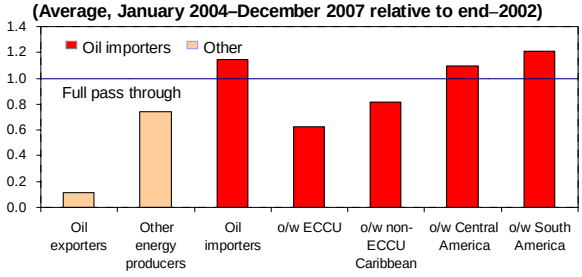
Sources: Bloomberg; IMF, *International Financial Statistics* and staff estimates; and country authorities.
1/ Assuming contemporaneous change in prices. Regional values are PPP-weighted.

differences in pricing and tax regimes (Figures 5.3–5.5, Table 5.2). The policy choice would be expected to be influenced by the importance of oil to the economy, in particular, oil intensity of consumption (See Box 5.1 at the end of the chapter).

With average pass-through coefficients exceeding one in all countries, *South American oil importers* have the highest computed pass-through coefficients in the LAC region. These high coefficients are mainly due to use of market-based or automatic pricing mechanisms coupled with ad valorem taxes. The policy choice may have been influenced by the low oil-use intensity (Box 5.1).

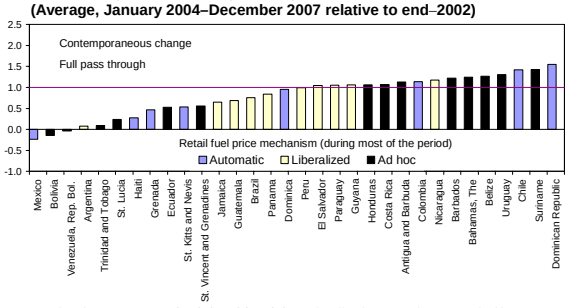
- For *Central America* as a whole, pass-through exceeds one, mainly reflecting frequent adjustment of prices (through either automatic or market-based pricing regimes) and ad valorem taxes, but there are significant differences across countries. The Dominican Republic has the highest pass-through

Figure 5.3. Latin America and the Caribbean: Pass Through Coefficients in Oil–Importing and –Exporting Countries (Average, January 2004–December 2007 relative to end–2002)



Sources: Bloomberg; IMF, *International Financial Statistics;* and staff estimates; and country authorities.
Note: ECCU - Eastern Caribbean Currency Union.

Figure 5.4. Latin America and the Caribbean: Pass Through Coefficient by Country (Average, January 2004–December 2007 relative to end–2002)



Sources: Bloomberg; IMF, *International Financial Statistics,* and staff estimates; and country authorities.

coefficient in the LAC region, mainly reflecting the ad valorem foreign exchange commission payable on all imported goods. The high pass-through coefficient for Honduras is a result of the automatic price adjustment regime that was in place until late 2005. Since then, the government has modified the import parity formula several times, reduced taxes, and frozen prices on several occasions. Specifically, gasoline prices were frozen briefly during late 2005 and again in April and September 2006, and fuel taxes were reduced somewhat in 2006 and throughout most of 2007 (Table 5.3).

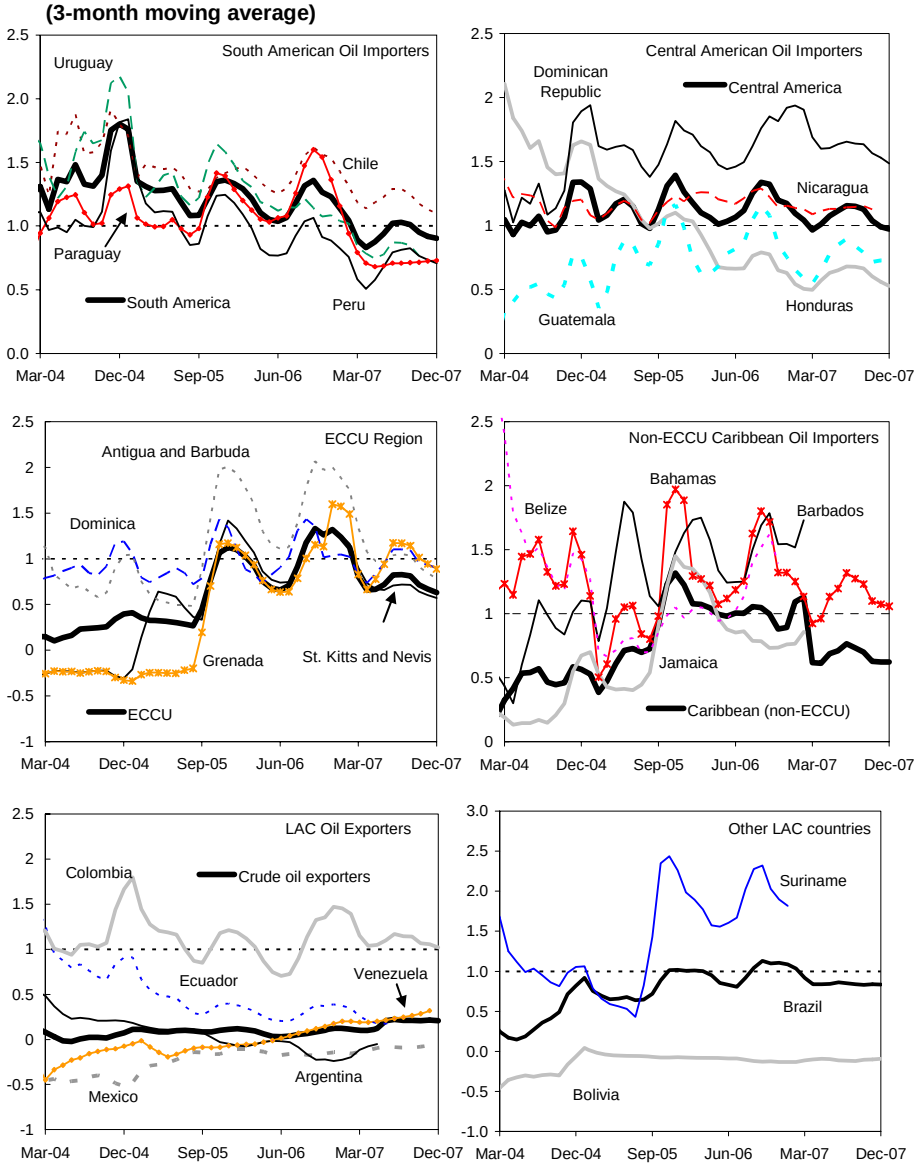
- *Caribbean* countries, particularly those in the Eastern Caribbean Currency Union region, have the lowest pass-through among oil importers, owing to fixed prices and residual taxes. Until late 2006, all the ECCU countries, with the exception of Dominica, had ad hoc pricing mechanisms that in general translated into prolonged price freezes and a decline in taxes. For example, fuel prices in Grenada and St. Kitts and Nevis were increased for the first time since 2000 in February 2005 and October 2005, respectively. As a result, the computed pass-through coefficients are negative for these countries during 2004 and remain negative for Grenada until September 2005. Effective tax rates declined sharply during 2005, turning negative (or near zero) in these ECCU countries.

- *Non-ECCU Caribbean* countries with ad hoc pricing regimes tend to have higher pass-through coefficients. Though the Bahamas and Belize have regulated prices, frequent ad hoc adjustments in these prices have yielded a high pass-through; for Barbados, large but infrequent price adjustments have resulted in high pass-through. Ad valorem taxes have also contributed to the high pass-through coefficients in these economies. The low pass-through findings for Jamaica could be due to changes in source of gasoline imports, because these face different margin costs. Though Jamaica refines its own gasoline, it tends to import gasoline from international markets when technical faults occur, for example, following natural disasters.

- The lowest pass-through coefficients were observed in *Bolivia and oil exporters*, but there are significant exceptions. The marketing of fuel products by state-owned oil monopolies, coupled with price adjustment mechanisms that limit fuel price increases and squeeze refinery margins, have contributed to the low pass-through in most energy-producing countries. Moreover, even where the pricing mechanism is market-based, such as in Argentina, fuel prices have remained broadly unchanged, reflecting price agreements with private companies backed up by taxes on fuel exports to divert supply to the domestic market.[10] The slightly negative pass-through estimate for Mexico is a result of the pricing policy—though domestic prices are

[10] Furthermore, companies face threats that taxes on fuel exports could be increased further in the event that retail fuel prices are raised.

Figure 5.5. Latin America and the Caribbean: Computed Passthrough Coefficients, March 2004–December 2007 (3-month moving average)



Sources: Bloomberg; IMF, *International Financial Statistics*; IMF staff estimates; and country authorities.

adjusted in line with Bank of Mexico's inflation target, margins have been compressed because actual inflation has tended to be higher than the target. The high pass-through in Colombia reflects ad valorem taxes. In Ecuador, pass-through is low, but remains above zero in spite of the fact that domestic prices have been fixed since 2003, reflecting the fact that the change in margins is less than the increase in inflation.

The computed pass-through coefficients are, however, sensitive to delays in passing world oil prices to consumers. Some countries with liberalized or automatic pricing regimes use smoothing mechanisms in order to reduce price volatility. In Dominica, for example, prices are adjusted using an eight-week average, whereas in Brazil prices are adjusted only when international oil price changes are perceived to be permanent (Table 5.3). As a

Table 5.3. Domestic Gasoline Pricing Practices

	Gasoline Prices		Recent Changes and Comments
	Fuel pricing mechanism	Frequency of adjustment	Changes in price mechanism since 2003 (If ad hoc, any recent price increases)
Net Oil Importers			
South America			
Chile	Automatic	Weekly	The reference price for petroleum derivatives was diversified to include non-U.S. prices and minor changes to the price fund were made in late 2005 following Hurricane Katrina.
Paraguay	Market-based		In practice, a smoothing mechanism is employed, characterized by long lags in price adjustments and uncertainty about their timing. During certain periods, prices have been subsidized.
Peru	Market-based	Discretionary adjustment of reference band	The Fuel Price Stabilization Fund (FEPC) was established in September 2004. The FEPC is based on a reference price band mechanism that compensates fuel producers and importers when international fuel prices are above the upper range reference price, and receives inflows when international prices are below the lower range reference price. The authorities have adjusted the reference price band several times since then, including in 2007. In addition, they have reduced the specific fuel excise to mitigate the impact of the upward adjustment in the reference band.
Uruguay	Ad-hoc	Frequent	The government sharply increased margins during the 2002/03 crisis in order to generate revenue through the state-owned oil company. Margins have not been reversed since then.
Central America			
Costa Rica	Ad hoc with some built-in automatic adjustment		Prices are adjusted at the request of producers, distributors or consumers. However, if the exchange rate changes by more than 5 percent since the last adjustment, prices are adjusted automatically.
Dominican Republic	Automatic	Weekly	Though the frequency of adjustment is weekly, this is based on world prices during the previous two weeks.
El Salvador	Market-based		
Guatemala	Market-based		
Honduras	Automatic	Weekly	Since 2005, this has been a de facto ad-hoc pricing regime. Since late 2005, the import parity formula (IPF) used to adjust prices has been modified several times (including altering the frequency of adjustment to bias prices downward) and gasoline prices have been fixed on several occasions - in late 2005, and between April and September 2006. The IPF was revised to allow for lower prices in January 2007, but the gasoline price freeze was reinstated the following month. In early 2008 gasoline prices were raised.
Nicaragua	Market-based		The government and fuel companies have agreed to smooth out large price adjustments.
Panama	Market-based	Bi-monthly	
ECCU region			
Antigua and Barbuda	Automatic	Infrequent	In late 2007, the authorities announced their intention to move to an automatic pricing regime (based on a three month moving average approach). Since the beginning of 2008 retail prices have been adjusted twice under the new mechanism, however the extent of the price adjustments suggests that the mechanism has not been fully implemented. Before this, an ad-hoc system was in place with infrequent adjustment - twice during 2005 and once during 2006.
Dominica	Automatic	Monthly	Automatic adjustment since September 30, 2003. This is based on an eight-week average of landed prices.
Grenada	Automatic	Monthly	In September 2006, Grenada formally adopted an automatic fuel pricign mechanism based on an eight-week average of landed prices. This has been implemented since October 2007. Prior to this, there was an ad-hoc system with infrequent adjustment, however, prices were only adjusted once in October 2005.
St. Kitts and Nevis	Automatic		Automatic adjustment since November 2006. Before this, an ad-hoc system was in place with infrequent adjustment - between 2002 and 2006, prices were adjusted twice (in early and late 2005).
St. Lucia	Ad hoc	Infrequent	Adjusted once during 2004 and 2005, and once during January 2008.
St. Vincent and Grenadines	Ad hoc	Infrequent	Adjusted once during 2004 and 2005, twice during 2006 and 2007, and once during January 2008.

Table 5.3 (*concluded*)

	Gasoline Prices		Recent Changes
	Fuel pricing mechanism	Frequency of adjustment	Changes in price mechanism since 2003 (If ad hoc, any recent price increases)
Caribbean (non-ECCU)			
Bahamas	Ad hoc	Frequent	Adjusted frequently since 2004. The pricing regime, throughout the period, has included a maximum permitted markup on wholesale and retail prices.
Barbados	Ad hoc	Infrequent	Adjusted once in 2004 and 2005, and twice during 2006.
Belize	Ad hoc	Every delivery	
Guyana	Market-based		
Haiti	Automatic	Every delivery	Automatic adjustment since 2003. Prices are adjusted after each oil shipment has been sold.
Jamaica	Market-based		
Net Oil Exporters			
Argentina	Market-based		Price agreements with private companies backed up by taxes on fuel exports to divert supply to the domestic market have limited price changes.
Colombia	Automatic	Monthly	The subsidy for fuel prices was included in the budget for the first time in 2007.
Ecuador	Ad hoc	Infrequent	Prices frozen since July 2003.
Mexico	Automatic	Gradually throughout the year	The adjustment mechanism is designed to ensure that prices remain constant in real terms. The post-tax price is adjusted throughout the year to ensure that prices remain unchanged in real terms (however, the CPI inflation is based on the BOM's inflation target). The government issued a decree in late 2007 to freeze prices until January 2008.
Trinidad and Tobago	Ad hoc	Infrequent	No adjustments since October 2003 - these were part of program to phase-out leaded gasoline for health and environmental concerns. The refinery margin was removed and compensated with an equivalent increase in the retailers' margin.
Venezuela	Ad hoc	Infrequent	No adjustment since January 2003.
Other Countries			
Brazil	Market-based		The largest oil company, Petrobas, employs a price-smoothing policy. As a result, prices are increased when they are perceived to be permanent. The government's veto powers in this partially state-owned company could have created pressure to delay passthr
Bolivia	Ad hoc	Frequent	Frequent adjustments since 2007.
Suriname	Automatic	Monthly	Automatic adjustment mechanism since December 2005 - the maximum pump prices are set for each of the three oil-importing companies, on the fifth day working day of each month, based on the average c.i.f. price of previous months of each company.

Source: Country authorities.

result, the pass-through coefficient for Brazil rises from 0.8 to 1.0 when a three-month adjustment lag is allowed for. Though most countries have not officially changed their fuel pricing regimes, a significant number (including those with liberalized pricing regimes) have taken measures to delay passing through world oil prices to consumers. For example, Mexico issued a decree in late 2007 to temporarily freeze retail prices until January 2008, and Honduras has frozen prices on several occasions as well as adjusted its pricing formula to allow long delays during periods of rising crude prices and the converse during period characterized by low prices.

The pass-through findings are also sensitive to base year choice, because of country-specific policy responses to oil price increases since 2002. For example, average pass-through coefficients using 2004 as the base year are lower, because reductions in petroleum taxes in most LAC oil importers in response to higher oil prices have helped cushion against high world oil prices (Table 5.4).

Table 5.4. Sensitivity of the Pass Through Results 1/

	Average pass through	Sensitivity of pass through results	
	Base year = Dec. 2002	Base year = Dec. 2003	Base year = Dec. 2004 2/
Net oil importers (by region)	**1.15**	**1.03**	**0.53**
South America	**1.21**	**0.97**	**0.40**
Chile	1.42	1.19	0.60
Paraguay	1.05	0.86	0.58
Peru	0.99	0.77	0.17
Uruguay	1.30	0.35	0.26
Central America	**1.10**	**1.14**	**0.70**
Costa Rica	1.07	1.01	0.44
Dominican Republic	1.55	1.39	1.06
El Salvador	1.11	1.14	0.85
Guatemala	0.69	1.09	0.48
Honduras	1.06	0.90	0.31
Nicaragua	1.18	0.97	1.01
Panama	0.84	0.90	0.61
ECCU region	**0.63**	**0.47**	**0.68**
Antigua and Barbuda	1.13	0.56	0.86
Dominica	0.96	0.84	0.56
Grenada	0.46	0.53	0.93
St. Kitts and Nevis	0.24	0.32	0.12
St. Lucia	0.53	0.63	1.12
St. Vincent and Grenadines	0.56	0.66	0.63
Caribbean (non-ECCU) countries	**0.82**	**0.90**	**0.72**
The Bahamas	1.24	0.96	0.39
Barbados	1.22	1.02	1.15
Belize	1.27	1.37	0.18
Guyana	1.05	0.99	0.64
Haiti	0.27	0.95	1.13
Jamaica	0.65	0.64	0.67
Net oil exporters	**0.10**	**0.07**	**0.09**
Argentina	0.10	-0.28	-0.23
Colombia	1.13	0.88	0.41
Ecuador	0.58	-0.15	-0.10
Mexico	-0.28	0.08	0.09
Trinidad and Tobago	0.10	-0.16	-0.09
Venezuela	-0.09	-0.21	0.04
Other countries	**0.74**	**0.61**	**0.54**
Brazil	0.72	0.68	0.55
Bolivia	-0.16	0.03	-0.10
Suriname	1.42	0.35	1.28

Sources: Bloomberg; *IMF, International Financial Statistics* and staff estimates; and country authorities.

1/ Results are computed using constant real margins approach and cover the period since January 2004, unless otherwise indicated.

2/ Base year is December 2004. Average pass through is for the period since January 2005.

Conclusions

We find low pass-through for the Latin America and Caribbean region as a whole, but the results display significant differences among countries, particularly between oil importers and exporters. Oil-importing Latin American countries display the highest pass-through, exceeding one in most cases, while oil exporters and Caribbean countries have low pass-through. Liberalized fuel pricing mechanisms are associated with higher retail fuel prices and price pass-through. In a number of cases, ad hoc adjustments have translated into prolonged price freezes. Tax regimes have also affected the degree of pass-through, with countries that have large ad valorem taxes tending to have high pass-through coefficients. Given the low impact of world oil prices on inflation (see Chapter 6 by Babihuga and Corbacho in this volume), partly attributable to the low share of gasoline in overall economic activity, countries with weak fiscal positions could consider moving to liberalized pricing mechanisms and targeted mitigating measures.

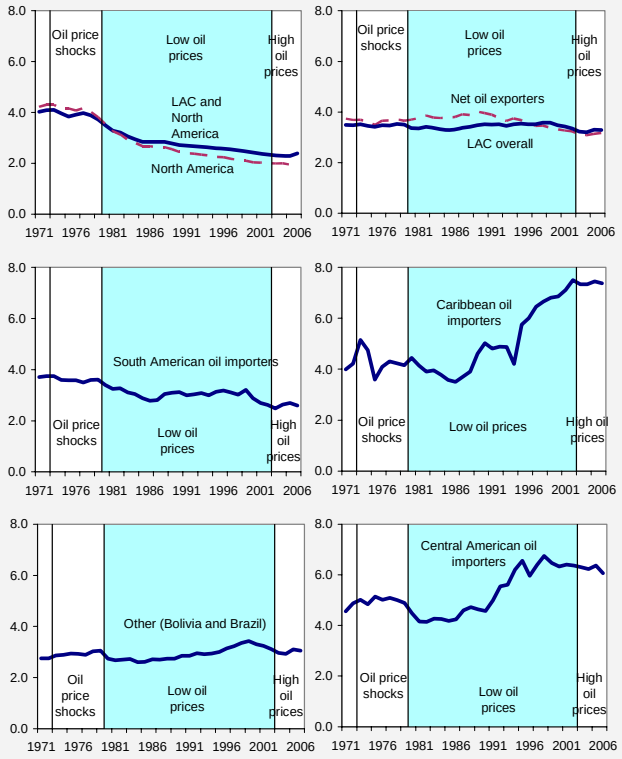
Box 5.1. LAC and North America: Trends in Oil Intensity of Consumption

We would expect the choice of an appropriate policy response to be influenced by the importance of oil in the economy, in particular, oil intensity of consumption. The intensity of oil use is proxied by dividing barrels of oil consumed by real GDP; to facilitate cross-country comparison, the derived oil intensity indicator is indexed to equal, on average, the nominal share of oil consumption in GDP for a given period.

For Latin America and the Caribbean (LAC) and North America as a whole, oil-use intensity has declined since the 1970s, helping moderate the macroeconomic impact of the recent increase in world oil prices. The decline is, however, largely driven by the heavy weights of Canada and the United States.

The observed trends in oil intensity of consumption have varied among Latin American countries. South American oil importers have witnessed a decline in oil-use intensity since the 1970s. With the notable exception of Venezuela, oil exporters as a group have also witnessed a decline in oil-use intensity, perhaps reflecting a shift toward domestic pricing policies that more closely reflected changes in world prices. Nonetheless, a few countries that have experienced increases in energy production (e.g., Brazil and Bolivia) have also shown increases in oil use, perhaps as an intermediate input in the production process. Furthermore, a number of countries in the LAC region have also experienced increasing oil intensities, possibly owing to an increasing shift toward large-scale, capital-intensive agricultural production methods.

Oil Consumption Intensity, 1971–2006 1/
(Index, barrels of oil per unit of real GDP)



Sources: IMF, *World Economic Outlook*,*International Financial Statistics,* and staff estimates; and country authorities.
1/ See text for a discussion of how this index is normalized.

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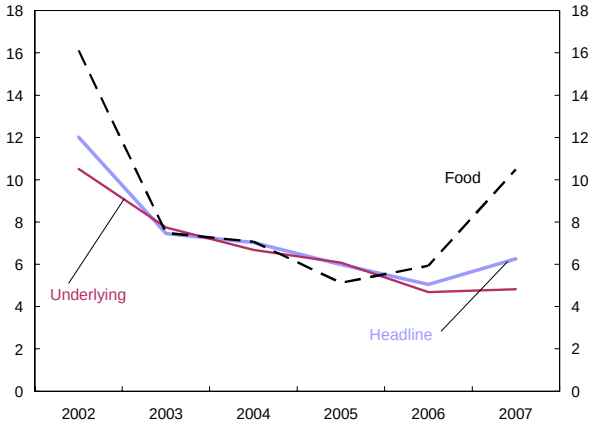
Chapter 6

World Commodity Prices and Inflation in Latin America

Rita Babihuga and Ana Corbacho

Inflation has recently picked up in most countries in Latin America, posing a risk for what is perhaps the region's most important macroeconomic accomplishment in the past decade—the sustained decline in inflation to the single-digit range. For the region as a whole, inflation increased from 2006 to 2007 by more than 1 percentage point to 6.3 percent (Figure 6.1). Food prices in particular have put increasing pressure on headline inflation, rising from 6 percent at end-2006, to more than 10 percent by the end of 2007. And although underlying inflation remains contained on average, the downward trend of the past five years has been reversed.

Figure 6.1. Inflation in Latin America
(In annual percent change) 1/



Source:IMF, *World Economic Outlook*.
1/ PPP-weighted average.

These trends in inflation could have external as well as domestic causes. Latin American GDP growth has been strong for four straight years, reaching 5.4 percent, on average, in 2007. Output gaps have been closing in many countries and are generally positive (IMF, 2007). At the same time, there have been sharp increases in international commodity prices, particularly in 2007. World food commodity prices, on average, soared by 30 percent in the year to end-2007, after growing by less than 15 percent in 2006.[1] World fuel prices rose even more sharply, by 45 percent compared with an increase of less than 10 percent in the previous year.

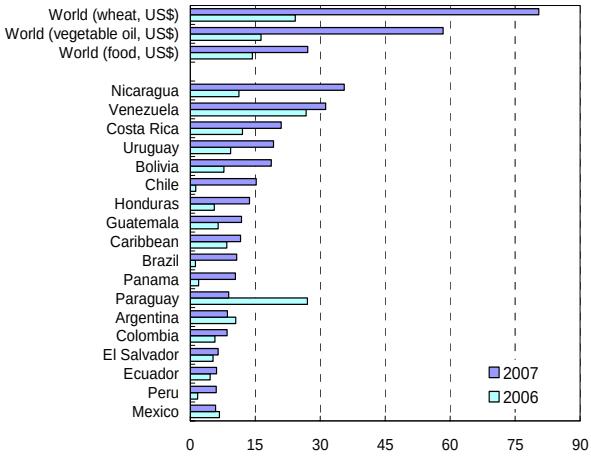
The objective of this paper is to assess the relative importance of commodity price increases and domestic activity on inflation in Latin America, and to establish whether commodity price increases are affecting "underlying" inflation (i.e., excluding food and fuel components of the price level) in addition to headline inflation. Forming a view on these issues is critical from the perspective of monetary policy. Central banks may not want to overreact to a temporary rise in inflation arising from either the effect of poor weather conditions or transitory surges in the world prices of key commodities. However, what appear to be isolated price shocks may instead reflect general demand pressures that surface first in markets where prices adjust more flexibly but then spread to other markets. Furthermore, central banks would likely be concerned if commodity price increases were to spill over into underlying or expected inflation, raising the threat of more generalized inflationary pressures—particularly if there is a risk of further increases in world food and fuel prices, as many analysts believe.

Our analysis, based primarily on vector autoregressions (VARs), shows that world commodity price shocks clearly have had an impact on inflation across the region. However, this impact appears to have been relatively modest. This result seems consistent with the fact that overall inflation

[1] The increases are measured as end-of-period rates using the IMF's World Economic Outlook index of world food and fuel commodity prices.

in the region rose by only 1.2 percentage points in 2007, even with a doubling of world food commodity inflation and a quadrupling of world fuel inflation since 2006. However, there is evidence that commodity price increases are affecting underlying inflation, suggesting that these external shocks could be propagating broader inflationary pressures. In several countries, the econometric evidence indicates that excess demand is also putting independent upward pressure on consumer prices, particularly for food. This suggests that monetary policy should aim to contain inflationary pressures arising from higher world fuel and food prices.

Figure 6.2. Food Inflation in Latin America
(In percent; end-of-period)



Sources: National authorities; WEO; and Haver Analytics.

From World Commodity Prices to Domestic CPIs: Stylized Facts

The recent run-up in inflation, and in particular the sharp rise in food inflation, has occurred in tandem with a rapid increase in world commodity prices. However, simple graphic analysis shows that the increase in the domestic fuel and food price subcomponents of the consumer price index (CPI) has been much smaller than the increase in world commodity prices. This suggests that the pass-through from world prices to domestic prices is smaller and more complex than might be immediately apparent (Figure 6.2). There are a number of factors for this.

First, the impact of rising world food and fuel prices on domestic consumer prices is limited by the weight of world commodities in domestic consumption baskets. Taking the example of food, domestic food inflation can be decomposed into a weighted average of items with prices determined mainly in the world market (e.g., wheat and by-products) and items with prices that mainly depend on local conditions (e.g., perishable fruit). In turn, headline inflation would be a weighted average of all food and nonfood items. In Brazil, for example, about 35 percent of the consumer food basket is composed of items whose prices are more strongly linked to the international market.[2] All else equal, a 10 percentage point increase in world food commodity prices would lead to an increase in consumer food prices in Brazil of 3.5 percentage points. But, because food has a total weight of less than 22 percent in the total consumption basket, the same increase in world food commodity prices would lead to an increase in headline inflation of only 0.7 percentage point.

Other factors can also drive a wedge between consumer and world commodity prices. Commodities are only one input in the production structure of firms selling domestic food and fuel products. For instance, crude oil makes up roughly 70 percent of the value added in a gallon of gasoline, whereas grains make up less than 5 percent of the cost of a loaf of bread. The remainder reflects packaging, processing, advertising, transportation, and other costs.[3] If local costs are large, even a substantial increase in the price of an imported factor of production may have little impact on prices.[4] Thus, changes in the input cost of these

[2] This includes meat and by-products of wheat, soybeans, coffee, rice, sugar, and oranges, as estimated by Credit Suisse (2008).
[3] JPMorgan (2008) and U.S. Department of Agriculture (2007).
[4] For example, Goldberg and Verboven (2001), Hellerstein (2006), and Nakamura (2008) document the role of local costs, among other factors, in explaining incomplete pass-through in

(continued)

commodities can be absorbed by several margins that are country- and sector-specific.

Finally, the impact of rising commodity prices on inflation could be amplified or mitigated by macroeconomic and fiscal factors. For instance, exchange rate appreciation or monetary tightening would buffer the pass-through from external factors, whereas poor weather conditions, as many countries have recently experienced, would go in the opposite direction. In addition, government tax and regulatory policies can create a gap between international and domestic prices.

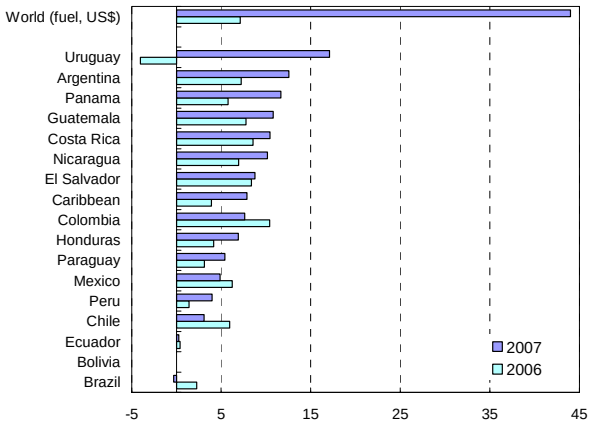
Empirical Analysis

What has been the role of external commodity shocks versus domestic sources of inflation in the region? One way to analyze this question would be to decompose headline inflation into the different items of the CPI and their relative contributions. This "inflation accounting" approach suggests that food inflation had a significant contribution to headline inflation in the most recent period (Figure 6.3). For instance, by end-2007, food inflation accounted for about 90 percent of headline inflation in Nicaragua, more than 70 percent in Peru and Bolivia, and about 53 percent in Brazil and Chile. Fuel inflation had a more modest contribution, ranging from 26 percent in Honduras to less than 5 percent in most countries in South America.

Although this approach is useful, it says nothing about the relative importance of domestic food and fuel price increases and, in particular, about how much of the inflation may be due to world commodity prices. To gain insight into the relative role of domestic and external factors in inflation, some central banks further decompose the CPI into tradable and nontradable components, or into categories of products that are believed to be

different markets. For the coffee industry, Nakamura shows that retail coffee prices respond sluggishly and incompletely to changes in coffee commodity prices. Local costs explain 78 percent of this incomplete pass-through, whereas markup adjustment and menu costs explain 20 and 2 percent, respectively.

Figure 6.3. Fuel Inflation in Latin America
(In percent; end-of-period)1/



Sources: National authorities; WEO; and Haver Analytics.
1/ The composition of the fuel index varies considerably, including only gasoline and energy products in some countries, and transportation and other services in others.

influenced by different factors. For example, the Central Bank of Chile estimated that about 20 percent of the increase in food prices in 2007 was due to bad local weather conditions, impacting locally produced fresh fruits and vegetables (see Central Bank of Chile, 2007). The Central Bank of Colombia (2007) concluded that demand for food from within the country and from Venezuela had positive contributions to inflation through September, while imported food items with prices linked to international markets had negative contributions, given exchange rate appreciation. This type of analysis suggests that when commodity prices and inflation move together, that movement may show the consequences of shocks on other markets or parameters as well.

All in all, the full impact of an external shock on domestic CPI would reflect both the direct effect of the shock and the indirect effects generated by the interaction of the CPI with other variables, such as the exchange rate, economic activity, and any monetary policy response to the shock. An inflation accounting approach would not distinguish how much of the increase in inflation is due to domestic versus external factors. Thus, a multivariate approach would help to identify the impact of different shocks on inflation while controlling for other relevant variables in the economy.

Methodology

To disentangle the impact on inflation of different external and domestic factors, we estimated a VAR model, which simultaneously regresses each variable on lags of itself and all other variables in the model. This approach captures the dynamic structure underlying the interaction of consumer prices with different domestic factors (such as economic activity and policy variables) and external commodity food and fuel prices. In particular, it can help capture the direct effects of higher costs of food and fuel commodities, as well as the indirect effects coming from the fact that fuel and food are inputs in the production of other goods.

The methodology is in line with other studies that have looked at the response of an economy to commodity price shocks and exchange rate fluctuations. Several recent studies have focused particularly on oil shocks, aiming to explain the structural decline in the oil pass-through to inflation in a number of countries (see, for instance, De Gregorio, Landerretche, and Neilson, 2007; Pincheira and Garcia, 2007; Blanchard and Galí, 2007; and Mishkin and Schmidt-Hebbel, 2007). However, given the more recent nature of the boom in world food prices, few studies have looked at this issue in detail.[5]

The model was applied to 10 countries in the region—5 Central American countries (Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua) and 5 large inflation-targeting countries (Brazil, Chile, Colombia, Mexico, and Peru).[6] We used monthly data, expressed as 12-month log differences in the following variables: world fuel and food commodity prices (in U.S. dollars); a measure of real economic activity (GDP or industrial production); nominal effective exchange rates; monetary aggregates in Central America and policy interest rates in the inflation-targeting countries (in levels); and different measures of consumer inflation—food, fuel, headline, and underlying (headline net of consumer food and fuel inflation).[7] The sample covers 1996–2007 for Central America, and the inflation-targeting period for the rest of the countries except Brazil, for which the sample covers 2002–07. Many of these countries have gone through periods of very different economic structures and policy regimes. To select the appropriate sample, we estimated rolling structural break point Chow tests. These tests indicated a structural break in Brazil following 2002, but no breaks for the period covered in the other countries. One to four lags were chosen using the Hanan-Quinn criteria.

We focused in particular on the impulse response of inflation, measured as the percentage change year-on-year, to unexpected and one-off shocks in three variables: world commodity fuel inflation, world commodity food inflation, and growth in domestic economic activity. To calculate the impulse responses, we applied a Cholesky factorization to generate an orthogonal set of innovations. This factorization assumes that innovations to the variables ordered first in the VAR are not influenced by innovations to variables ordered last. In keeping with other studies, we used the following ordering: world fuel inflation; world food inflation; domestic economic growth; money growth or policy rates; exchange rate growth; and domestic inflation. Similar results were obtained under different orderings and also when using generalized impulse techniques, in which an orthogonal set of innovations is insensitive to variable ordering (Pesaran and Shin, 1998).

[5] IMF (2007) presented VAR analysis for a few countries. Using regression analysis, JPMorgan (2008) concluded that agricultural commodity prices have had a significant, although modest, impact on consumer food prices.

[6] The choice of countries was driven both by data availability and by the achievement of stationary VARs—that is, VARs with roots having a modulus less than one and lying inside the unit circle. Absent the stationarity condition, some results, such as impulse response functions, are not valid.

[7] Models using commodity prices in local currency, and output gaps calculated with Hodrick-Prescott filters, yielded similar results.

Results: Overall Inflation

Figure 6.4 shows the estimated impulse responses for headline inflation to shocks in world fuel and food prices, as well as activity. The results suggest that higher world prices for food and fuel are indeed a factor in the recent rise in headline inflation.

However, the econometric analysis indicates that higher world prices for food and fuel are far from explaining the entire increase in headline inflation:

- Variation in world commodity prices typically explains about 30 percent of the variation in headline inflation, with world food prices playing a much larger role than world fuel prices. World fuel prices are particularly important in Chile, and world food prices in El Salvador, whereas world commodity prices explain less than 20 percent of the variation in headline inflation in Nicaragua and Mexico.
- World food commodity price shocks have a positive and significant impact on headline inflation in all 10 countries (Table 6.1). In general, these results suggest that the 30 percent run-up in world food prices since 2006 would have raised annual headline inflation rates by an average of 1 percentage point, based on past relationships. This is equivalent to the increase in inflation in the whole region in 2007. Following the occurrence of the shock, headline inflation typically rises to a peak within six months. However, the results suggest that it takes one to two years for the impact to fully dissipate.
- World fuel price shocks have had statistically significant but smaller effects than those of world food prices. The results suggest that the 50 percent run-up in world fuel prices since 2006 would have raised headline inflation rates in the region by about 0.3 percentage point. The effects vary across the region and are relatively large in Brazil, Chile, and Honduras.

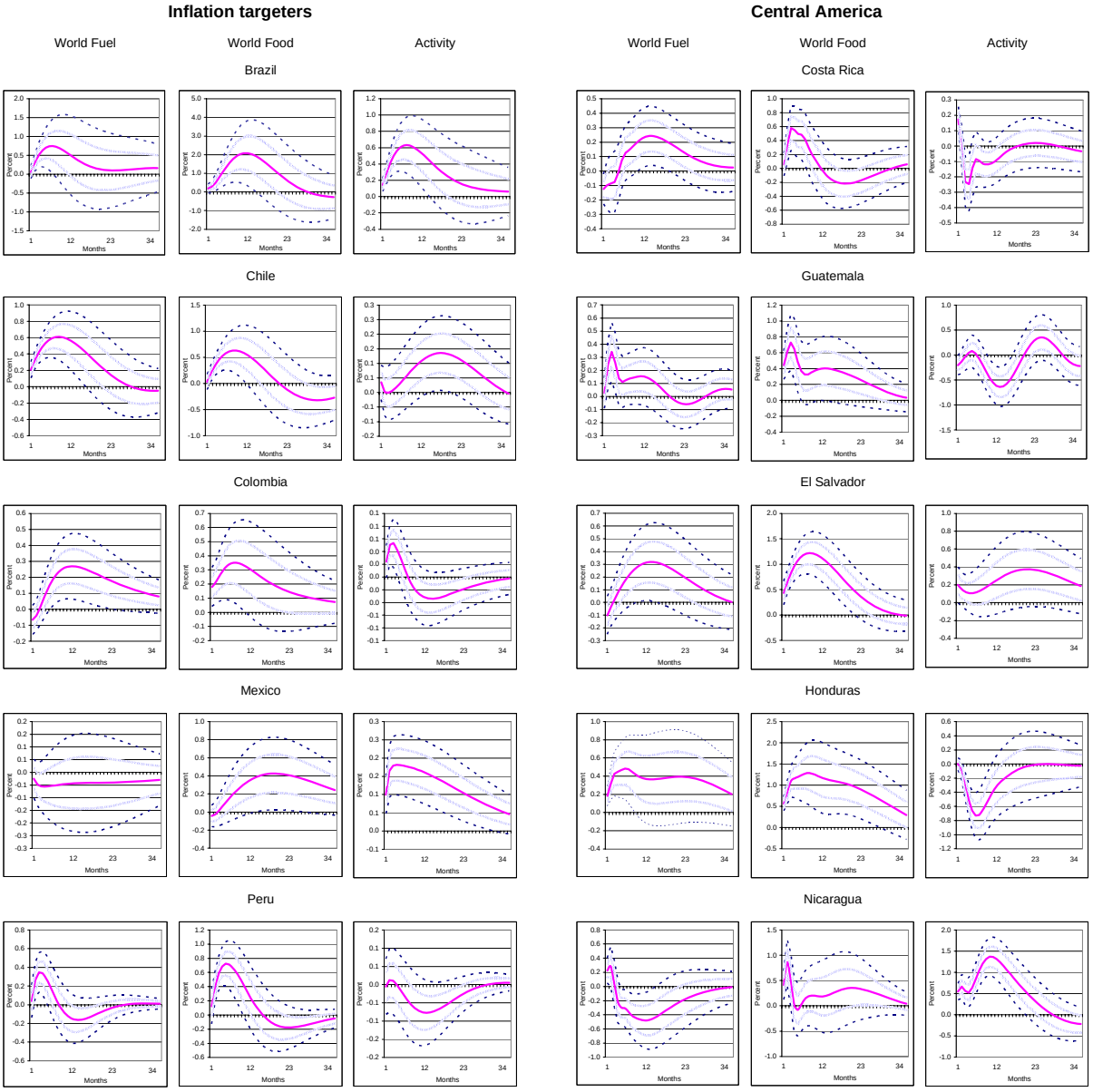
Table 6.1. Response of Headline Inflation to Different Shocks 1/

		World		
	Period	Fuel	Food	Activity
Inflation-targeting countries				
Brazil	1 month	0.06	0.19 *	0.14 ***
	3 months	0.48 ***	0.49 **	0.40 ***
	6 months	0.74 **	1.33 ***	0.61 ***
	1 year	0.50	2.08 **	0.53 **
	2 years	0.10	0.48	0.14
	Largest impac	0.74 **	2.08 **	0.63 ***
Chile	1 month	0.21 ***	0.03	0.03 *
	3 months	0.41 ***	0.33 ***	0.00
	6 months	0.57 ***	0.57 ***	0.03
	1 year	0.56 ***	0.55 *	0.11 *
	2 years	0.11	-0.16	0.10 *
	Largest impac	0.61 ***	0.63 ***	0.11 *
Colombia	1 month	-0.07 *	0.18 ***	0.02 *
	3 months	0.01	0.25 ***	0.05 ***
	6 months	0.16 **	0.34 ***	0.02
	1 year	0.27 ***	0.30 *	-0.03 *
	2 years	0.17 *	0.14	-0.02 *
	Largest impac	0.27 ***	0.35 **	0.05 ***
Mexico	1 month	-0.03	-0.04	0.10 ***
	3 months	-0.05 *	0.01	0.18 ***
	6 months	-0.05	0.15 *	0.18 ***
	1 year	-0.04	0.35 *	0.16 ***
	2 years	-0.04	0.40 **	0.10 ***
	Largest impac	-0.06	0.40 **	0.18 ***
Peru	1 month	0.04	0.12	-0.01
	3 months	0.35 ***	0.58 ***	0.01
	6 months	0.20 *	0.71 ***	-0.03
	1 year	-0.15 *	0.25 *	-0.08 *
	2 years	-0.02	-0.18 *	-0.02
	Largest impac	0.35 ***	0.72 ***	0.01
Central America				
Costa Rica	1 month	-0.12 **	0.05	0.17 ***
	3 months	-0.09	0.58 ***	-0.23 ***
	6 months	0.08	0.48 ***	-0.09
	1 year	0.23 **	-0.03	-0.09 *
	2 years	0.11 *	-0.15	0.02
	Largest impac	0.23 **	0.58 ***	0.17 ***
El Salvador	1 month	-0.10 *	0.43 ***	0.20 *
	3 months	0.02	0.82 ***	0.12 *
	6 months	0.17 *	1.14 ***	0.11
	1 year	0.31 **	1.12 ***	0.25 *
	2 years	0.18 *	0.31 *	0.36 *
	Largest impac	0.31 **	1.21 ***	0.36 *
Guatemala	1 month	0.03	0.44 ***	-0.20 **
	3 months	0.34 ***	0.73 ***	-0.04
	6 months	0.11 *	0.37 *	0.04
	1 year	0.15 *	0.40 *	-0.61 ***
	2 years	-0.06	0.24 *	0.34 *
	Largest impac	0.34 ***	0.73 ***	0.34 *
Honduras	1 month	0.18 ***	0.56 ***	0.00
	3 months	0.43 ***	1.09 ***	-0.30 ***
	6 months	0.48 ***	1.23 ***	-0.73 ***
	1 year	0.37 *	1.17 ***	-0.32 *
	2 years	0.39 *	0.86 **	0.00
	Largest impac	0.48 ***	1.29 ***	0.00
Nicaragua	1 month	0.23 **	0.41 ***	0.54 ***
	3 months	0.04	0.51 *	0.56 ***
	6 months	-0.31 **	0.02	0.84 ***
	1 year	-0.48 **	0.19	1.32 ***
	2 years	-0.16	0.32 *	0.25
	Largest impac	-0.44 *	0.86 **	1.37 ***
Memorandum items				
Average (Largest impact)		0.28	0.88	0.32
Inflation targeters		0.38	0.84	0.20
Central America		0.19	0.93	0.45

Source: IMF staff estimates.

1/ Size of the shock: 50 percentage points in fuel; 30 in food; and 5 in activity.
*** Indicates significance at the 95 percent level; ** at 90 percent; and * at 75 percent.

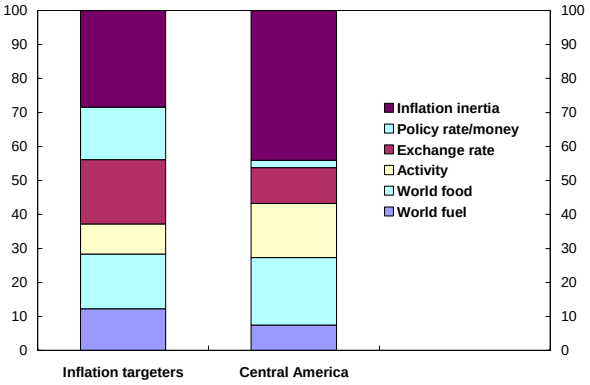
Figure 6.4. Impulse Response of Headline Inflation



Source: Authors' calculations
Note: 90 percent error band 75 percent error band

The model also examined the impact of other factors on inflation (Figure 6.5). Compared with the Central American countries, exchange rates explain more of the variation in headline inflation in the inflation-targeting countries, in line with their more flexible exchange rate regimes. Similarly, policy interest rates play a much more prominent role. In contrast, inflation inertia appears sizable in Central America. This suggests that in the inflation-targeting countries, inflation may converge faster to trend, implying some payoff to credible inflation targets.

Figure 6.5. Contribution to Variation in Inflation
(After 24 months; in percent)



Source: IMF staff estimates.

As expected, headline inflation is affected by economic activity as well, significantly so in most countries. The effects are positive in all the inflation-targeting countries (except Peru), and in Nicaragua and El Salvador. Contrary to what might be expected, a pickup in economic activity appears to reduce headline inflation in other Central American countries. This result deserves further analysis and may be a consequence of measurement errors in monthly activity indicators. One possibility to be explored is whether these indicators capture supply shocks (e.g., in agriculture), rather than demand movements, thus leading to lower inflation.

Results: Underlying Inflation

We find evidence that the increases in world fuel and food prices have spilled over onto underlying inflation in a number of countries. Table 6.2 shows that the spillover from world fuel shocks is significant and positive in most countries, with the impact on underlying inflation being almost as large as the impact on headline inflation. The spillover from world food prices is significant in Brazil, Chile, Colombia, and several Central American countries, with the impact on underlying inflation being about one-third that on headline inflation. The more prominent spillover from world fuel shocks probably reflects the fact that fuels are used as an input into the domestic production of a broader set of goods than are world food items.

Table 6.2. Response of Underlying Inflation to Different Shocks 1/

	Period	World Fuel	World Food	Activity
Inflation-targeting countries				
Brazil	1 month	0.07 *	0.05	0.10 ***
	3 months	0.22 ***	0.08	0.23 ***
	6 months	0.45 **	0.42 *	0.40 ***
	1 year	0.59 *	1.23 **	0.50 ***
	2 years	0.12	1.42 *	0.21 *
	Largest impact	0.60 **	1.42 *	0.50 ***
Chile	1 month	0.05 *	-0.06 *	0.01
	3 months	0.07 *	0.21 ***	-0.02
	6 months	0.06	0.38 ***	0.00
	1 year	-0.04	0.21 *	0.05 *
	2 years	-0.01	-0.15 *	0.01
	Largest impact	0.07 *	0.38 ***	0.05 *
Colombia	1 month	-0.02	0.08 *	0.01 *
	3 months	0.04 *	0.16 ***	0.02 *
	6 months	0.12 **	0.25 ***	0.00
	1 year	0.18 **	0.28 **	-0.02 *
	2 years	0.13 *	0.20 *	-0.02 *
	Largest impact	0.18 **	0.29 **	0.02 ***
Mexico	1 month	0.08 ***	-0.04 *	0.07 ***
	3 months	-0.01	-0.06 *	0.19 ***
	6 months	-0.07 *	-0.02	0.18 ***
	1 year	-0.11 *	0.08	0.15 ***
	2 years	-0.11 *	0.14	0.10 ***
	Largest impact	-0.11 *	0.14	0.19 ***
Peru	1 month	-0.17 **	-0.07	-0.08 ***
	3 months	0.30 ***	-0.15 *	-0.11 ***
	6 months	0.49 ***	-0.13	-0.04 *
	1 year	0.22 **	0.01	0.02
	2 years	-0.02 *	-0.03	0.00
	Largest impact	0.49 ***	-0.16 *	-0.12 ***
Central America				
Costa Rica	1 month	-0.05	0.13 *	0.12 ***
	3 months	-0.17 *	0.31 **	-0.22 ***
	6 months	0.02	0.12	-0.05
	1 year	0.11 *	-0.04	-0.13 *
	2 years	0.13 *	-0.16	-0.05
	Largest impact	0.13 *	0.33 *	-0.22 ***
El Salvador	1 month	-0.20 ***	0.04	0.20 ***
	3 months	-0.01	0.18 **	0.22 ***
	6 months	0.14 **	0.22 **	0.26 ***
	1 year	0.19 **	0.11 *	0.27 ***
	2 years	0.06 *	-0.07	0.14 *
	Largest impact	0.19 ***	0.23 **	0.27 *
Guatemala	1 month	-0.04 *	0.05 *	0.05 *
	3 months	0.06 *	-0.04	-0.06
	6 months	-0.07 *	-0.10 *	-0.16 *
	1 year	-0.18 ***	-0.15 *	-0.08
	2 years	-0.11 *	-0.02	-0.25 *
	Largest impact	0.06 *	0.09 *	-0.25 *
Honduras	1 month	-0.14 ***	0.17 **	0.01
	3 months	-0.21 **	0.08	-0.23 ***
	6 months	-0.08	-0.03	-0.43 ***
	1 year	0.06	0.30	-0.15 *
	2 years	0.18 *	0.66 *	-0.21 *
	Largest impact	0.18 *	0.66 *	-0.43 ***
Nicaragua	1 month	0.50 ***	0.41 ***	0.41 ***
	3 months	0.14 *	0.36 *	0.50 ***
	6 months	-0.21 *	-0.03	0.97 ***
	1 year	-0.63 ***	-0.06	1.27 ***
	2 years	-0.29	0.22	0.51 *
	Largest impact	0.57 ***	0.53 ***	1.33 ***
Memorandum items				
Average (Largest impact)		0.24	0.39	0.14
Inflation targeters		0.25	0.41	0.13
Central America		0.23	0.37	0.14

Source: IMF staff estimates.

1/ Size of the shock: 50 percentage points in fuel; 30 in food; and 5 in activity.
*** Indicates significance at the 95 percent level; ** at 90 percent; and * at 75 percent.

There is also evidence that shocks to economic activity have an impact on underlying inflation. The responses are particularly pronounced in Brazil, Mexico, El Salvador, and Nicaragua. In these countries, the responses are similar in size to those of headline inflation.

Results: Domestic Food and Fuel Inflation

The results also suggest that world commodity fuel and food prices have had a noticeable impact on both the domestic fuel and food subcomponents of the CPI (Table 6.3). However, this impact has been considerably less than one-to-one. The model suggests that, based on historical relationships,

- The 30 percent run-up in world food prices since 2006 would have raised annual consumer food inflation rates by an average of close to 2 percentage points in these countries. This is equivalent to about half of the average rise in food inflation in the region that took place in 2007 (from 6 to 10 percent). The model estimates a larger average impact in Central America than in the inflation-targeting countries.

- The 50 percent run-up in world fuel prices since 2006 would have raised annual consumer fuel inflation by an average of 2 percentage points. In general, the inflation-targeting countries have tended to experience a more significant pass-through from international prices than the Central American countries. This may reflect less use of regulatory and subsidy policies to contain domestic fuel prices in the inflation-targeting countries, except in Mexico, where government policy usually targets constant domestic gasoline and diesel prices in real terms.

- In most countries, consumer food inflation also seems to rise in response to increases in economic activity. The shocks are statistically significant in all the inflation-targeting countries, and very large in Nicaragua. The response of consumer fuel inflation to shocks in activity is more mixed, with a positive and sizable impact

Table 6.3. Response of Food and Fuel Inflation to Different Shocks 1/

		Domestic Fuel		Domestic Food	
	Period	World fuel	Activity	World food	Activity
Inflation-targeting countries					
Brazil	1 month	0.21	-0.21	0.37 *	0.21 ***
	3 months	5.89 ***	-0.43	1.75 ***	0.18
	6 months	5.53 ***	1.57 **	3.92 ***	0.40
	1 year	0.71	1.34 **	3.75 **	0.56
	2 years	-0.62	-0.14	-0.64	-0.14
	Largest Impact	6.37 ***	2.01 ***	4.62 ***	0.62 *
Chile	1 month	0.69 ***	-0.37 ***	0.10	0.24 ***
	3 months	1.88 ***	-0.57 ***	0.24	0.29 **
	6 months	2.55 ***	-0.29 *	0.50	0.30 *
	1 year	1.67 ***	0.11	0.95 *	0.16
	2 years	0.08	-0.04	1.03 *	0.07
	Largest Impact	2.55 ***	0.11	1.03 *	0.31 *
Colombia	1 month	-0.81 ***	-0.03	0.44 *	0.06 *
	3 months	0.99 ***	-0.38	0.53 *	0.18
	6 months	2.30 ***	-0.62 ***	0.68	0.10
	1 year	2.34 ***	-0.50 ***	0.50	-0.03
	2 years	1.07 *	-0.13	0.05	-0.02
	Largest Impact	2.57 ***	-0.63 ***	0.69 **	0.18 ***
Mexico	1 month	-0.29 **	0.07	-0.14	0.23 **
	3 months	-0.30 *	0.34 ***	0.03	0.23 **
	6 months	-0.19	0.31 ***	0.28	0.25 **
	1 year	-0.03	0.24 **	0.51 *	0.18 **
	2 years	0.06	0.14 **	0.25 *	0.03
	Largest Impact	0.06	0.34 ***	0.51 *	0.25 **
Peru	1 month	1.78 ***	-0.14	0.34 *	0.09 *
	3 months	4.22 ***	-0.22	1.17 ***	0.12 *
	6 months	3.87 ***	0.15	1.46 ***	-0.01
	1 year	-0.18	-0.16	0.58 *	-0.14 *
	2 years	-0.25	-0.13	-0.50	-0.02
	Largest Impact	4.44 ***	-0.33 *	1.46 ***	0.14 *
Central America					
Costa Rica	1 month	-0.26 *	0.04	0.10	0.03
	3 months	0.67 ***	0.00	0.54 ***	-0.01
	6 months	1.42 ***	0.02	1.01 ***	-0.05
	1 year	1.53 ***	0.13	1.32 ***	-0.04
	2 years	0.06	0.20 *	0.77	0.05
	Largest Impact	1.64 ***	0.20 *	1.32 ***	0.05
El Salvador	1 month	1.25 ***	-0.07 *	1.05 ***	0.31 *
	3 months	1.47 ***	0.42 **	1.80 ***	-0.06
	6 months	1.52 ***	0.90 ***	2.46 ***	-0.21
	1 year	1.15 ***	1.18 ***	2.17 ***	0.20
	2 years	0.26	0.63 *	0.30	0.61 **
	Largest Impact	1.53 ***	1.18 ***	2.56 ***	0.61 **
Guatemala	1 month	-0.05	-0.04	1.08 ***	-0.65 ***
	3 months	1.53 ***	0.16	1.91 ***	-0.27 *
	6 months	1.02 ***	0.42	1.46 ***	0.16
	1 year	0.66 **	-0.67 *	1.41 ***	-1.23 **
	2 years	-0.38 *	0.57	0.67	0.98 *
	Largest Impact	1.53 ***	-0.67 *	1.94 ***	-1.23 **
Honduras	1 month	0.65 ***	-0.07	0.88 ***	0.20 **
	3 months	1.29 ***	-0.53 ***	1.81 ***	-0.32 *
	6 months	0.83 ***	-0.98 ***	2.19 ***	-0.73 **
	1 year	0.04	-0.72 ***	1.94 ***	-0.10
	2 years	0.03	0.18 **	0.72 *	0.11
	Largest Impact	1.29 ***	-0.98 ***	2.22 ***	-0.73 **
Nicaragua	1 month	0.41 ***	0.75 ***	0.46 *	0.49 **
	3 months	1.11 ***	0.44 *	1.17 **	0.49 **
	6 months	0.76 ***	0.29	1.04 **	0.76 ***
	1 year	-0.08	1.56 ***	0.67 *	1.07 ***
	2 years	-0.71 *	1.45 ***	0.31 *	-0.02
	Largest Impact	1.11 ***	1.56 ***	1.24 **	1.17 ***
Memorandum items					
Average (Largest Impact)		2.31	0.28	1.76	0.14
Inflation targeters		3.20	0.30	1.66	0.30
Central America		1.19	0.22	1.55	-0.02

Source: IMF staff estimates.

1/ Size of the shock: 50 percentage points in fuel; 30 in food; and 5 in activity.
*** Indicates significance at the 95 percent level; ** at 90 percent; and * at 75 percent.

evident in Brazil, El Salvador, Mexico, and Nicaragua.

Conclusions

The analysis suggests that shocks to world fuel and food commodity p rices have had a significant effect on several measures of inflation in the region. For most countries, world food inflation has played a more prominent role than rising world prices of fuel. Among other factors, this reflects the higher share of food in the consumption basket, as well as active policies to smooth the impact of rising international fuel prices. The estimated spillover to underlying and expected inflation indicates there is a risk that these commodity shocks could fan inflationary pressures. In several countries, there is also evidence that excess demand has put upward pressure on consumer prices, particularly for food items, as indicated by the positive responses in the model of headline and domestic food inflation to shocks in economic activity.

However, the results also support the view that, at least based on past experience, a large portion of recent food inflation increases cannot be accounted for by world food commodity price developments. For a number of countries, part of the answer is weather-related shocks that affected domestic food supplies. A further explanation is that prices for raw commodities account for only a portion of total costs, and other factors may be driving up these components. For instance, the boom in world food prices has coincided with the surge in fuel commodity prices, which affect irrigation and other inputs in the production of all food items. Excess demand pressures may be driving up these costs as well.

It is also possible that the recent rapid increase in world food prices has changed the speed and amount of pass-through, in a way that the model cannot yet capture. A structural break of this kind would become clear only when more data are available. Inflation dynamics may also be asymmetric when faced with rapid increases versus decreases in commodity prices. Still, the key finding from the analysis is that policy reactions and other domestic factors have an important impact on inflation, even when shocks may originate from external commodity prices.

Looking forward, food and fuel commodity prices may remain elevated. The recent sustained increase in commodity prices reflects in large part the strength of demand growth in emerging and developing economies and the increasing use of grains in biofuels production. In light of these shifting patterns, fuel and food commodity prices have continued to edge up in early 2008. Although in the short run producers may absorb higher input costs from commodities by compressing margins, they are more likely to adjust consumer prices when faced with persistently higher commodity prices. Therefore, inflation dynamics in the region could be further affected if commodity price shocks continue. Our analysis indicates that the inflation response to shocks in world commodity prices peaks within six months, although it takes one to two years for the effects to fully dissipate. This suggests that inflation may remain elevated for a protracted period of time following an upward price shock.

How should monetary policy respond? The food price pressures from supply shocks should prove temporary, provided policymakers react to mitigate second-round effects. It will also be important to take account of the fact that some longer-lasting reductions in domestic supply, unconnected to weather conditions, may be expected because land use may change in response to the higher returns available for certain globally traded food crops. The empirical analysis and these considerations suggest that monetary policy should seek to contain inflationary pressures arising from higher world food and fuel prices. In this context, allowing the exchange rate to appreciate in line with market forces would help ease inflationary pressures. Of course, the appropriate policy response will depend on, among other factors, the track record of policy management, the intensity of second-round effects, the seriousness of balance sheet and other vulnerabilities, and the scale of external linkages.

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Part III

Financial Linkages

Chapter 7

Financial Flows from the United States to Latin America: Basic Patterns, Causes, and Implications

Ravi Balakrishnan and Fernando M. Gonçalves

Much research has shown the importance of U.S. financial conditions for the rest of the world (see Chapter 12), but the literature analyzing the causes and impact of U.S. financial flows is much sparser. As financial globalization continues (IMF, 2005), however, cross-border capital flows are becoming increasingly important, and changes in the pattern of such flows may have potentially serious macroeconomic consequences.

With this in mind, this chapter analyzes the impact of financial *flows* from the United States to the major Latin American economies. We focus on flows from the United States because of limited data available from other countries, and because U.S. flows can be regarded as a proxy for advanced capital market flows—which are highly integrated—to these countries.

We document the basic patterns of financial flows to Latin America, using both balance of payments and Treasury International Capital (TIC) system data to look at both portfolio flows and foreign direct investment (FDI) from the United States and elsewhere. We then investigate what drives U.S. financial flows to major Latin American countries and study the impact of flows on key domestic financial variables. We estimate a series of vector autoregressions (VARs) across countries, with endogenous variables, such as measures of U.S. financial conditions, U.S. equity and debt flows, domestic and external fundamentals, and measures of global risk aversion. This allows us to investigate the effect of U.S. and domestic economic and financial conditions on financial flows, as well as the effect of U.S. and domestic economic variables on domestic financial conditions.

Latin American assets still make up an extremely small share of U.S. investors' portfolios, and, indeed, this share has fallen since the Asian crisis. Moreover, a significant portion of portfolio and FDI inflows to Latin America come from other countries. Nonetheless, Brazilian and Mexican equity markets and Colombian and Peruvian bond markets have sizable exposures to U.S. investors. In determining U.S. flows and other financial conditions in Latin America, the VAR analysis points to a large role for external factors (such as global risk aversion and U.S. interest rates) compared with a small role for domestic fundamentals (such as domestic production, growth prospects, and interest rates). Moreover, VARs with and without flows suggest that econometric analysis excluding flows is not misspecified. Overall, although U.S. investments in Latin America may not be as important as previously thought and have fallen since the Asian crisis, U.S. financial conditions still appear to have a major impact on the region's financial health.

Basic Trends Across the Region

Overall Capital Flows Snapshot

Table 7.1 provides a snapshot of the composition of regional capital flows over the past 15 years. There are clear differences across countries, but as a general rule, portfolio investment in the region has declined relative to GDP in recent years as countries' current account deficits have turned into substantial surpluses. Although bond flows tended

Table 7.1. Indicators of External and Financial Vulnerability
(In percent of GDP)

	1991-98	1999-2003	2004-06
Argentina			
Current account balance	-3.0	1.3	3.0
Capital and financial account balance	3.5	-0.4	-3.4
Net foreign direct investment	1.5	3.1	2.0
Net portfolio investment	4.0	-3.5	-1.2
Portfolio investment assets	-1.0	-0.1	0.2
Portfolio investment liabilities	5.0	-3.4	-1.4
Equity	0.8	-1.0	0.1
Bonds and notes	4.2	-2.4	-1.5
Net other investment	-1.9	0.0	-4.3
Brazil			
Current account balance	-1.5	-2.6	1.5
Capital and financial account balance	1.6	2.6	-1.4
Net foreign direct investment	1.1	3.7	0.6
Net portfolio investment	2.8	0.3	0.2
Portfolio investment assets	-0.1	-0.1	-0.1
Portfolio investment liabilities	2.9	0.4	0.3
Equity	0.6	0.5	0.6
Bonds and notes	2.4	-0.1	-0.4
Net other investment	-2.3	-1.4	-2.3
Chile			
Current account balance	-3.2	-0.9	2.3
Capital and financial account balance	3.1	1.8	-2.2
Net foreign direct investment	3.0	4.1	4.4
Net portfolio investment	0.6	-2.1	-4.2
Portfolio investment assets	-0.8	-4.0	-5.2
Portfolio investment liabilities	1.4	2.0	1.0
Equity	1.0	0.0	0.5
Bonds and notes	0.4	2.0	0.5
Net other investment	-0.5	-0.2	-2.5
Colombia			
Current account balance	-2.7	-0.5	-1.6
Capital and financial account balance	2.6	0.5	1.3
Net foreign direct investment	1.9	2.0	3.8
Net portfolio investment	0.8	-0.2	-1.2
Portfolio investment assets	-0.3	-1.4	-1.8
Equity	0.0	0.0	0.0
Bonds and notes	-0.2	-1.0	-0.3
Portfolio investment liabilities	1.1	1.2	0.7
Equity	0.3	0.0	0.1
Bonds and notes	1.0	1.2	0.6
Net other investment	-0.1	-1.2	-1.4
Mexico			
Current account balance	-3.9	-2.5	-0.6
Capital and financial account balance	4.4	2.9	0.6
Net foreign direct investment	2.3	3.0	2.0
Net portfolio investment	2.5	0.8	0.8
Portfolio investment assets	-0.1	0.2	0.1
Equity	0.0	0.0	0.0
Bonds and notes	-0.1	0.2	0.1
Portfolio investment liabilities	2.5	0.7	0.7
Equity	1.1	0.2	0.1
Bonds and notes	2.1	0.5	0.0
Net other investment	-0.4	-1.0	-2.1
Venezuela			
Current account balance	1.6	7.2	15.5
Capital and financial account balance	-0.3	-5.3	-13.5
Net foreign direct investment	2.3	1.8	0.1
Net portfolio investment	0.5	-0.7	-2.2
Portfolio investment assets	-0.2	-0.5	-1.9
Equity	-0.1	-0.1	0.0
Bonds and notes	0.0	-0.3	-1.7
Portfolio investment liabilities	0.6	-0.1	-0.3
Equity	0.7	0.0	0.0
Bonds and notes	0.0	-0.1	-0.3
Net other investment	-3.1	-6.4	-11.4

Sources: IMF - *Balance of Payments Statistical Yearbook, World Economic Outlook,* and staff calculations.

to dominate before the Asian crisis, equity inflows into the biggest Latin American economies—Brazil and Mexico—have increased in recent years.

Systemic Importance of U.S. Investors in Latin America

Treasury benchmark surveys of U.S. holdings of foreign securities give us a detailed picture of where U.S. residents invest (see the appendix for data sources). Based on the December 2001 survey, Burger and Warnock (2006) argued that, regarding bond purchases, U.S. residents invested overwhelmingly in industrialized rather than emerging market countries. Moreover, they showed a remarkable level of home bias even toward industrialized country bonds. The authors argued that the high variability and negative skewness of bond returns in emerging markets explain their extremely low weight in U.S. investors' portfolios.

Table 7.2 updates Burger and Warnock (2006) by looking at trends in equity and bond holdings in the asset surveys through 2006. The variables *w_us* and *w_m* are, respectively, the shares of a country's instruments in U.S. investors' portfolios (including their holdings of U.S. assets) and in the global market. Thus, the ratio *w_us* / *w_m* provides a measure of the degree to which U.S. investors are underweight in a particular country's assets relative to what an international capital asset pricing model would predict. Clearly, U.S. investors have exhibited a home bias in all foreign assets, particularly with respect to bonds.

Confirming the analysis of Burger and Warnock (2006), the majority of foreign investments remain in industrialized countries (nearly 90 percent). Moreover, although U.S. investors have become less underweight in foreign assets overall, this is mostly driven by declining home bias with respect to industrialized country equities. The degree to which U.S. investors are underweight in Latin America is lower than in emerging Asia, but recent trends favor the latter. In particular, while U.S. investors have become slightly less underweight in emerging Asian equities, they have become more underweight in

Table 7.2. Portfolio Share of U.S. Investors' Holdings of Foreign Assets Relative to ICAPM Benchmarks 1/

	2006			2001			1997		
	ω_{us}	ω_m	ω_{us} / ω_m	ω_{us}	ω_m	ω_{us} / ω_m	ω_{us}	ω_m	ω_{us} / ω_m
Total: equity, domestic and international long-term debt securities									
Argentina	0.03	0.15	0.17	0.02	0.23	0.07	0.17	0.31	0.56
Brazil	0.25	1.19	0.21	0.13	0.86	0.15	0.23	1.12	0.21
Chile	0.03	0.16	0.18	0.02	0.14	0.16	0.04	0.18	0.20
Colombia	0.01	0.09	0.15	0.01	0.06	0.18	0.02	0.06	0.34
Mexico	0.25	0.63	0.40	0.18	0.54	0.34	0.29	0.48	0.60
Peru	0.01	0.06	0.15	0.01	0.02	0.28	0.02	0.03	0.49
Venezuela	0.01	0.21	0.07	0.01	0.05	0.26	0.04	0.08	0.45
Latin America 2/	0.59	2.48	0.24	0.38	1.91	0.20	0.80	2.26	0.36
Emerging Asia 2/	1.18	8.83	0.13	0.50	5.09	0.10	0.47	4.28	0.11
Industrial countries 2/	8.81	46.94	0.19	6.08	42.94	0.14	5.78	45.67	0.13
Equity									
Argentina	0.01	0.07	0.13	0.01	0.07	0.09	0.12	0.26	0.45
Brazil	0.44	1.16	0.38	0.20	0.57	0.34	0.29	0.63	0.45
Chile	0.02	0.28	0.08	0.02	0.18	0.10	0.04	0.24	0.17
Colombia	0.00	0.08	0.04	0.00	0.02	0.06	0.01	0.06	0.11
Mexico	0.40	0.66	0.61	0.24	0.44	0.53	0.32	0.56	0.57
Peru	0.00	0.10	0.04	0.00	0.02	0.18	0.02	0.04	0.50
Venezuela	0.00	0.02	0.20	0.00	0.02	0.19	0.02	0.04	0.49
Latin America 2/	0.88	2.38	0.37	0.47	1.33	0.35	0.81	1.83	0.44
Emerging Asia 2/	2.28	13.23	0.17	1.06	7.29	0.15	0.62	6.55	0.09
Industrial countries 2/	14.25	41.82	0.34	10.94	39.19	0.28	8.52	40.29	0.21
Domestic and international long-term debt securities									
Argentina	0.04	0.21	0.20	0.02	0.35	0.07	0.23	0.35	0.65
Brazil	0.08	1.21	0.07	0.08	1.08	0.07	0.18	1.50	0.12
Chile	0.04	0.07	0.48	0.03	0.11	0.23	0.03	0.14	0.23
Colombia	0.02	0.09	0.25	0.02	0.09	0.20	0.03	0.05	0.61
Mexico	0.11	0.60	0.18	0.15	0.61	0.24	0.26	0.42	0.62
Peru	0.01	0.03	0.47	0.01	0.02	0.35	0.01	0.02	0.45
Venezuela	0.02	0.35	0.06	0.02	0.08	0.27	0.05	0.11	0.47
Latin America 2/	0.32	2.56	0.13	0.32	2.34	0.14	0.80	2.60	0.31
Emerging Asia 2/	0.16	5.40	0.03	0.10	3.46	0.03	0.32	2.50	0.13
Industrial countries 2/	3.74	50.92	0.07	2.56	45.74	0.06	3.07	49.89	0.06

Source: IMF staff calculations.

1/ U.S. holdings of foreign equity and bond securities are from U.S. Treasury International Capital System Benchmark surveys; ωus , ωm refer to the weight (in percent) in U.S. investors' and the world market portfolio; $\omega us / \omega m$ is the ratio.

2/ Latin America represents the total of Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. Emerging Asia includes China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand. Industrialized countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Latin American equities and bonds relative to before the Asian crisis.

Such trends suggest that U.S. investors reevaluated the risks associated with investing in emerging markets in general after the Asian crisis, and again in Latin America after the Argentine crisis. This result is consistent with the findings of Balakrishnan, Bayoumi, and Tulin (forthcoming). They look at the U.S. net foreign asset position with respect to bonds in industrialized countries and emerging markets, and find that, with respect to emerging markets, U.S. purchases have been largely negative since the late 1990s. Moreover, when decomposing this trend into flows related to declining home bias, financial deepening, and relative growth of bond markets, they find that there has been a large negative residual

since the late 1990s, which they argue is consistent with some reassessment of the attractiveness of emerging market debt in general after the Asian crisis.

Given the size of U.S. investors' portfolios, however, the fact that Latin America makes up only a small share of their portfolios does not imply that they are not systemically important in Latin American securities markets. As of 2006, U.S. investors hold significant shares of equity markets in Brazil and Mexico (15 and 25 percent, respectively), and bond markets in Chile and Peru (16 percent each). Overall, U.S. holdings are located mainly in Brazil and Mexico (valued at US$110 billion in each country, out of US$250 billion for the region). Equity holdings are more than double the size of bond holdings. The rapid ramping-up of equity holdings in Brazil and Mexico, however, is not a story simply of increasing equity inflows, but also of big valuation gains as stock markets have soared. Nevertheless, despite the fact that a significant portion of portfolio inflows into these countries come from other foreign investors, the increase in equity flows to Brazil and Mexico appears to be driven by U.S. investors.

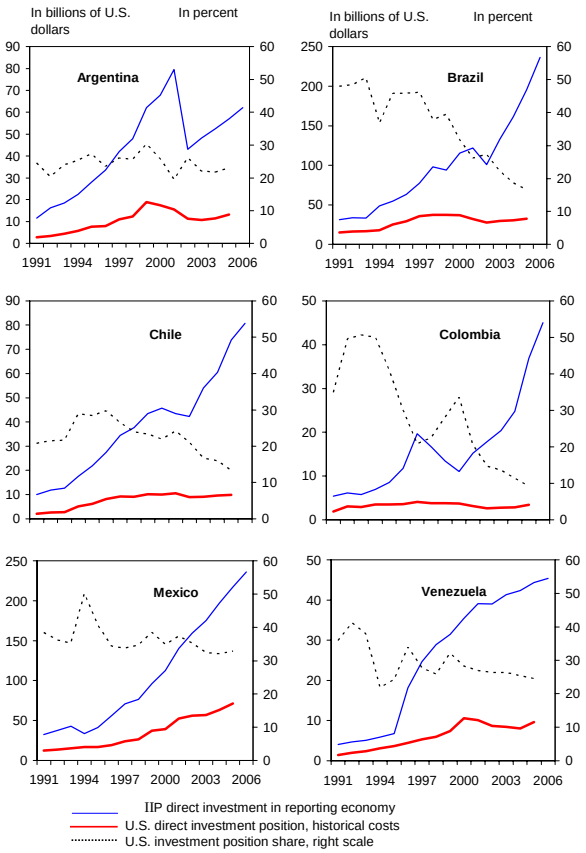
Regarding the stock of U.S. FDI assets, Figure 7.1 shows that as FDI has continued in the major Latin American countries, the share of U.S. investors has generally fallen. In the early 1990s, in Brazil, Colombia, and Mexico, the U.S. share of FDI was greater than 50 percent. It has since fallen to below a quarter for all countries considered, except Mexico where it remains about a third.

Overall, therefore, although U.S. investors' importance may not be as high as commonly perceived, and indeed may have fallen since the Asian and Argentine crises, these investors still remain systemically important in many Latin American countries, especially the biggest ones.

Link Between Equity and Bond Flows

One important aspect of portfolio flows is the extent to which bond and equity flows have been linked within countries and across countries. The

Figure 7.1. Direct Investment Positions



Sources: Haver Analytics; IMF, *Balance of Payments Statistical Yearbook*; and IMF staff calculations.

extent to which bond and equity flows are linked within a country could be suggestive of common factors driving both types of flows, whereas the extent to which flows to Latin American countries are correlated could be suggestive of the importance of global or regional factors.

Table 7.3 estimates the variance-covariance matrix for both total balance of payments and U.S. flows to Brazil and Mexico. To provide more texture we split the past 15 years into three subperiods, 1991–98 (pre–Asian crisis, but including the "Tequila crisis"), 1999–2004 (post–Asian crisis, but including crises in Brazil), and 2005–06 (the most recent "goldilocks period"). In general, equity and bond flows have been positively correlated within countries. Interestingly, whereas overall bond and equity flows are more correlated than U.S. equity and bond flows to Brazil, the reverse is true for Mexico. Indeed, the correlation of overall bond and equity flows to Mexico has been falling over time, and turned

Table 7.3. Correlations of Brazil and Mexico Bond and Equity Quarterly Inflows

1991–98

	BRA BOP Equity	BRA BOP Bond	MEX BOP Equity	MEX BOP Bond	BRA U.S. Equity	BRA U.S. Bond	MEX U.S. Equity	MEX U.S. Bond
BRA BOP equity	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
BRA BOP bond	0.41	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MEX BOP equity	0.31	-0.13	1.00	n.a.	n.a.	n.a.	n.a.	n.a.
MEX BOP bond	0.35	-0.13	0.26	1.00	n.a.	n.a.	n.a.	n.a.
BRA U.S. equity	0.75	0.26	0.48	0.43	1.00	n.a.	n.a.	n.a.
BRA U.S. bond	0.38	0.03	0.20	-0.02	0.11	1.00	n.a.	n.a.
MEX U.S. equity	0.28	0.22	0.69	0.15	0.09	-0.05	1.00	0.45
MEX U.S. bond	0.36	0.22	0.44	0.36	0.54	-0.13	0.45	1.00

1999–2004

	BRA BOP Equity	BRA BOP Bond	MEX BOP Equity	MEX BOP Bond	BRA U.S. Equity	BRA U.S. Bond	MEX U.S. Equity	MEX U.S. Bond
BRA BOP equity	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
BRA BOP bond	0.41	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MEX BOP equity	0.15	0.09	1.00	n.a.	n.a.	n.a.	n.a.	n.a.
MEX BOP bond	0.29	0.26	0.10	1.00	n.a.	n.a.	n.a.	n.a.
BRA U.S. equity	0.48	0.30	0.19	0.28	1.00	n.a.	n.a.	n.a.
BRA U.S. bond	0.49	0.29	0.24	0.38	0.25	1.00	n.a.	n.a.
MEX U.S. equity	0.37	0.11	0.53	0.36	0.30	0.11	1.00	n.a.
MEX U.S. bond	-0.27	0.03	-0.13	0.40	0.17	-0.03	0.00	1.00

2005–06

	BRA BOP Equity	BRA BOP Bond	MEX BOP Equity	MEX BOP Bond	BRA U.S. Equity	BRA US Bond	MEX U.S. Equity	MEX U.S. Bond
BRA BOP equity	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
BRA BOP bond	0.33	1.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MEX BOP equity	0.51	0.44	1.00	n.a.	n.a.	n.a.	n.a.	n.a.
MEX BOP bond	0.07	0.45	-0.50	1.00	n.a.	n.a.	n.a.	n.a.
BRA U.S. equity	0.19	-0.04	0.49	-0.70	1.00	n.a.	n.a.	n.a.
BRA U.S. bond	0.07	0.42	0.48	0.02	0.27	1.00	n.a.	n.a.
MEX U.S. equity	0.40	0.26	0.69	-0.58	0.58	0.40	1.00	n.a.
MEX U.S. bond	-0.25	0.56	0.05	0.42	-0.57	0.05	0.21	1.00

Source: IMF staff calculations.

negative in 2005–06, possibly suggesting that foreign investors are becoming sophisticated in differentiating between asset classes in Mexico.

Regarding trends across countries, U.S. portfolio flows to Brazil and Mexico have been positively correlated with overall portfolio flows to these countries. Equity flows especially have become increasingly correlated over time, which could be consistent with global and regional factors dominating foreign equity investment allocations. Total bond flows to Brazil and Mexico have also become more correlated over time, although U.S. bond flows do not show any clear pattern.

To look beyond correlations and focus on causality, we estimate VARs and perform Granger causality tests with U.S. bond and equity flows (normalized by debt and market capitalization, respectively) to Brazil and Mexico. Impulse responses from bivariate VARs using a Cholesky decomposition (the ordering does not matter) show that U.S. bond and equity flows are complements rather than substitutes, although the results are not significant. Granger causality tests suggest that equity flows cause bond flows in both countries but not vice versa.

In sum, portfolio flows to Brazil and Mexico have generally been positively correlated, as have equity and bonds flows to each country, with the exception of equity and bond flows to Mexico during 2005–06. Overall, these results suggest the presence of a global or regional factor in determining portfolio flows—something we will come back to in the next section.

VAR Analysis

This section sheds light on what drives capital flows and analyzes their impact on Latin America. To do so, we build on the approach of Bekaert, Harvey, and Lumsdaine (2002; hereafter BHL), who estimate VARs for a variety of emerging markets, using world interest rates, equity flows, dividend yields, and equity returns. We run VARs for Brazil and Mexico, given their significant exposures to the United States, and Chile, which is considered by many to be the epitome of macroeconomic stability in Latin America.[1] Before describing our approach, a summary of the literature will help put our results in context.

Related Literature

The survey in Chapter 12 reviews the literature on the impact of U.S. and global conditions on financial conditions in emerging markets. The literature is vast and the use of a VAR approach is common (see, for example, Canova, 2005). Overall, the results suggest that even during calm times, there are statistically significant spillovers from mature markets (mostly the United States) to Latin American markets. For example, Ehrmann and Fratzscher (2006) estimate that a 25 bp change in the federal funds rate leads to a 1 percent decline in Brazilian equities and a 0.25 percent decline in Mexican equities.

The main message during calm times is that although spillovers exist, the main drivers of Latin American equity returns are either country-specific

[1] In Balakrishnan and Gonçalves (forthcoming), we also include Colombia, but the spirit of the results remains the same.

or global factors. The difficulty, of course, is separating U.S. shocks from global shocks. Moreover, there has been little consensus in the literature on the relative importance of global versus domestic factors. Some papers (Arora and Cerisola, 2000; and Grandes, 2002) emphasize the direct relationship between short-term U.S. interest rates and emerging market spreads; others (Eichengreen and Mody, 1998) have found a negative relationship. Most papers (González Rozada and Levy Yeyati, 2005; and Diaz Weigel and Gemmill, 2006) have attributed more importance to global rather than domestic factors.

There have been few papers that explicitly analyze the impact of cross-border financial flows on macroeconomic conditions in Latin America. Most authors focus on the impact of foreign financial prices variables (such as U.S. interest rates and equity prices), following the implicit logic that capital flows are one channel through which changes in industrialized financial markets spill over to emerging market countries. However, little if any research has tested this proposition. Analyzing the potential impact of cross-border financial flows on macroeconomic conditions above and beyond that implied by changes in financial variables seems like a worthwhile endeavor, especially in a world of increasing financial globalization. In particular, if the results were different from the prevailing literature, excluding capital flows could be an important source of misspecification in econometric models.

BHL have incorporated financial flows in their analysis. They estimate VARs for a variety of emerging markets, using a measure of the world interest rate, equity flows, dividend yields, and equity returns. They follow Froot, O'Connell, and Seasholes (2001) and order flows before returns, but also add the world interest rate (ordered first) and the dividend yield (ordered between equity flows and returns). This allows them to test the effects of the world interest rate on flows, returns, and dividend yields; the impact of flows on returns and dividend yields; and the effect of past returns and dividend yields on flows.

The low level of U.S. interest rates has often been cited as an important reason for increased capital flows to emerging markets in the early 1990s as it led to a chase for higher yielding assets (e.g., Calvo, Leiderman, and Reinhart, 1993). The inclusion of the interest rate in the VAR permits the assessment of the role of international liquidity as an exogenous "push" factor for capital flows into Latin America.

The impact of flows on returns and dividend yields can be used to assess whether flows have a temporary or permanent effect on stock prices. In fact, although U.S. flows are expected to increase stock market prices, this effect may be due to flows temporarily driving prices away from fundamentals ("price pressure" hypothesis) or it could reflect a permanent decrease in the cost of capital owing to risk-sharing benefits from the opening of capital markets ("permanent impact" hypothesis). The price pressure hypothesis would suggest that an increase in capital flows temporarily induces high equity returns, which are reversed afterward as prices revert to fundamental levels. The permanent impact hypothesis would imply that the dividend yield would permanently decrease owing to a permanent drop in prices.

The effect on flows of shocks to equity returns and dividend yields can be used to assess whether investors are momentum traders or return chasers (Bohn and Tesar, 1996). If momentum is important for U.S. investors' decisions, flows would respond to past equity returns. If, on the other hand, investors' decisions reflect updated expectations about future returns, flows would react to changes in expected returns.

We build on BHL's approach by adding a global risk aversion measure (the Chicago Board of Trade "Volatility Index," or VIX) as well as measures of U.S. and domestic fundamentals besides interest rates, and also by considering bond flows as well as equity flows; the former have often been larger and more volatile than equity flows in many countries. These additions allow us to address a number of questions not considered by BHL. First, do risk aversion and real sector developments in the United

States serve as exogenous push factors? Second, how do risk aversion and real factors compare with liquidity (measured by the U.S. interest rate) as determinants of capital flows?[2] Finally, what is the role of domestic variables ("pull factors")?

Choice and Ordering of Variables

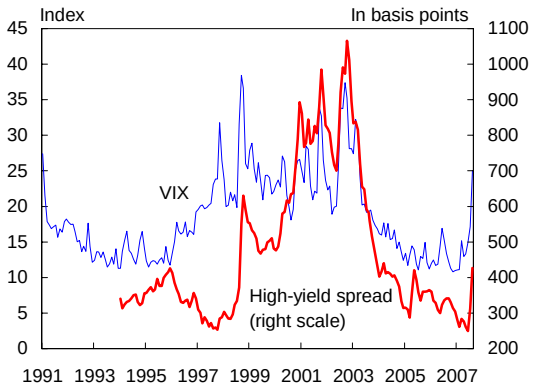
The endogenous variables included in our VAR can be divided into four types:

- **U.S. variables.** The VIX, the federal funds rate, and growth in U.S. industrial production.
- **Domestic macroeconomic variables.** Growth in domestic industrial production and the domestic short-term interest rate.
- **Financial flows.** Net bond and equity flows from the United States to Latin American countries (as shares of debt and market capitalization, respectively).
- **Domestic financial variables.** Dividend yield and equity returns (difference to the S&P 500).

We also include new cross-border listings (as a share of a country's market capitalization) as an exogenous variable. Such listings are often thought to influence the attractiveness of foreign equities to U.S. investors (Edison and Warnock, 2003).

Short-term interest rates and industrial production growth quantify liquidity conditions and real developments in both the United States and the recipient country. The degree of investors' risk aversion is measured by the VIX. Although the VIX is considered a measure of global risk aversion, it is actually the volatility of a range of S&P 500 options (Figure 7.2). Thus, the extent to which it is a global factor rather than a U.S. factor is not clear—this is a common problem when trying to distinguish factors.[3]

Figure 7.2. VIX and High-Yield Spread



Source: Bloomberg L.P.

As noted in BHL, the dividend yield is a very meaningful variable. In a standard infinite period asset pricing model

$$p_t - d_t = E_t \sum_{j=1}^{\infty} \rho^{j-1} (\Delta d_{t+j} - r_{t+j}),$$

where lower-case variables denote logs, p is the stock price, d are dividends, ϱ is the discount factor, and r are total returns (dividends plus price appreciation). Thus, when prices are high relative to dividends, investors expect dividends to rise in the future, or total returns to be low in the future, or future cash flows to be discounted at a lower than usual rate. As Cochrane (2001) notes, most of the variation in the price-dividend ratio results from the fluctuations in expected returns. However, as pointed out by BHL, unexpected returns nuance this picture. In the short term, a positive shock to the dividend yield may simply reflect a negative unexpected return, which may lead to short-term outflows if investors are momentum driven. In the long term, higher dividend yields should indicate higher expected returns, implying that a positive shock on dividend yields would lead to inflows after

[2] As pointed out by BHL, a potentially good reason for an inverse link between U.S. interest rates and capital flows to emerging markets is that "low U.S. interest rates may have increased the Americans' wealth and therefore increased their risk tolerance, leading them to rebalance towards riskier emerging market securities."(p. 244). By including a measure of risk aversion, it is possible to distinguish between interest rate effects that are a consequence of liquidity tightening and those that result from increased risk aversion.

[3] The selection process leading to these variables is described in Balakrishnan and Gonçalves (forthcoming).

a few periods if the return-chasing hypothesis is correct.

Bekaert and Harvey (2000) also argue that because of their low variability, dividend yields are better at capturing permanent price increases induced by the cost of capital (largely via the discount rate) than by average returns. An important question is the impact of an increase in risk aversion, and consequently the equity risk premium on the dividend yield. Rising risk aversion should increase future expected returns demanded on equity; in other words, lead to a higher current dividend yield. Thus, the dividend yield should also unambiguously capture movements in risk aversion.

The ordering of our VAR is such that U.S. variables are considered the most exogenous, followed by domestic macroeconomic variables, and then domestic financial variables. The exact ordering is as follows: (1) the VIX, (2) the growth rate of industrial production in the United States, (3) the U.S. federal funds effective rate, (4) the growth rate of domestic industrial production, (5) domestic short-term interest rates, (6) bond flows as a share of debt, (7) equity flows as a share of market capitalization, (8) the dividend yield, and (9) domestic equity returns minus the S&P 500 return.

By placing the VIX before U.S. industrial production growth and interest rates, we disregard any contemporaneous feedback that may exist between the later two variables on risk aversion. Instead, we consider the same-period effect that risk aversion may have on real developments and the interest rate. The ordering also implies that the contemporaneous influence of industrial production growth on the interest rate is taken into account, but not vice versa. This means that monetary policy reactions to contemporaneous real developments are captured by the model but any effect of interest rates on growth in the same month is not accounted for, which seems sensible given that interest rate effects on real activity may have long lags. Using the same logic, the domestic industrial production growth rate is placed ahead of domestic short-term interest rates.

Given our finding that equity flows Granger cause bond flows, but not vice versa, the chosen ordering for the flows variables is first equity and then bonds. Both precede the dividend yield and equity return, implying that the contemporaneous effect of these variables on flows, which could potentially be ascribed to price pressure effects, is removed. By placing the dividend yield before equity returns and both variables after flows, the contemporaneous effect of shocks to the returns on both the capital flows and dividend yields is omitted. Hence, only the effect of past returns (momentum trading) on the endogenous variables is considered.

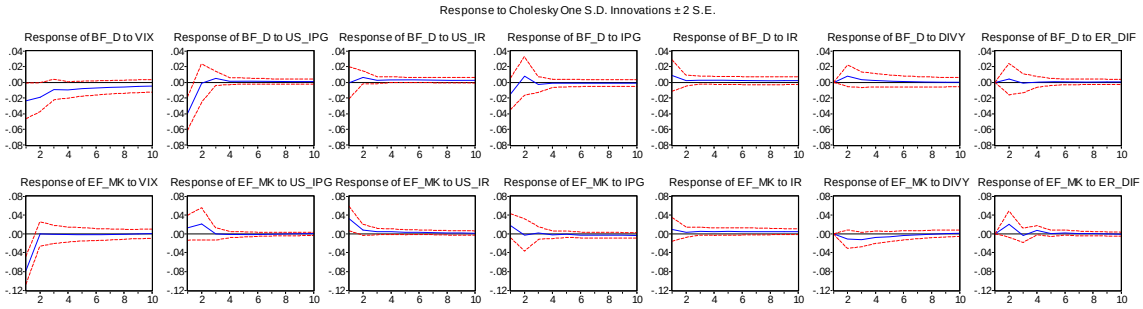
Determinants of Financial Flows

The results of our analysis are summarized as follows. First, we focus on determinants of bond and equity flows (Figure 7.3). An increase in risk aversion (i.e., a positive shock in the VIX) is typically associated with a drop in the share of bond and equity flows in debt and market capitalization, respectively. The drop in equity flows is significant for Mexico and especially for Brazil. The drop in bond flows is slightly significant only for Brazil. Interestingly, Chile is the only country in which the responses of both bond and equity flows to a shock in risk aversion are not significant. This is consistent with the view that Chile is perceived by U.S. investors as a country that has had solid macroeconomic fundamentals for a long period of time, and therefore may be less vulnerable to a rise in risk aversion. In terms of magnitudes, a one standard deviation shock to the VIX leads to a 2–5 percent drop in the bond flows ratio and a 2–6 percent drop in the equity flows ratio.

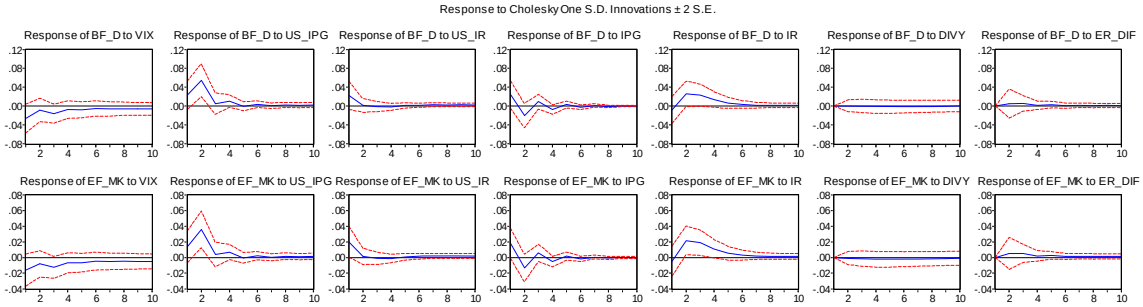
A shock to growth in real activity in the United States (measured by U.S. industrial production growth) has different effects across different types of flows and countries. In Brazil, positive shocks to U.S. growth lead to positive and significant bond outflows. The magnitude of the outflow is about 4 percent of the bond-to-debt ratio in response to a shock of one standard deviation in growth. In Chile, U.S. real shocks lead to significant inflows (with a lag) of both equity and bonds to Chile. The

Figure 7.3. Determinants of Financial Flows

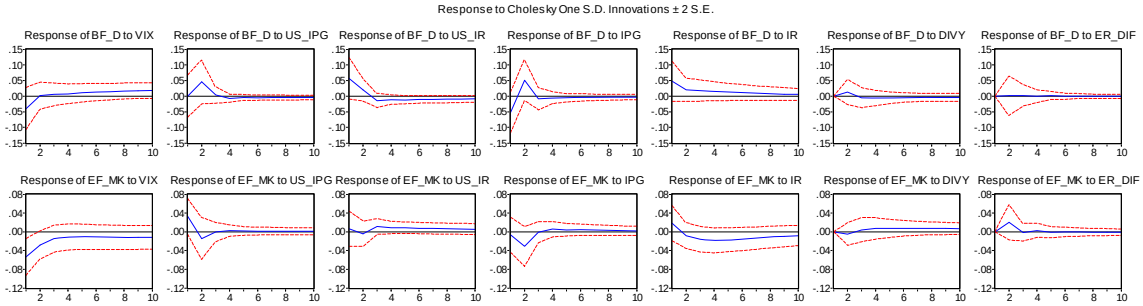
Brazil



Chile



Mexico



Source: Authors' calculations.

Note: The variables are defined as follows:

BF_D is bond flows relative to debt;
EF_MK is equity flows relative to market capitalization;
VIX is the monthly average of the VIX index;
US_IPG is U.S. industrial production growth;
US_IR is the effective federal funds rate;
IPG is domestic industrial production growth;
IR is the domestic short-term interest rate;
DIVY is the dividend yield; and ER_DIF is the equity return differential.

magnitude of the inflows is more than 5 percent for the bonds ratio and about 4 percent for the equity ratio in response to a one standard deviation shock. All other responses of flows to U.S. real shocks are not statistically significant.

Positive shocks to U.S. short-term interest rates have no statistically significant effect on financial flows from the United States to Latin America, except for equity flows to Brazil, where the coefficient is surprisingly positive but barely significant. These results differ from the literature of the 1990s (e.g., Calvo, Leiderman, and Reinhart, 1993), which found that an increase in U.S. interest rates has a negative effect on flows. One possible explanation for the difference is that our sample period mostly covers the 2000s, not the 1990s. Although the strong and long-lasting increase in U.S. interest rates observed since 2004 may have exerted a negative effect on U.S. flows to Latin America (as in the early 1990s), this effect may have been more than compensated for by concomitantly rising commodity prices and their associated positive spillovers to investors' perceptions of domestic fundamentals.

Interestingly, the response of financial flows to shocks in domestic real developments is not statistically significant for any of the four countries considered. Similarly, the responses of flows to shocks to the domestic interest rate are also not statistically significant, except in the case of equity flows to Chile, which respond positively (with a lag) to an increase in domestic interest rate, as expected. The magnitude of the response to a one standard deviation shock is of about 2 percent of the flows ratio.

Finally, other domestic financial conditions may affect flows. In particular, if equity flows increase in response to positive equity return shocks, there is evidence of momentum trading. On the other hand, if dividend yield shocks are perceived as permanent and lead to equity inflows, there is evidence that investors chase future expected returns. Figure 7.3 shows that impulse responses of flows to dividend yield and equity return shocks are not significant. Nonetheless, it is clear that shocks to equity returns are on average associated with inflows in all countries, which may be interpreted as weak evidence in favor of the momentum-trading hypothesis.

Table 7.4 shows the variance decomposition of bond and equity flows for each of the three countries. The table highlights those variables that explain at least 5 percent of the variance of flows. The results confirm that the VIX is an important determinant of at least one type of flow in all four cases, but the country where it has the smallest relevance is Chile. In some cases, U.S. industrial production growth explains a relevant part of the variance of flows. In Brazil, the U.S. interest rate accounts for more than 5 percent of the variance of equity flows, whereas for other countries its relevance is minor. Domestic industrial production growth is relevant for explaining the variance of bond flows to Mexico and of equity flows to Chile, whereas domestic interest rates account for a significant part of the variance of both types of flows to Chile. The results also suggest that the dividend yield and equity returns are not important factors in determining flows.

In short, the evidence from impulse responses and variance decompositions suggests the following conclusions:

- In general, the VIX is an important determinant of flows, although less so in the case of Chile.[4]
- U.S. industrial production is also an important determinant of flows, especially in Brazil and Chile.

[4] A related result by Österholm and Zettelmeyer (see Chapter 2), who study the effect of external conditions on growth in Latin America, is that a one standard deviation in the high-yield spread led to a 0.9 percentage point drop in Latin American annual growth (measured as a weighted index for Argentina, Brazil, Chile, Colombia, Mexico, and Peru) after three quarters. They state that results were similar when the VIX was used in place of the high-yield spread.

Table 7.4. Variance Decomposition of Bond and Equity Flows

Brazil

Bond flows

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.1	5.5	15.2	0.0	2.1	0.7	76.5	0.0	0.0	0.0
2	0.1	8.5	14.2	0.4	2.6	0.7	72.7	0.2	0.6	0.1
3	0.1	9.1	14.3	0.4	2.6	0.8	71.7	0.3	0.7	0.2
4	0.1	9.8	14.1	0.5	2.6	0.8	70.9	0.3	0.7	0.2
5	0.1	10.3	14.0	0.6	2.6	0.9	70.4	0.3	0.8	0.2
6	0.1	10.7	14.0	0.6	2.6	0.9	70.0	0.3	0.8	0.2
7	0.1	11.0	13.9	0.7	2.6	0.9	69.6	0.3	0.8	0.2
8	0.1	11.2	13.9	0.8	2.6	1.0	69.3	0.4	0.8	0.2
9	0.1	11.4	13.8	0.8	2.6	1.0	69.1	0.4	0.8	0.2
10	0.1	11.6	13.8	0.9	2.6	1.0	68.8	0.4	0.8	0.2

Equity flows

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.1	30.2	0.9	5.4	1.5	0.4	0.2	61.5	0.0	0.0
2	0.1	28.3	3.0	5.3	1.4	0.5	1.3	57.7	0.6	2.0
3	0.1	27.9	2.9	5.4	1.4	0.6	1.3	57.2	1.3	2.0
4	0.1	27.7	2.9	5.5	1.4	0.7	1.3	56.7	1.5	2.3
5	0.1	27.6	2.9	5.5	1.4	0.8	1.3	56.5	1.7	2.3
6	0.1	27.5	2.9	5.5	1.5	0.9	1.3	56.4	1.7	2.3
7	0.1	27.5	2.9	5.5	1.5	1.1	1.3	56.3	1.7	2.3
8	0.1	27.4	2.9	5.6	1.5	1.2	1.3	56.2	1.7	2.3
9	0.1	27.4	2.9	5.6	1.6	1.3	1.3	56.1	1.7	2.3
10	0.1	27.4	2.9	5.6	1.6	1.3	1.3	56.0	1.7	2.3

Mexico

Bond flows

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.3	1.8	0.0	3.7	3.1	2.5	89.0	0.0	0.0	0.0
2	0.3	1.6	2.1	3.8	5.5	2.7	83.4	0.7	0.2	0.0
3	0.3	1.6	2.1	4.0	5.5	3.0	82.8	0.7	0.2	0.0
4	0.3	1.7	2.1	4.1	5.5	3.2	82.4	0.7	0.3	0.0
5	0.3	1.8	2.1	4.2	5.5	3.4	82.0	0.7	0.3	0.0
6	0.3	1.9	2.2	4.3	5.5	3.5	81.6	0.7	0.3	0.0
7	0.3	2.1	2.2	4.4	5.5	3.6	81.2	0.7	0.3	0.0
8	0.3	2.4	2.2	4.5	5.5	3.6	80.8	0.7	0.3	0.0
9	0.3	2.7	2.2	4.5	5.5	3.7	80.5	0.7	0.3	0.0
10	0.3	3.0	2.2	4.6	5.4	3.7	80.1	0.7	0.4	0.0

Equity flows

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.2	9.0	3.5	0.1	0.1	1.0	0.1	86.1	0.0	0.0
2	0.2	9.2	3.3	0.2	2.6	1.0	0.9	81.8	0.1	1.0
3	0.2	9.4	3.2	0.4	2.5	1.6	1.9	79.9	0.1	1.0
4	0.2	9.5	3.1	0.6	2.5	2.4	2.0	78.6	0.2	1.0
5	0.2	9.7	3.1	0.8	2.5	3.1	2.1	77.5	0.3	1.0
6	0.2	9.8	3.0	0.9	2.6	3.6	2.2	76.5	0.4	1.0
7	0.2	10.0	3.0	1.0	2.6	4.0	2.2	75.7	0.6	1.0
8	0.2	10.3	3.0	1.1	2.6	4.2	2.2	75.0	0.7	1.0
9	0.2	10.5	3.0	1.1	2.6	4.4	2.2	74.5	0.8	1.0
10	0.2	10.8	2.9	1.2	2.5	4.5	2.2	74.0	0.9	1.0

Chile

Bond flows

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.1	3.8	2.9	2.7	3.3	0.3	86.9	0.0	0.0	0.0
2	0.2	3.3	15.2	2.2	4.4	3.1	71.6	0.1	0.0	0.1
3	0.2	4.2	14.7	2.1	4.6	5.2	68.8	0.1	0.0	0.2
4	0.2	4.4	14.9	2.1	4.8	5.9	67.6	0.2	0.0	0.2
5	0.2	4.6	14.8	2.1	4.8	6.0	67.2	0.2	0.0	0.3
6	0.2	4.7	14.8	2.1	4.8	6.0	67.1	0.2	0.0	0.3
7	0.2	4.9	14.8	2.1	4.8	6.0	66.9	0.2	0.0	0.3
9	0.2	5.2	14.8	2.1	4.8	6.0	66.6	0.2	0.0	0.3
10	0.2	5.3	14.7	2.2	4.7	6.0	66.5	0.2	0.0	0.3

Equity flows

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.1	3.1	2.2	4.9	4.0	0.3	79.6	5.9	0.0	0.0
2	0.1	3.0	13.9	3.8	4.9	4.7	64.4	5.2	0.0	0.2
3	0.1	4.3	13.2	3.6	4.9	7.6	61.0	4.9	0.0	0.5
4	0.1	4.6	13.3	3.6	5.0	8.5	59.6	4.9	0.1	0.5
5	0.1	5.0	13.2	3.5	5.0	8.7	59.1	4.8	0.1	0.6
6	0.1	5.1	13.2	3.5	5.0	8.7	58.8	4.8	0.2	0.6
7	0.1	5.3	13.2	3.6	5.0	8.7	58.6	4.8	0.2	0.6
9	0.1	5.7	13.1	3.6	5.0	8.7	58.3	4.8	0.2	0.6
10	0.1	5.9	13.1	3.6	5.0	8.7	58.1	4.8	0.2	0.6

Source: Authors' calculations.
Note: The variables are defined as follows:
S.E. is the standard error;
VIX is the monthly average of the VIX index;
US_IPG is U.S. industrial production growth;
US_IR is the effective federal funds rate;
IPG is domestic industrial production growth;
IR is domestic short-term interest rate;
BF_D is bond flows relative to debt;
EF_MK is equity flows relative to market capitalization;
DIVY is the dividend yield; and ER_DIF is the equity return differential.
Shaded variables are those that explain at least 5 percent of the flow variance.

- In the case of Chile, domestic variables (industrial production growth and domestic interest rate) are relevant determinants of flows.

One caveat of our analysis is that in general we are unable to explain more than half of the variance of capital flows, with a few instances where we can only explain a fraction of about 10 percent. This is an important result because it documents the fact that existing literature on determinants of financial flows, which typically focuses on explanatory variables similar to ours, may be omitting important drivers of flows that future research should attempt to uncover.

Domestic Financial Conditions and the Transmission of Shocks

The effect of shocks to financial flows

The impulse responses of domestic financial condition variables (the dividend yield and the equity return differential) to shocks on financial flows (see Balakrishnan and Gonçalves, forthcoming) show that, although there are discrepancies across countries, shocks to flows generally lead to a persistent drop in the dividend yield and a short-lived increase in equity return that is not reverted afterward. The responses are consistent with the permanent impact hypothesis, but not with the price pressure hypothesis. However, contrary to the case of risk aversion shocks, surprisingly, these responses to financial flows shocks are not statistically significant, indicating that the adjustment to shocks may occur more prominently through prices (VIX and interest rates) than through quantities (financial flows).

The effect of U.S. and domestic macroeconomic conditions

The previous section has shown that U.S. financial flows may not be as relevant to Latin American domestic financial conditions as one would have expected. Nonetheless, this does not mean that Latin American countries' financial markets are isolated from external developments. In fact, variance decompositions confirm the point that

flows are not very relevant for explaining domestic variables, whereas some external and domestic macroeconomic variables have a considerable influence (Table 7.5). Although cross-country differences are significant, the VIX seems to be particularly important in almost all instances for explaining the variance of the dividend yield and equity return. The most notable exception is Chile, where the VIX seems to be less relevant.

Figure 7.4 shows the impulse response functions of the dividend yield and equity return differential in reaction to shocks to external variables (the VIX, and U.S. industrial production growth and interest rate) and domestic macroeconomic variables (domestic industrial production growth and interest rate). A rise in risk aversion leads to a statistically significant and persistent increase in the dividend yield in both Brazil and Mexico. This is consistent with the interpretation that the required rate of return on equity (captured by the dividend yield) increases as U.S. investors become more risk-averse.

Shocks to U.S. industrial production growth have no statistically significant effect on the dividend yield, but are positively associated with persistent increases in the dividend yield. This is true in all countries except Mexico, where close industrial ties may imply that the cost of capital decreases in response to better growth prospects in the United States.

As expected, shocks to U.S. interest rates seem to lower the long-term expected returns (measured by the dividend yield) in both Brazil and Mexico (statistically significantly in the former case). In the case of Chile, the effect is virtually null.

An increase in domestic industrial production growth leads to a lower cost of capital (i.e., a drop in dividend yield) for both Brazil and Mexico. Again, in the case of Chile the effect is virtually zero. The effect of an increase in the domestic interest rate on the dividend yield is small and not significant for all countries.

In short, domestic financial conditions are not particularly affected by flows per se, while shocks to

Table 7.5. Variance Decomposition of Dividend Yield and Equity Return Differential

Brazil

Dividend yield

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.0	0.1	0.5	1.9	1.6	2.2	4.6	0.9	88.2	0.0
2	0.0	10.6	2.1	4.6	4.7	1.8	2.4	0.5	61.0	12.3
3	0.0	16.1	1.6	5.4	6.3	1.4	1.7	0.5	55.5	11.4
4	0.1	21.2	1.4	6.0	6.2	1.1	1.4	0.5	50.5	11.9
5	0.1	25.2	1.3	6.3	6.0	0.9	1.1	0.5	47.0	11.7
6	0.1	28.5	1.2	6.5	5.7	0.8	1.0	0.6	44.1	11.6
7	0.1	31.1	1.1	6.7	5.4	0.8	0.9	0.7	41.9	11.5
8	0.1	33.2	1.1	6.8	5.1	0.9	0.8	0.7	40.1	11.3
9	0.1	34.9	1.0	6.8	4.8	1.0	0.8	0.8	38.6	11.2
10	0.1	36.2	1.0	6.9	4.6	1.2	0.7	0.8	37.4	11.0

Equity return differential

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	9.6	17.5	6.1	4.3	0.0	0.4	0.4	0.2	1.9	69.3
2	10.3	15.8	6.4	3.8	1.5	0.7	0.7	0.8	2.5	67.9
3	10.4	15.5	6.2	3.8	1.9	0.7	0.7	0.8	2.4	68.0
4	10.4	15.4	6.2	3.8	2.0	0.7	0.8	0.8	2.5	67.8
5	10.4	15.4	6.2	3.8	2.0	0.8	0.8	0.8	2.5	67.8
6	10.4	15.4	6.2	3.7	2.0	0.8	0.8	0.8	2.5	67.7
7	10.5	15.4	6.2	3.7	2.0	0.8	0.8	0.8	2.5	67.7
8	10.5	15.5	6.2	3.7	2.0	0.9	0.8	0.8	2.5	67.6
9	10.5	15.5	6.2	3.7	2.1	0.9	0.8	0.8	2.5	67.6
10	10.5	15.5	6.2	3.7	2.1	0.9	0.8	0.8	2.5	67.5

Mexico

Dividend yield

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.0	0.0	1.7	0.2	2.8	1.4	0.0	2.4	91.6	0.0
2	0.0	4.3	2.1	0.3	8.3	0.7	0.8	1.2	65.3	17.1
3	0.0	10.0	3.2	0.9	7.2	0.5	3.2	1.0	57.9	16.1
4	0.0	16.7	3.2	1.6	7.2	0.6	4.7	0.9	49.5	15.5
5	0.0	23.3	3.3	2.1	6.7	0.9	5.6	0.9	42.9	14.5
6	0.0	29.4	3.2	2.5	6.2	1.1	6.2	0.8	37.4	13.3
7	0.0	34.8	3.1	2.8	5.7	1.3	6.5	0.7	33.0	12.1
8	0.0	39.4	2.9	3.1	5.2	1.4	6.6	0.6	29.7	11.1
9	0.0	43.3	2.8	3.2	4.8	1.4	6.6	0.6	27.2	10.2
10	0.0	46.4	2.6	3.3	4.5	1.4	6.5	0.5	25.2	9.5

Equity return differential

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	5.2	6.8	2.6	1.3	1.0	0.0	1.1	2.5	2.7	82.1
2	5.9	5.6	2.8	1.2	5.8	1.0	3.2	2.0	2.6	75.9
3	5.9	5.7	2.9	1.2	6.3	1.2	3.2	1.9	3.0	74.6
4	6.0	5.6	2.8	1.3	7.1	1.6	3.2	1.9	3.1	73.4
5	6.0	5.5	2.9	1.3	7.0	2.0	3.2	1.9	3.1	73.0
6	6.0	5.5	2.9	1.4	7.1	2.3	3.3	1.9	3.1	72.5
7	6.0	5.6	2.8	1.5	7.1	2.6	3.3	1.9	3.1	72.1
8	6.1	5.7	2.8	1.5	7.1	2.9	3.4	1.9	3.1	71.6
9	6.1	5.8	2.8	1.6	7.1	3.1	3.4	1.9	3.1	71.2
10	6.1	6.0	2.8	1.6	7.1	3.3	3.4	1.9	3.1	70.8

Chile

Dividend yield

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	0.0	0.5	2.3	0.0	0.6	1.4	0.5	0.0	94.7	0.0
2	0.0	0.5	5.3	0.0	0.3	2.8	0.9	0.2	83.9	5.9
3	0.0	0.4	4.8	0.0	0.4	4.2	0.6	0.2	82.0	7.2
4	0.0	0.4	5.0	0.1	0.3	5.1	0.5	0.1	80.8	7.8
5	0.0	0.3	5.1	0.1	0.4	5.5	0.4	0.1	80.1	8.0
6	0.0	0.3	5.2	0.1	0.3	5.7	0.4	0.1	79.7	8.2
7	0.0	0.3	5.3	0.1	0.3	5.8	0.3	0.1	79.4	8.3
8	0.0	0.3	5.5	0.2	0.3	5.9	0.3	0.1	79.2	8.3
9	0.0	0.3	5.6	0.2	0.3	5.9	0.3	0.1	79.0	8.3
10	0.0	0.4	5.6	0.2	0.3	5.9	0.3	0.1	78.9	8.3

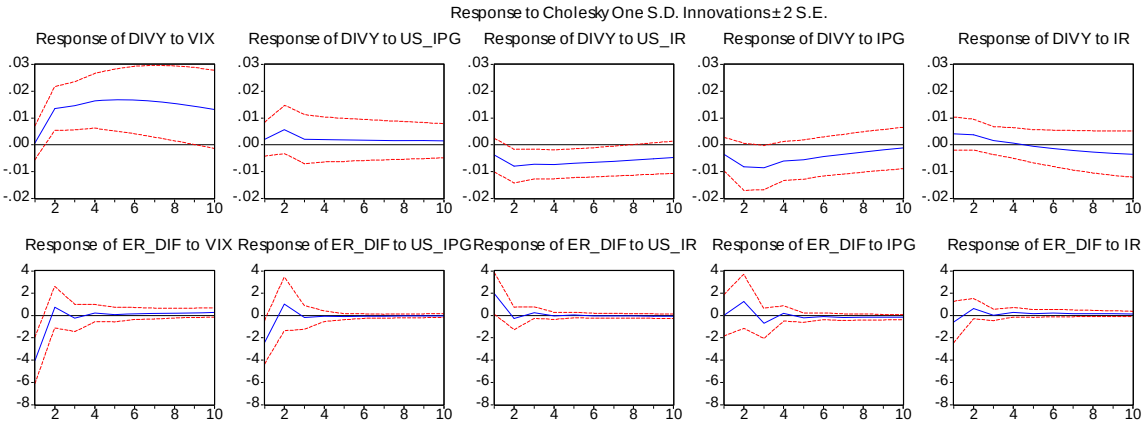
Equity return differential

Period	S.E.	VIX	US_IPG	US_IR	IPG	IR	BF_D	EF_MK	DIVY	ER_DIF
1	4.9	3.8	9.7	2.7	1.3	2.2	0.5	1.9	0.9	77.0
2	5.1	4.8	11.3	2.7	1.5	2.4	2.9	2.1	0.8	71.5
3	5.1	4.8	12.3	2.6	1.6	2.7	2.9	2.0	0.8	70.2
4	5.1	4.8	12.3	2.6	1.7	2.9	2.9	2.0	0.8	70.0
5	5.1	4.8	12.3	2.6	1.7	2.9	2.9	2.0	0.8	69.9
6	5.1	4.8	12.3	2.6	1.7	2.9	2.9	2.0	0.8	69.9
7	5.1	4.9	12.3	2.6	1.7	2.9	2.9	2.0	0.8	69.9
8	5.1	4.9	12.3	2.7	1.7	2.9	2.9	2.0	0.8	69.8
9	5.1	4.9	12.3	2.7	1.7	2.9	2.9	2.0	0.8	69.8
10	5.1	5.0	12.3	2.7	1.7	2.9	2.9	2.0	0.8	69.7

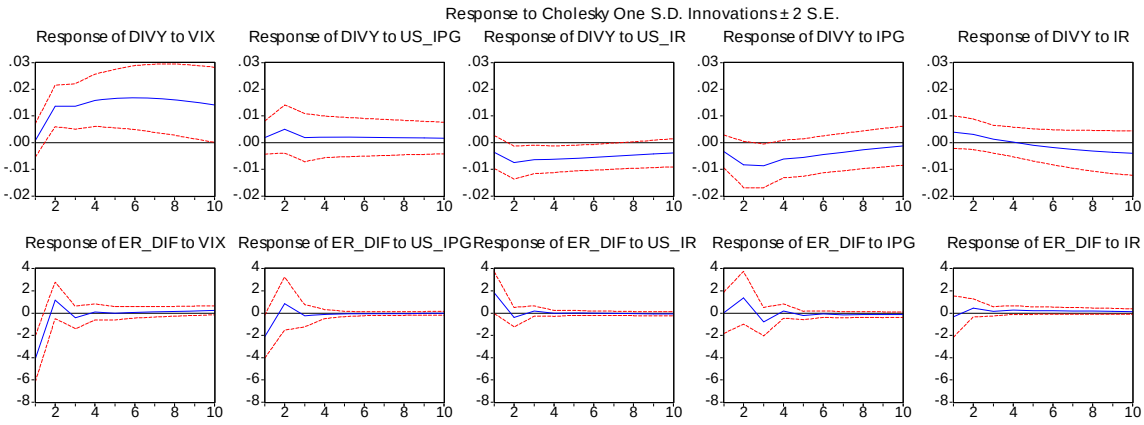
Source: Authors' calculations.
Note: The variables are defined as follows:
S.E. is the standard error;
VIX is the monthly average of the VIX index;
US_IPG is U.S. industrial production growth;
US_IR is the effective federal funds rate;
IPG is domestic industrial production growth;
IR is domestic short-term interest rate;
BF_D is bond flows relative to debt;
EF_MK is equity flows relative to market capitalization;
DIVY is the dividend yield; and ER_DIF is the equity return differential.
Shaded variables are those that explain at least 5 percent of the flow variance.

Figure 7.4. Response of Domestic Financial Conditions to Shocks on U.S. and Domestic Macroeconomics Variables: VARs with and without Financial Flows

Brazil with Flows



Brazil without Flows



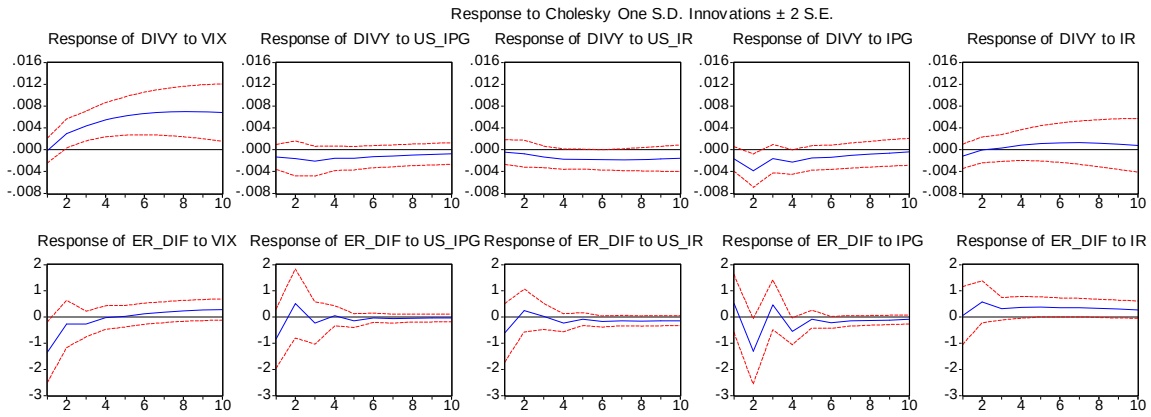
Source: Authors' calculations.

Note: The variables are defined as follows:

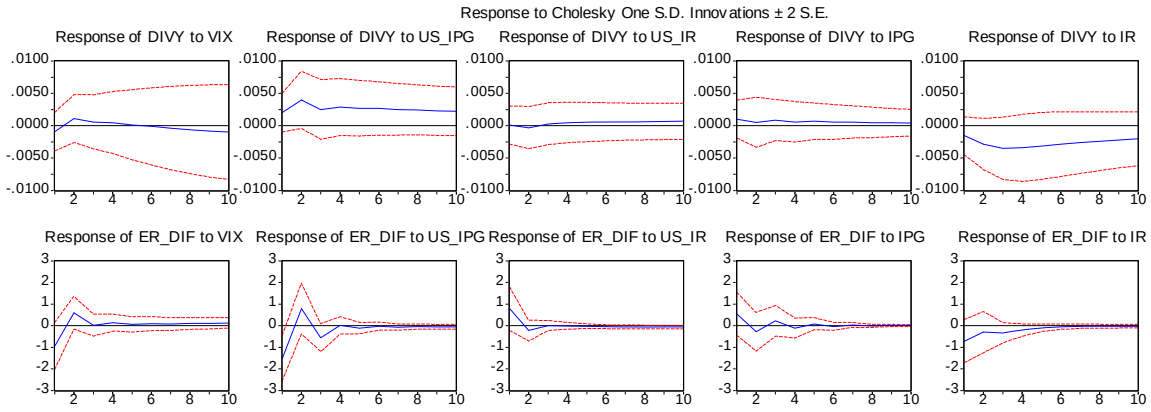
BF_D is bond flows relative to debt;
EF_MK is equity flows relative to market capitalization;
VIX is the monthly average of the VIX index;
US_IPG is U.S. industrial production growth;
US_IR is the effective federal funds rate;
IPG is domestic industrial production growth;
IR is the domestic short-term interest rate;
DIVY is the dividend yield;
ER_DIF is the equity return differential.

Figure 7.4. Response of Domestic Financial Conditions to Shocks on U.S. and Domestic Macroeconomics variables: VARs with and without Financial Flows (*concluded*)

Mexico with Flows



Chile with Flows



Source: Authors' calculations.
Note: The variables are defined as follows:
BF_D is bond flows relative to debt;
EF_MK is equity flows relative to market capitalization;
VIX is the monthly average of the VIX index;
US_IPG is U.S. industrial production growth;
US_IR is the effective federal funds rate;
IPG is domestic industrial production growth;
IR is the domestic short-term interest rate;
DIVY is the dividend yield;
ER_DIF is the equity return differential.

risk aversion typically result in significant drops in equity returns and persistent increases in the dividend yield.

Flows and the transmission of shocks

Finally, the literature on the transmission of shocks on U.S. financial and economic conditions to the rest of the world frequently omits financial flows. Does that represent an important misspecification? In other words, how is the transmission of other external shocks to domestic financial conditions affected by the inclusion of financial flows into the empirical analysis?

To answer this question, we also estimate VARs without financial flows. The impulse responses of domestic financial conditions to shocks in external variables in these VARs are also shown in Figure 7.4 for Brazil (similar results hold for Chile and Mexico). Clearly, there are only slight differences between the impulse responses of domestic variables to external shocks of VARs with and without financial flows. This shows that there may not be much to learn about the transmission of external shocks by including financial flows in the analysis.

Dimensionality Issues and Robustness of Results

A sensible concern about the VAR approach in this chapter is whether we are using too many variables given the limited sample size. As in any VAR analysis, we are faced with the so-called dimensionality curse: the number of parameters grows with the square of the number of variables.

An increase in the number of monthly observations could help alleviate this problem, but would generate others. In fact, two of the three countries we examine have floated their exchange rates in late 1999s (the exception being Mexico), and an extension of the sample to the 1990s would pose the question of whether the choice of exchange rate regime could be influencing flows. Another problem of extending the sample to the 1990s is that this was a period of significant liberalization of emerging financial markets, which may have served as an important stimulus for financial flows. Therefore, our focus on the 2000s has the virtue of controlling for features that are not emphasized in our analysis.

As an alternative to an increase in the sample size, we perform the estimation of a number of lower-dimension VARs to test the robustness of our results. For that, we use the four groups of explanatory variables—U.S. variables (the VIX, and U.S. industrial production growth and interest rate), domestic macroeconomic variables (industrial production growth and interest rate), financial flows (bond and equity flows normalized by debt and market capitalization, respectively), and domestic financial conditions (dividend yield and equity return differentials)—as separate blocks.

In examining the robustness of the results on the determinants of flows, we perform five VARs: (1) U.S. variables, financial flows, and domestic financial conditions; (2) domestic macroeconomic variables, financial flows, and domestic financial conditions; (3) U.S. variables and financial flows; (4) domestic macroeconomic variables and financial flows; and (5) financial flows and domestic financial conditions. As expected, the results are quantitatively different, but the main messages remain valid: external factors, especially the VIX, are more important than domestic factors in determining financial flows, with the exception of Chile, where the opposite occurs.

Similarly, we estimate shorter VARs in order to assess the robustness of our results for the drivers of domestic financial conditions. Besides VARs (1), (2), and (5) above, the following were also estimated: (6) U.S. variables and domestic financial conditions, and (7) domestic macroeconomic variables and domestic financial conditions. The key result remains that VIX is an important determinant of domestic financial conditions, whereas flows are not. Chile continues to be the exception.

Conclusions

This chapter has attempted to analyze the pattern, causes, and implications of financial flows from the United States to Latin America.

First, using a variety of capital flows data sources, we find that total capital flows—both FDI and portfolio debt and equity flows—have generally fallen as a ratio to GDP compared with the time before the Asian crisis. Part of this is no surprise, given that in recent years the current account positions of most major Latin American countries have improved dramatically on the back of the commodity price boom.

When we look specifically at U.S. holdings and flows, we find that Latin American assets make up an extremely small share of U.S. investors' portfolios, whose foreign purchases are largely in industrialized countries. Moreover, even this share has fallen since the Asian crisis, particularly with respect to bonds, likely reflecting a broad reassessment undertaken by U.S. investors of the attractiveness of emerging market debt in the aftermath of the Asian crisis. Despite the seeming lack of importance of Latin American assets in U.S. investors' portfolios, Brazilian and Mexican equity markets and Colombian and Peruvian bond markets have sizable exposures to U.S. investors. Thus, U.S. investors do remain systemically important in many countries.

Second, we use VARs to analyze the causes and consequences of financial flows. This analysis points to a larger role for external factors than for domestic fundamentals in determining financial flows. Among external factors, the VIX is generally more important than U.S. interest rates or U.S. industrial production. The major exception is Chile, for which U.S. industrial production and domestic factors are more important than the VIX, suggesting that Chile's strong macroeconomic record of recent decades has largely cushioned it from sudden capital movements associated with changes in global risk aversion.

Turning to the impact of financial flows, comparing the results from VARs with and without flows suggests that previous analyses that omitted financial flows are not misspecified, because the impulse responses for shocks other than to flows barely change. Moreover, shocks to flows do not explain much of the variance of domestic financial variables. Indeed, the VIX seems to be a key factor, except in the case of Chile. These results suggest financial shocks are largely transmitted via prices and not necessarily via financial flows.

Overall, although U.S. investors remain systemically important in some Latin American countries, the degree of this importance has declined since the Asian crisis. Still, U.S financial conditions, especially measures of risk aversion, have a major impact on the region's macroeconomic and financial health. The fact that Chile has remained largely immune to changes in the VIX suggests that although it may be difficult to "proof" domestic financial systems from U.S. macroeconomic developments, a long record of macroeconomic stability can certainly help mitigate the pernicious effect of changes in global risk sentiment on domestic macroeconomic and financial conditions.

Appendix. Sources for Capital Flow Data

For overall capital flows to the region, we use balance of payments data. For portfolio capital flows specifically from the United States, we use the Treasury International Capital (TIC) system. This records monthly transactions involving U.S. residents and foreigners, mainly reported by brokers and dealers. On the liabilities side, long-term securities are classified into equities, as well as corporate, agency, and treasury bonds. On the asset side (i.e., liabilities of Latin American residents to U.S. residents), they are only classified into equities and bonds. For U.S. FDI flows and stocks, we use Bureau of Economic Analysis data, which is available by country.

For overall equity and bond holdings of U.S. residents in Latin American countries, we use the TIC benchmark survey of U.S. holdings of foreign securities, which is now produced annually. As is well known, these surveys are more reliable than the monthly TIC capital flow data, because they do not

suffer from custodial and financial center bias.[5] In particular, the monthly data indicate the country through which investors purchase securities and not necessarily the ultimate owner of securities.[6] However, as Warnock and Cleaver (2002) argue, such biases do not appear to be significant for Latin American countries, and are more important for U.S. equity flows to industrialized countries.

For a list of data included in the VAR exercises, see Balakrishnan and Gonçalves (forthcoming).

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[5] As noted by Warnock and Cleaver (2002), for asset surveys (U.S. holdings of foreign securities), the reporters consist mainly of all large custodians and large institutional investors; smaller custodians and institutional investors were sampled, but 99 percent of the data came from the major reporters. The security-level data and associated identifiers (such as an ISIN or SEDOL number) provide information on the issuer's country of residence and, hence, ensure that the country attribution of the data is accurate.

[6] For example, if a U.S. resident instructed a private bank in the Cayman Islands to buy Mexican peso bonds from a Mexican resident, this may not show up in the TIC system.

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Chapter 8

Financial Linkages Between the United States and Latin America: Evidence from Daily Data

Roberto Benelli and Srideep Ganguly

With financial markets becoming increasingly integrated, financial market linkages are believed to be an increasingly important mechanism for the transmission of shocks across countries. Starting from the early 1990s, there has been a tremendous increase in financial liberalization in developing countries and a substantial increase in financial interdependencies of Latin America with the United States (Calvo, Leiderman, and Reinhart, 1993; and Edwards, Gómez Biscarri, and Perez de Gracia, 2003). This situation raises the question of whether increased financial liberalization and interdependence have magnified the spillovers of financial shocks from the United States to Latin America.

This chapter aims at investigating the linkages between financial markets in the United States and the seven largest Latin American economies.[1] We focus on spillovers of shocks that originate in the U.S. stock, bond, and currency markets.[2] In particular, this chapter aims at documenting changes in linkages that occur across periods of different market volatility and over time. We find that more recent episodes of market turbulence stand out from preceding episodes. However, our data sample ends in August 2006, and thus does not include the fallout of the U.S. subprime crisis.

Our main results can be summarized as follows: First, for stock markets, most recent episodes of market turbulence were unusual because they showed an increased sensitivity of Latin American markets to U.S. shocks, reversing a trend of weakening linkages. Second, currency markets in Latin America exhibited a decrease in cross-market linkages with the United States during the last episode of volatility, which was consistent with increased flexibility in exchange rate regimes compared with the 1990s. Third, the sovereign external bond markets in Latin America displayed a trend of weakening linkages with U.S. corporate bonds while becoming more sensitive to movements in other emerging market bond markets.

Related Literature

Most research on cross-country linkages has been carried out under the umbrella of the "contagion" literature that has flourished over the past two decades. The objective of this line of research has been to quantify the strength of spillovers across markets during and after financial crises. Whereas the earlier literature dates back to the aftermath of the October 1987 U.S. stock market crash (Eun and Shim, 1989; King and Wadhwani, 1990; and Hamao, Maulis, and Ng, 1991), after the 1997 Asian crisis research on contagion became increasingly popular.[3] However, the definition of the term "contagion" and the relative importance of different propagation channels of financial shocks have remained topics of debate.

[1] The Latin American countries considered in this paper are Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. These represent approximately 90 percent of the Latin American and Caribbean region's GDP.

[2] Masson (1998) employs the term "spillovers" for effects that arise from macroeconomic interdependence among developing countries, but following Gelos and Sahay (2001), this chapter uses the term in a broader sense: a "spillover" is any type of impact on other countries' financial markets.

[3] For comprehensive surveys of the empirical literature, see Claessens, Dornbusch, and Park (2001).

The most commonly accepted definition is that contagion occurs if a shock to one market (in the "crisis" country) results in an increased correlation between that market and another country's market. Most early research found support for the existence of this type of financial contagion in stock market returns after a major crisis. However, Forbes and Rigobon (2002) disputes these early findings by pointing out that the correlation coefficients—the tool commonly used to gauge changes in comovements across markets—leads to biased estimates of correlations across markets if market volatility changes across crisis and noncrisis periods (that is, in the presence of heteroscedasticity), as is often the case during turbulent periods. Once they correct for this bias, they find virtually no evidence of contagion. Recently, the contagion literature has moved beyond the initial approach of assessing the strength of comovements in asset price returns. Contagion may not be limited to asset returns, though. Diebold and Yilmaz (2006) have recently documented the existence of strong contagion in volatility across markets.

An extensive strand of this literature, particularly relevant to our chapter, has documented how the United States is a major source of spillovers to financial markets around the globe (Ng, 2000; and Chan-Lau and Ivaschenko, 2003). Arora and Cerisola (2001) show that the stance and predictability of U.S. monetary policy influence country risk, proxied by sovereign bond spreads, because both factors are important determinants of economic growth in developing countries. Similarly, Wongswan (2005) finds that surprises in U.S. monetary policy announcements have significant impacts on Latin American stock markets and other developing stock markets. Pagan and Soydemir (2000) find evidence of strong linkages between the stock markets of Mexico and the United States; linkages between the U.S. stock market and the stock markets of Argentina, Brazil, and Chile were weaker but also significant.[4] Canova (2005) takes a broader perspective and studies the transmission of U.S. demand and supply shocks to Latin America. He finds that U.S. monetary shocks produce significant fluctuations in Latin America, but other demand and supply shocks do not.

Our chapter contributes to this literature by undertaking a comprehensive analysis of the linkages among the U.S. and Latin American stock, currency, and bond markets using daily data and a new criterion to identify periods of market turbulence. We study whether there has been a systematic pattern—and whether this has changed in recent times—in linkages between financial markets of the two regions.[5]

Identifying Tranquil Versus Turbulent Times

Our starting point is a definition of market turbulence in the United States. We define "tranquil" and "turbulent" based on the implied stock market volatility in the United States, reported by the Chicago Board Options Exchange. The Volatility Index (VIX) measures market expectations of near-term volatility conveyed by stock index option prices. Because stock market volatility is commonly associated with periods of financial turmoil, the VIX is often referred to as an "investor fear gauge." A key advantage of using implied volatility is its forward-looking nature. A second advantage is that it is generally believed to be exogenous to emerging market economies, and thus provides a clear identification of episodes of market turbulence that constitute external shocks for these economies. Historically, the VIX has hit its highest levels during times of financial turmoil and investor fear and abated when markets recovered and investor fear subsided. It also seems to have a well-documented relationship with future recessions (IMF, 2006a). Finally, the VIX is particularly

[4] There are many other studies on both short-run and long-run linkages between the U.S. and Latin American equity markets. *(continued)*

These include Chen, Firth, and Meng Rui (2002); Fernández-Serrano and Sosvilla-Rivero (2003); and Garrett, Hyde, and Varas (2004).

[5] Gelos and Sahay (2001) and Chakrabarti and Roll (2002) carried out a similar exercise for transition economies.

relevant to the questions addressed in this chapter because of its tendency to jump during past episodes of "sudden stops" to emerging market capital inflows, as emphasized by Caballero and Panageas (2004).

A simple preliminary exercise suggests that the VIX measure of market volatility is likely to affect the behavior of U.S. markets in a nonlinear fashion, which justifies a criterion for identifying tranquil and turbulent periods based on the VIX. To see this, we estimated the following simple equation:

$$Y_t = a + \beta_1 VIX_{t-1} + \beta_2 VIX^2_{t-1} + \nu_t \qquad (1)$$

The dependent variable, Y_t, represents, in turn, the daily percentage change in U.S. stock prices, the daily percentage change in the U.S. dollar exchange rate against the euro, and the change in U.S. corporate spreads, depending on the market under consideration. The dependent variable is regressed on the lagged VIX value and the lagged VIX value squared.

Estimation results, presented in Table 8.1, show that the stock market is more likely to fall, the dollar to depreciate, and corporate spreads to widen when the VIX rises. These findings are consistent with market views that VIX values above 25 are "large" and provide the rationale for a criterion that identifies two regimes for market volatility.

Table 8.1. VIX Regressions

	Dependent Variables		
	U.S. stock price index (percentage change)	U.S. exchange rate against the Euro (percentage change)	U.S. corporate bond spreads (basis points, daily change)
Lagged VIX	0.052**	-0.0067	-0.83***
	(0.023)	(0.012)	(0.182)
Lagged VIX squared	-0.0015***	0.00015	0.021***
	(0.0005)	(0.0002)	(0.0043)
Constant	-0.332	0.075	7.156***
	(0.223)	(0.133)	(1.81)
Observations	2520	1998	2497

Sources: See appendix for data sources and definitions.

Note: *, **, and *** denote 10, 5 and 1 percent significance levels based on robust standard errors. The standard errors are in parentheses.

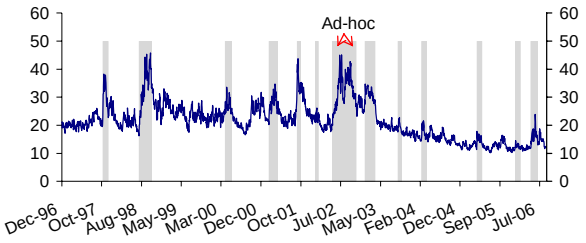
Criterion: *A turbulent period starts on the trading day when the change in the VIX is greater than three times the 20-day rolling standard deviation of the VIX as of the previous day:* [6]

$$VIX_t > VIX_{t-1} + 3\sigma_{t-1} \qquad (2)$$

The turbulent period ends on the trading day when the 20-day rolling averages of the VIX continuously decrease for at least five trading days. A tranquil period begins the day after the previous turbulent period ended.

Though chosen somewhat arbitrarily, this criterion reflects the high volatility of the VIX time series. It identifies turbulent periods that begin with sudden spikes in volatility. Setting the required jump to three times the previous day's standard deviation guarantees that we do not pick up too many turbulent periods. We also require that a turbulent period end only when the VIX has shown a clear tendency to abate. This criterion identifies 11 episodes of turbulence, represented by vertical bars in Figure 8.1, between January 1997 and August 2006 (see Benelli and Ganguly, 2007). We also chose to add two additional episodes that were not captured by our criterion because the increases in the VIX, though large, were more gradual than in other cases, and thus did not meet our criterion for turbulent periods even though visual inspection of the VIX time series reveals that the market

Figure 8.1. Implied Stock Market Volatility (VIX)



Source: See appendix for data and sources.

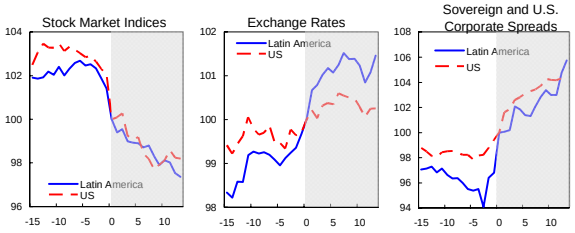
[6] The standard deviations are based on 20-day rolling averages of VIX data. We chose 20 as the typical number of trading days in a month.

underwent significant and persistent increases in volatility during these two periods (these two periods are labeled "ad hoc" in Figure 8.1).[7]

Our variables of interest are defined as follows (see Benelli and Ganguly (2007) for data sources and definitions): daily stock market returns based on percentage changes of each country's aggregate stock market index; daily percentage changes in the exchange rates of the U.S. dollar and Latin American currencies relative to the euro; daily changes (in basis points) in U.S. corporate bond spreads, defined as the difference between high-yield corporate bonds and five-year U.S. treasury bonds; and, for the Latin American countries, daily changes (in basis points) in external government debt spreads over U.S. treasuries.[8]

A preliminary look at the episodes reveals that, at least for the first few days, the onset of turbulent periods seemed to affect markets in both the United States and Latin American countries. The onset of market turbulence in the United States was generally associated with a fall in stock market indices in both the United States and Latin America, exchange rate depreciations of the dollar and Latin American currencies against the euro, and increases in U.S. corporate and Latin American government spreads (Figure 8.2). Moreover, these comovements between market movements in the United States and Latin America were quantitatively substantial. The next step is to investigate these patterns of correlation in greater detail.

Figure 8.2. Stock Market, Exchange Rates, and Spreads before and during Turbulent Periods (Day 0 = First Day of Turbulent Period; Value on the First Day of Turbulent Period = 100)



Source: See appendix for data sources and definitions.
Note: The figure shows the average values across the 13 turbulent periods and Latin American countries of the stock market indices, exchange rates against the euro, Latin American sovereign spreads, and U.S. corporate spreads before and during the turbulent period. All series are normalized so that their value at the beginning of a turbulent period is equal to 100. Argentine sovereign spreads during the time of default are not included.

Are Linkages Different in Tranquil and Turbulent Times?

We address this question by first reporting a set of standard descriptive statistics and analyzing the dynamic responses of Latin American markets to U.S. shocks using simple vector autoregressive models. We also examine the importance of U.S. market volatility for domestic market volatility.

Descriptive Statistics

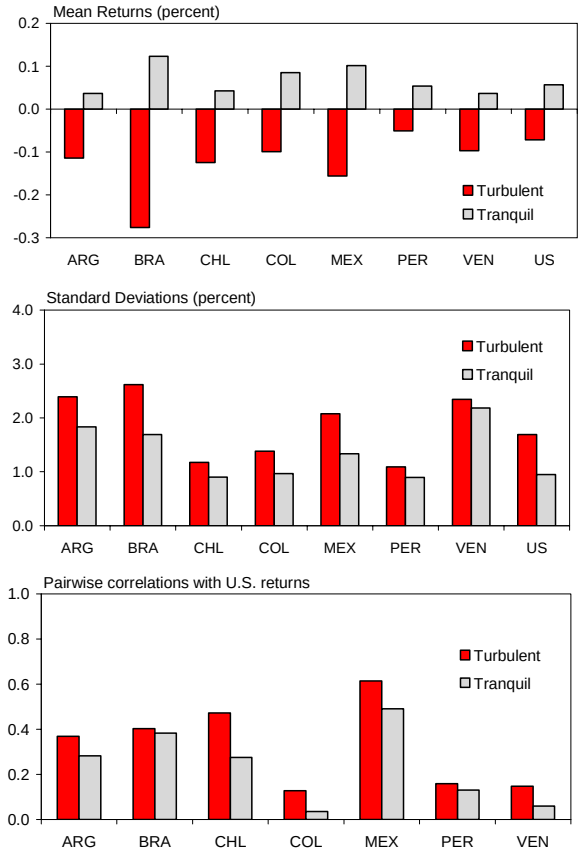
The change in market behavior across tranquil and turbulent periods is most evident for stock markets. In our sample, stock returns were negative on average and more volatile in both the United States and the Latin American countries during turbulent times (Figure 8.3 and panel A of Table 8.2). Moreover, the (unadjusted) pairwise correlations between the U.S. and the local markets increased, in line with previous evidence on stock market correlations (Sarkar and Patel, 1998). Finally, the correlations between the United States and domestic markets were larger for the largest Latin American economies (Argentina, Brazil, and Mexico).

The picture is less clear-cut for exchange rates (panel B of Table 8.2). Although some countries experienced, on average, larger depreciations during turbulent periods, this was not the case for all countries. As could have been expected, turbulent periods were associated with greater exchange rate volatility for almost all countries, including the United States, although the differences in volatilities were often small. The (unadjusted) correlations of Latin American exchange rates against the euro with the U.S. dollar–euro exchange rate were also generally large, but there was no pronounced tendency toward an increase or decrease of correlations during turbulent periods. The picture is even less clear-cut regarding sovereign spreads in

[7] We carried out our analysis with just the 11 episodes and found our results did not differ much from those obtained using the 13 episodes. Thus, we report results based on the 13 episodes only.

[8] Because exchange rates are based on the euro, our data are restricted and start from 1999.

Figure 8.3. Descriptive Statistics of Stock Market Market Returns in Normal vs. Turbulent Times



Source: See appendix for data sources and definitions.

Latin America and U.S. corporate spreads (panel C), although the volatility of spreads is greater and (unadjusted) correlations of sovereign spreads with U.S. corporate spreads, which are small to begin with, somewhat increases during turbulent periods.

Dynamic Response to U.S. Shocks

We now investigate the dynamic interdependence of financial markets using a vector autoregression (VAR) model. We split the sample into two subsamples corresponding to tranquil and turbulent periods and we estimate bivariate VARs on the United States and each of the seven Latin American countries separately for each of the two subsamples. Exogenous variables were also included in the models to control for other sources of correlation between U.S. and domestic asset markets.

More specifically, we estimated the following model:

$$X_t = \beta(L)\, X_t + \delta(L)\, Z_t + \varepsilon_t \quad (3)$$

$$X_t = \{x_t^{us}, x_t^{i}\}' \quad (4)$$

$$Zt = \{MSCI^{non\text{-}latin}, i_t^{us}, i_t^{i}\} \quad (5)$$

where X_t is a two-dimensional vector of asset returns in the United States (x_t^{us}) and a Latin American country (x_t^{i}) on day t; Z_t is a vector of exogenous variables; ε_t is a two-dimensional vector of disturbances; and $\beta(L)$ and $\delta(L)$ are polynomial lags. The number of lags for the endogenous variables was set to two or higher, depending on the statistical significance of higher lags.[9] The model structure was identical for the stock market, exchange rate, and spread correlation, except for the choice of the exogenous variables (Z_t). For illustration purposes, equation (5) shows our choice of exogenous variables in the stock market case. Here, the vector Z_t includes a nonLatin American emerging market stock index ($MSCI^{non\text{-}latin}$) and U.S. and domestic interest rates (i_t^{us} and i_t^{i}, respectively). In the model for currency markets, the vector Z_t includes domestic and U.S. interest rates, and also the daily return on a non–Latin American emerging bond index in the case of the spreads model.[10]

Provided that structural shocks are properly identified, impulse responses based on these bivariate VARs provide insight into the dynamic linkages between the U.S. and Latin American markets. Because our interest lies in the response of emerging market economies to shocks in a large economy (the United States), it is plausible to rely on a triangular Cholesky decomposition of the covariance matrix (with the U.S. variable coming first in the ordering of variables). This assumption implies that a shock to a U.S. market can have a contemporaneous (same-day) impact on a Latin

[9] The number of lags for the endogenous variables was generally found to be higher in tranquil periods. For the exogenous variables, lags higher than one were generally not significant.

[10] Although interest rates are an imperfect measure of aggregate shocks, they are a good proxy for global shifts in real economic variables or policies that affect asset market performance. Forbes and Rigobon (2002) follow a similar approach.

Table 8.2. Summary Descriptive Statistics

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	Latin America (average)	United States
A. Daily stock returns (percent)									
All sample									
Mean	0.01	0.05	0.01	0.06	0.06	0.04	0.03	0.04	0.03
Standard deviation	1.93	1.89	0.96	1.06	1.51	0.93	3.07	1.62	1.12
Correlation with the U.S.	0.31	0.40	0.34	0.08	0.54	0.14	0.06	0.26	...
Observations	2737	2737	2737	2737	2737	2737	2737	2737	2737
Turbulent periods									
Mean	-0.11	-0.28	-0.12	-0.10	-0.16	-0.05	-0.10	-0.13	-0.07
Standard deviation	2.39	2.62	1.17	1.38	2.08	1.09	2.34	1.87	1.69
Correlation with the U.S.	0.37	0.40	0.47	0.13	0.61	0.16	0.15	0.33	...
Observations	494	494	494	494	494	494	494	494	494
Tranquil periods									
Mean	0.04	0.12	0.04	0.09	0.10	0.05	0.04	0.07	0.06
Standard deviation	1.83	1.69	0.90	0.97	1.34	0.90	2.19	1.40	0.95
Correlation with the U.S.	0.28	0.38	0.27	0.04	0.49	0.13	0.06	0.24	...
Observations	2243	2243	2243	2243	2243	2243	2243	2243	2243
B. Daily exchange rate changes (percent)									
All sample									
Mean	0.07	0.04	0.01	0.03	0.01	0.01	0.10	0.04	0.01
Standard deviation	1.53	1.22	0.79	0.79	0.83	0.66	2.14	1.14	0.64
Correlation with the U.S.	0.30	0.45	0.51	0.55	0.57	0.69	0.07	0.45	...
Observations	1951	1951	1951	1951	1951	1951	1951	1951	1951
Turbulent periods									
Mean	0.00	0.10	0.03	0.07	0.02	-0.01	0.05	0.04	-0.01
Standard deviation	1.25	1.49	0.91	0.84	0.96	0.70	2.18	1.19	0.66
Correlation with the U.S.	0.42	0.39	0.50	0.54	0.54	0.66	0.14	0.46	...
Observations	403	403	403	403	403	403	403	403	403
Tranquil periods									
Mean	0.09	0.03	0.01	0.02	0.01	0.01	0.12	0.04	0.01
Standard deviation	1.61	1.15	0.77	0.77	0.80	0.66	2.16	1.13	0.64
Correlation with the U.S.	0.27	0.47	0.52	0.57	0.58	0.71	0.05	0.45	...
Observations	1548	1548	1548	1548	1548	1548	1548	1548	1548
C. Daily spread changes (basis points)									
All sample									
Mean	-0.33	-0.48	-0.06	-0.25	-0.38	-0.25	-0.51	-0.32	-0.08
Standard deviation	283.38	28.57	5.31	12.00	11.85	12.97	25.37	16.01	8.65
Correlation with the U.S.	0.06	0.13	0.01	0.01	0.00	0.14	0.06	0.06	...
Observations	1856	1856	1856	1856	1856	1856	1856	1856	1856
Turbulent periods									
Mean	-19.61	-0.93	-0.12	0.52	-0.61	0.61	-1.55	-0.35	-0.85
Standard deviation	477.52	50.40	5.42	15.21	11.07	14.66	24.13	20.15	10.89
Correlation with the U.S.	0.15	0.14	0.03	0.15	0.10	0.15	0.07	0.11	...
Observations	403	403	403	403	403	403	403	403	403
Tranquil periods									
Mean	5.02	-0.36	-0.04	-0.45	-0.31	-0.48	-0.23	-0.31	0.13
Standard deviation	201.50	18.78	5.31	11.02	12.14	12.55	25.89	14.28	7.96
Correlation with the U.S.	-0.02	0.11	0.00	-0.03	-0.05	0.12	0.02	0.03	...
Observations	1453	1453	1453	1453	1453	1453	1453	1453	1453

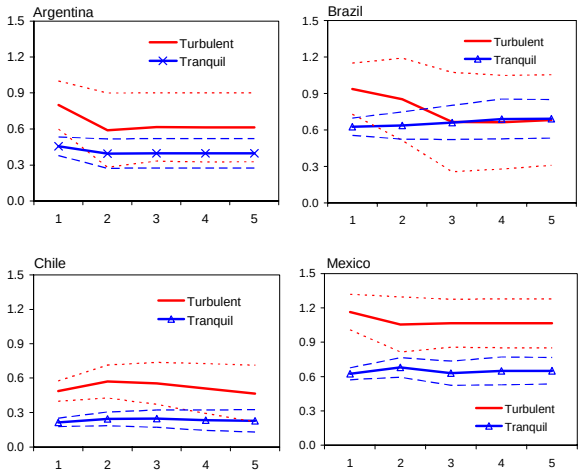
Sources: See appendix for data sources and definitions.

Note: "All sample" covers the period from January 1, 1997 through August 31, 2006. "Turbulent periods" correspond to the periods described in Section 3 of the text (dates are reported in the appendix). "Tranquil periods" correspond to the periods before turbulent periods. Latin America average of the daily spread changes does not include Argentina.

American market, while a contemporaneous effect of a shock in a Latin American market on the U.S. market is ruled out.

To compare the effect of shocks during periods characterized by different underlying volatilities, we need to define what constitutes a shock of the "same magnitude." This is because larger shocks tend to occur more frequently, in periods with high

Figure 8.4. Cumulative Response of Daily Returns to a One-Standard Deviation Shock to U.S. Returns (Tranquil vs. Turbulent Periods; in percent)



Source: Authors' calculations.

volatility, and thus it would be misleading to compare shocks of the same nominal magnitude across turbulent and tranquil times. Instead, we chose to track the response of domestic asset markets to one standard deviation shocks to U.S. returns, which controls for the fact that larger shocks are more likely in more turbulent times.

As before, we found that the stock market showed the most pronounced difference between turbulent and tranquil times. Figure 8.4 presents impulse response functions of domestic markets to a one standard deviation shock in the U.S. stock market in both turbulent and tranquil times. For Argentina, Brazil, Chile, and Mexico, the response to a U.S. shock in turbulent times lies above the response to a shock in tranquil times by a factor of up to two. For these four countries, the differences between the responses are statistically significant for at least the first day when the shock hits (two days for Chile and more than five days for Mexico).[11] In the countries for which impulse responses are not reported (Colombia, Peru, and Venezuela), the impulse response functions were generally not statistically different across turbulent and tranquil periods, although their point estimates were qualitatively similar. It is worth noting that, in both tranquil and turbulent times, the effect of shocks is larger in the three largest countries (Argentina, Brazil, and Mexico), where domestic markets also tend to overshoot in turbulent times.

Statistical results were less clear-cut for currency and bond markets, although the pattern of responses was generally similar to that documented for the stock market. For most countries, the impulse response functions for the currency market during turbulent times were generally found to be positive and stronger than the impulse response functions estimated for tranquil times for the first three days for most countries—indicating stronger depreciation in turbulent times—but the differences were not statistically significant. In the case of the government bond market, the point estimates of the impulse response functions in turbulent times lay above those estimated in tranquil times for all countries except Venezuela.

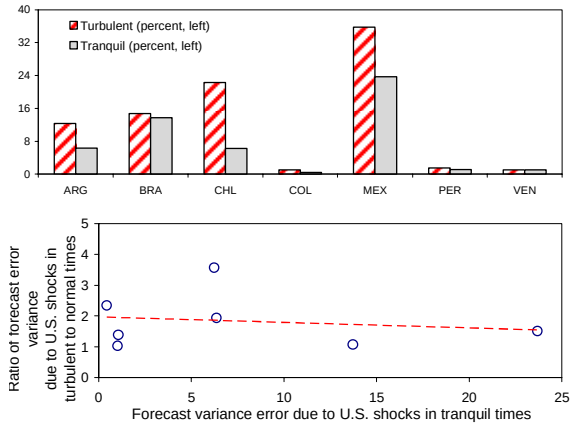
Importance of U.S. Market Volatility for Domestic Market Volatility

The forecast error variance decomposition in a bivariate model describes the proportion of the movements in an economic variable that is explained by its own (structural) shocks rather than by shocks to the other variable in the system. Thus, we use a variance decomposition exercise to determine how much of the expected volatility in a market can be attributed to domestic and foreign sources.

For stock markets (Figure 8.5), the importance of U.S. shocks for domestic market volatility varies considerably across countries. The share of forecast error variance in tranquil times that can be explained by U.S. stock returns ranges from almost nothing in Peru and Venezuela to around 25 percent in Mexico, the country where U.S. stock market volatility matters most in both tranquil and turbulent times. In Argentina, Brazil, Chile, and Mexico, the importance of U.S. stock market volatility also increased during turbulent times, with Chile being the country where the increase was highest (by a

[11] The failure to find more pronounced statistically significant differences is driven by the large standard errors found for the models estimated on turbulent times.

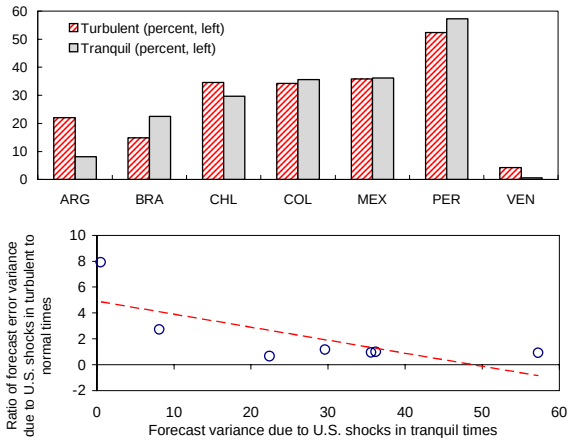
Figure 8.5. Forecast Error Variance of Stock Returns Due to U.S. Stock Return Shocks



Source: See appendix for data sources and definitions.

The top panel shows the share of the forecast variance (at a 10 day horizon) that is due to U.S. shocks in both tranquil and turbulent times. The bottom panel plots the share of the forecast error variance due to U.S. shocks in normal times (on the horizontal axis) against the ratio of the forecast error variance due to U.S. shocks in turbulent times to the forecast error variance due to U.S. shocks in tranquil times (on the vertical axis).

Figure 8.6. Forecast Error Variance of Exchange Rate Changes to U.S. Exchange Rate Shocks



Source: See appendix for data sources and definitions.

Note:The top panel shows the share of the forecast variance (at a 10 day horizon) that is due to U.S. shocks in both tranquil and turbulent times. The bottom panel plots the share of the forecast error variance due to U.S. shocks in normal times (on the horizontal axis) against the ratio of the forecast error variance due to U.S. shocks in turbulent times to the forecast error variance due to U.S. shocks in tranquil times (on the vertical axis).

factor of almost four). It is worth pointing out, however, that countries that were more sensitive to U.S. shocks during tranquil times were not necessarily those that experienced a greater increase in sensitivity to U.S. shocks in turbulent times.

As for exchange rates, the role of U.S. exchange rate shocks was generally important for the volatility of Latin American currencies, in both tranquil and turbulent times (Figure 8.6). Excluding Venezuela (where the official exchange rate was pegged against the U.S. dollar for most of the sample period), the share of forecast error variance owing to U.S. shocks in tranquil times ranged from close to 10 percent for Argentina to more than 50 percent in Peru. The share of forecast error variances owing to U.S. shocks was also high in turbulent times, but it increased for only three countries (Argentina, Chile, and Venezuela—the last from very low levels).

Finally, it is perhaps somewhat surprising that the share of forecast error variance of sovereign spreads that was explained by U.S. corporate spread shocks was generally fairly small, suggesting that, despite some similarities between these asset classes, linkages among them were not strong in our sample.

To summarize our results so far, we have noted that, for the three assets under consideration, U.S. shocks explained a larger proportion of volatility of Latin American assets during turbulent times as opposed to tranquil times. Table 8.3 summarizes our findings from the descriptive statistics, impulse response functions, and variance decompositions. These results are generally consistent with previous findings in the literature that financial linkages between the U.S. and Latin American markets are indeed different in "tranquil" and "turbulent" times, with U.S. shocks having a larger impact on Latin American markets during turbulent times.

Table 8.3. Tranquil vs. Turbulent Times (Summary of Results)

	A: Descriptive statistics during turbulent times		
Assets	Average changes	Volatility	Correlations (unadjusted)
Stocks	negative	higher	higher
Currencies	mixed	higher	lower
Bonds	mixed	higher	higher
	B: Response to U.S. shocks during turbulent times		
Stocks		greater	
Currencies		greater	
Bonds		greater	
	C: Share of market volatility explained by U.S. shocks during turbulent times		
Stocks		increases	
Currencies		increases	
Bonds		increases (but remains small)	

Source: Authors' estimates.

Have Linkages Shifted over Time?

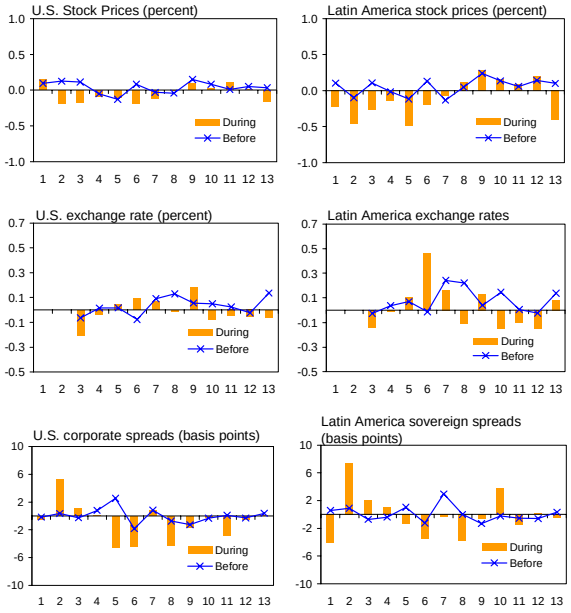
Our next objective is to study whether linkages have changed over time. To address this question, we first examine average returns and their volatility over subsequent tranquil and turbulent episodes. This

examination provides preliminary evidence on whether there has any been any clear shift in the behavior of asset markets during tranquil and turbulent episodes. Next, we return to the issue of measuring changes in correlations between the U.S. and Latin American asset markets. As mentioned earlier, the correlations between asset returns during turbulent periods need to be adjusted to overcome the problem that correlations may be biased as a result of changes in underlying asset volatilities, as pointed out by Forbes and Rigobon (2002).

Figures 8.7 and 8.8 show average returns and volatilities for the U.S. and Latin American financial markets for each of the tranquil and turbulent periods in our sample. Starting from stock prices, the figures show that the gap between average stock returns in turbulent and tranquil periods narrowed in more recent episodes (after 2003, corresponding to the eighth turbulent period). A similar pattern seems to hold for stock price volatilities as well. This pattern could suggest that the linkages between the two regions have weakened over time, although this trend appears to have reversed in the latest turbulent period in our sample (May–June 2006), when average stock returns became negative and volatilities increased compared with the preceding tranquil period.

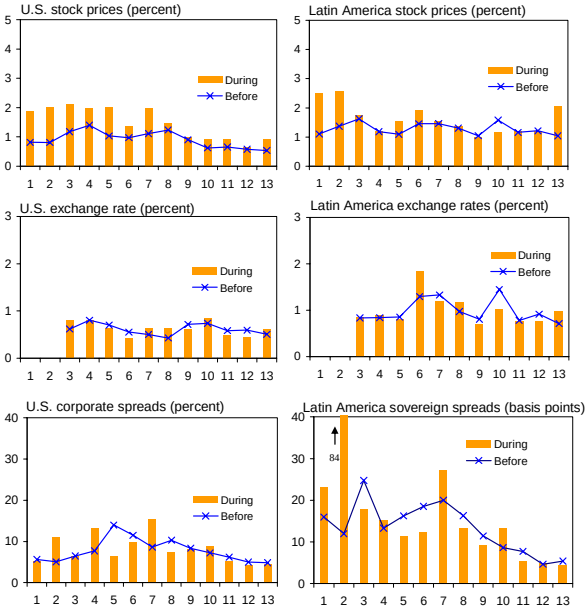
With regard to exchange rates, Latin American exchange rates over the past few years tended to appreciate against the euro during periods of tranquility and periods of turbulence. By contrast, the last episode saw both depreciations and increases in volatilities. Similar to the behavior of stock markets, movements of exchange rates tend to be larger in Latin America than in the United States, in line with evidence provided by Ganguly and Breuer (2007) showing that nominal exchange rate volatility tends to be more than three times as large in developing countries than in developed countries, even after controlling for fundamentals and different horizons.

Figure 8.7. Asset Price Changes Before and During Turbulent Period



Note: The charts show average daily changes in stock prices (in percent), in exchange rates against the euro (in percent), and in bond spreads (in basis points) for the United States and Latin America (calculated as the average across the seven included Latin American countries) for each of the 13 turbulent periods ("during") and each of the tranquil periods preceding the turbulent periods ("before").

Figure 8.8. Asset Price Volatilities Before and During Turbulent Period



Note: The charts show standard deviations of daily changes in stock prices (in percent), in exchange rates against the euro (in percent), and in bond spreads (in basis points) for the U.S. and Latin America (calculated as the average across the seven included Latin American countries) for each of the 13 turbulent periods ("during") and each of the tranquil periods preceding the turbulent periods ("before").

Finally, the bond markets in Latin America were far less volatile in more recent years (see also IMF, 2006b). Moreover, there was no specific pattern in their comovements with the U.S. corporate bond market.

We now turn to a more formal analysis of correlations. We rely on the Forbes and Rigobon (2002) methodology to correct for the fact that standard correlation coefficients are conditional on the actual value of market volatility, and thus may be biased. Because turbulent periods are typically characterized by increased volatility, "the conditional correlation coefficient (the unadjusted correlation coefficient) will tend to increase after a crisis, even if the unconditional correlation coefficient (the underlying cross-market relationship) is the same as during more stable periods" (Forbes and Rigobon, p. 11). Therefore, a test based on the unadjusted correlation may be biased upward, that is, it may show a spurious increase in correlations. Without adjusting for this bias, one cannot deduce if increases in unadjusted correlation represent increases in correlations or instead increases in market volatility.

The first step to properly measure correlations is to estimate bivariate VARs for two subsamples corresponding to turbulent and tranquil periods. We use the same VAR models as in the section, "Are Linkages Different in Tranquil and Turbulent Times?" Specifically, for each of the three markets under consideration, a model is estimated for the U.S. variable and the corresponding variable in the domestic Latin American market. These models provide estimates of the variance-covariance matrices during the tranquil and turbulent periods. The variance–covariance matrices are in turn used to calculate the adjusted cross-market correlation coefficients for each set of countries and periods. Forbes and Rigobon (2002) show that, if there is an increase in volatility in the U.S. asset returns during the turbulent period (measured by the variance of the structural shocks in the VAR model), that is, $\sigma^2_{H,US} > \sigma^2_{L,US}$, there can be an increase in the calculated sample correlations between the U.S. and Latin American returns. To adjust for this bias, Forbes and Rigobon propose an "unconditional" (adjusted) correlation, calculated as follows:[12]

$$\rho_t = \frac{\rho_t^c}{\sqrt{1+\delta_t\,[1-(\rho_t^c)^2]}} \tag{6}$$

where ϱ is the adjusted correlation coefficient, ϱ^c is the conditional (unadjusted) correlation coefficient, and δ is the relative increase in the variance of the U.S. asset:

$$\delta = (\sigma^2_{H,US} \,/\, \sigma^2_{L,US}) - 1 \tag{7}$$

After the adjusted correlation coefficients were transformed with a Fisher transformation (to ensure that they are normally distributed), standard tests can be used to examine whether the adjusted correlation changes significantly during turbulent periods compared with the tranquil period. More specifically, we can test the null hypothesis

$$H_0: \ \varrho_H = \varrho_L \tag{8}$$

against the alternative hypothesis

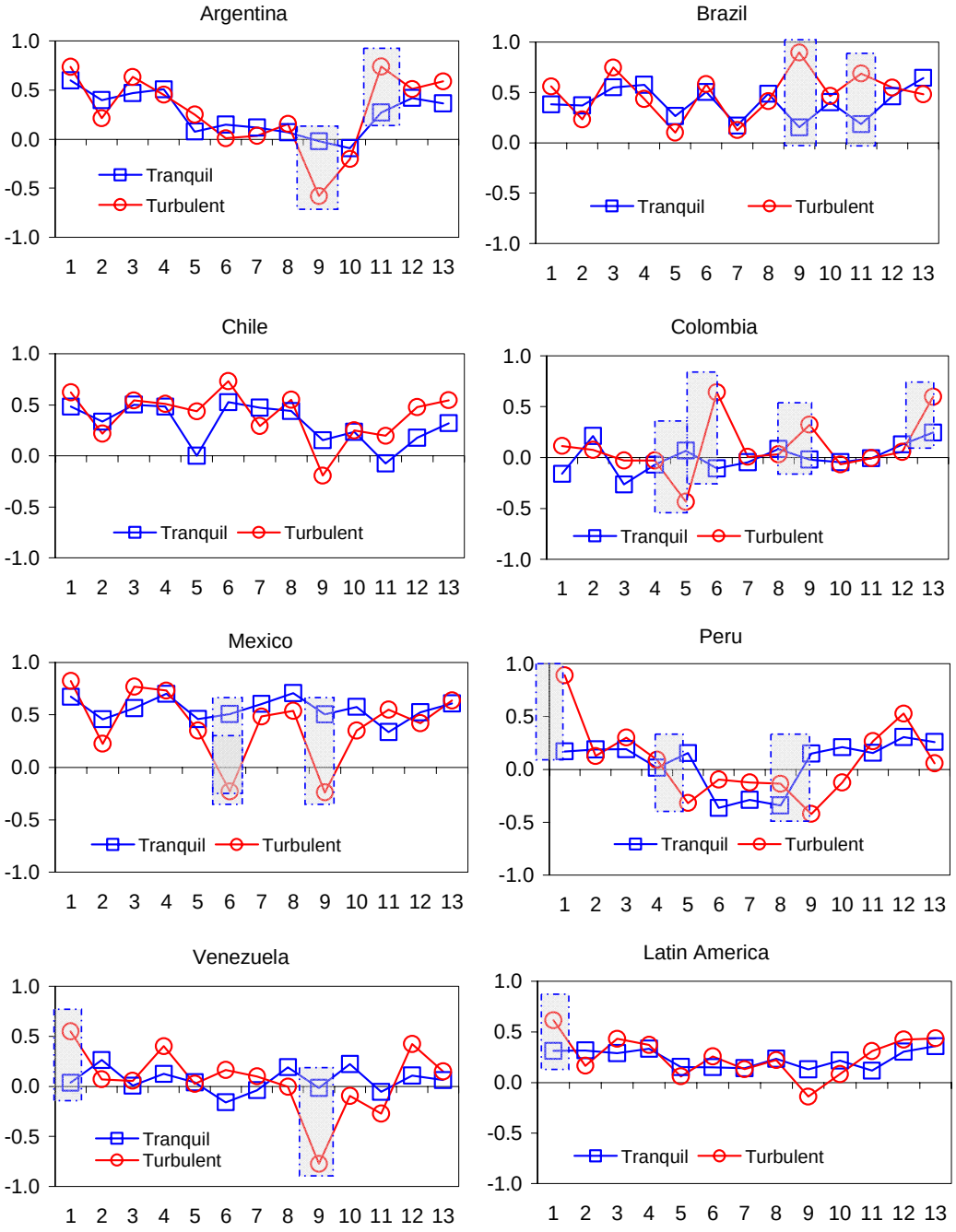
$$H_1: \ \varrho_H \neq \varrho_L. \tag{9}$$

Rejection of the null hypothesis indicates a significant change in cross-market linkages.

The results suggest the presence of significant changes in correlation, although there are differences among stock, currency, and bond markets. For stock markets, although correlations between the U.S. and Latin American stock markets declined over time during the earlier part of our sample period, they increased during recent turbulent episodes (and especially during the episode corresponding to the spring of 2006; Figure 8.9). The most obvious changes in cross-market linkages during turbulent episodes are found in currency markets, however, with correlations increasing in many (but not all) instances during turbulent times (Figure 8.10). It is thus interesting that the turbulent episode in 2006 saw a decline in correlations for most countries (during both tranquil and turbulent

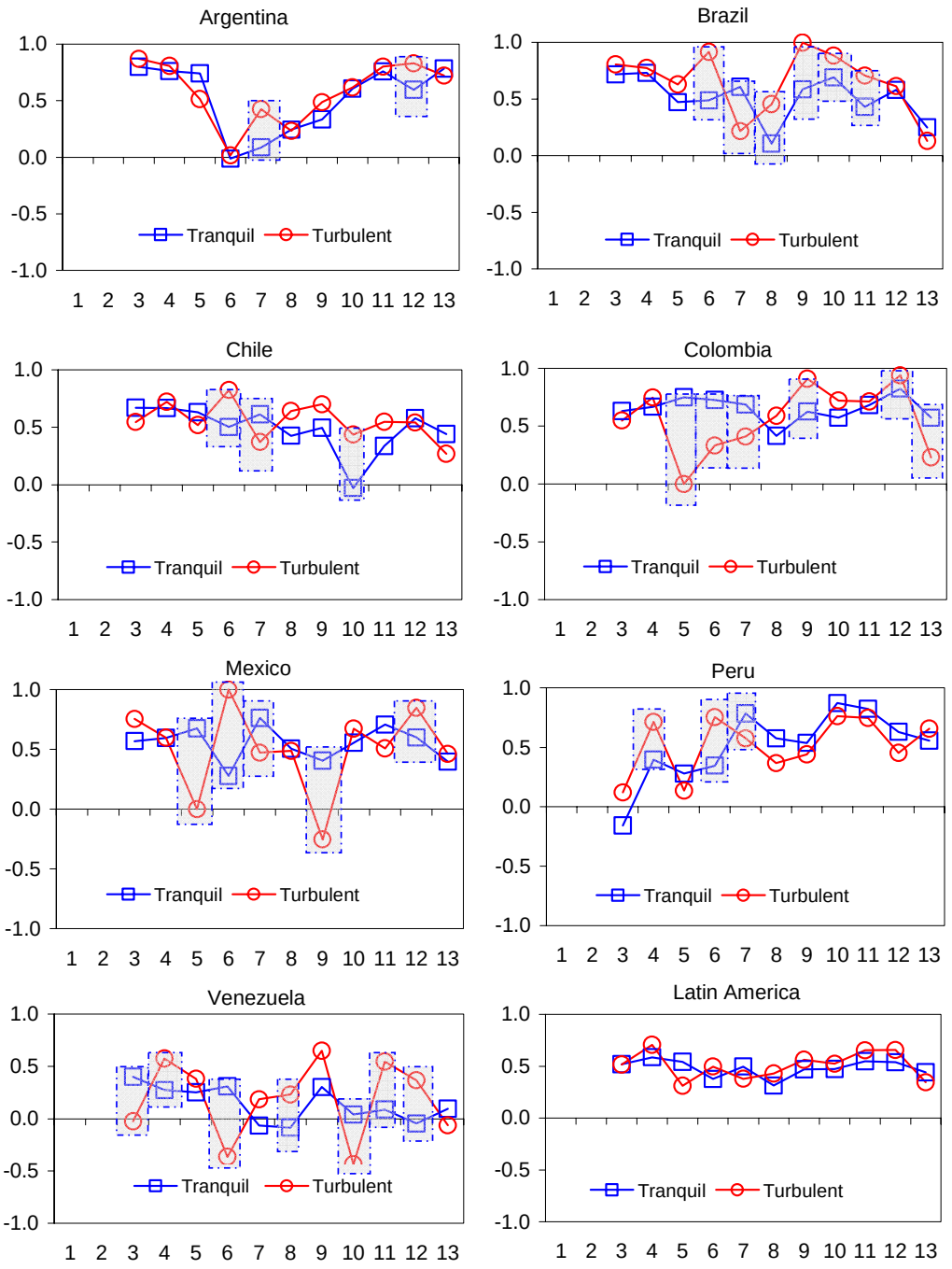
[12] Equation (6) assumes that there is no endogeneity or omitted-variable bias.

Figure 8.9. Adjusted Correlations Between Stock Changes



Note: The charts show the adjusted correlations between daily price changes in the U.S. and each Latin American country during each turbulent period and the tranquil period preceding each turbulent period. The adjustment is made according to the Forbes-Rigobon (2002) methodology. The shaded boxes indicate statistically different correlations. For Latin America, averages of the seven countries are reported.

Figure 8.10. Adjusted Correlations Between Exchange Rate Changes



Note: The charts show the adjusted correlations between daily changes in exchange rates against the euro for the U.S. and each Latin American country during each turbulent period and the tranquil period preceding each turbulent period. The adjustment is made according to the Forbes-Rigobon (2002) methodology. The shaded boxes indicate statistically different correlations. For Latin America, averages of the seven countries are reported.

periods), which is consistent with higher exchange rate flexibility in the region. Finally, no significant pattern emerges for bond markets, because correlations were generally low over time and across countries (with some exceptions).

This evidence leads us to tackle more directly our initial question: whether recent episodes of market turbulence suggested a shift in the pattern of cross-country financial linkages. More specifically, we compare the sensitivity of Latin American markets to the U.S. market during the May–June 2006 turbulence with the 12 previous episodes of turbulence. We do this by estimating the following equation for two samples, one covering the first 12 turbulent episodes and one only the 2006 episode:

$$Y_t = \alpha + \beta Y_t + \gamma US_t + \eta US_t * DUM + \\ + \mu X_t + \mu X_t * DUM + \upsilon_t \quad (10)$$

This equation was estimated for each of the seven Latin American countries and for each of the three assets under consideration. The dependent variable, Y_t, represents the daily percentage change in domestic stock prices, the daily percentage change in the domestic exchange rate against the euro, or the change in domestic sovereign spreads, depending on the market under consideration. The dependent variable is regressed on its lagged value, the percentage change in the corresponding U.S. variable (in the case of the bond markets, the change in U.S. corporate spreads is used), and a variable X_t that captures other potentially relevant factors that can affect asset price changes, such as the percentage change in non-Latin MSCI stock market indices for the stock market case; domestic and U.S. interest rate differentials for the currency market case; and the change in non-Latin government spreads for the bond market. Finally, to test whether the behavior of domestic markets changes during turbulent times, the coefficients on the right-hand-side variables (other than the lagged endogenous variable) are interacted with a dummy variable that takes a value of one during turbulent times and zero otherwise. Equation (10) is estimated using White heteroscedasticity-consistent standard errors and covariance.

The main findings can be summarized as follows (see Benelli and Ganguly (2007) for a full set of results):

- Although the sensitivity of Latin American stock markets to the U.S. stock market was generally higher in turbulent periods than in tranquil periods that preceded them, the increase during the 2006 market turbulence was much more pronounced. There is also evidence that, after controlling for the U.S. market, the direct linkages between Latin and non-Latin emerging markets tended to remain unaffected in turbulent times during all episodes.
- As for the foreign exchange markets, there is less evidence of changes in the strength of linkages with the U.S. dollar during turbulent times. However, in some countries (Brazil, Chile, and Mexico), the estimated coefficient for the impact of the U.S. exchange rate decreased somewhat during the last episode.
- Despite the fact that sovereign spreads in Latin America were hardly correlated with U.S. corporate spreads in tranquil times, their sensitivity to U.S. corporate spreads tended to increase during turbulent times. This pattern was also observed during the last turbulent period in 2006, although estimates are generally imprecise. On the other hand, there was no clear-cut pattern in the correlations between Latin and non-Latin emerging market spreads. However, compared with previous episodes, sovereign spreads in Latin America were more sensitive to changes in non-Latin emerging spreads during the most recent episode in our sample.

It appears that the most recent episode of market turbulence in our sample (May–June 2006) stood out from preceding ones; Latin American stock markets showed increased sensitivity to U.S. stock market shocks, reversing a trend of weakening linkages. On the other hand, currency markets in

Latin America exhibited a decrease in cross-market linkages with the United States over our sample, likely reflecting greater exchange rate flexibility.[13] Compared with other financial markets, sovereign bond markets in Latin America were weakly linked with U.S. corporate bonds, while there was an increase in sensitivity to movements in other emerging market bond markets, signaling the increasing consolidation of emerging markets into an asset class of their own. Increased market integration across financial markets and a move toward increased exchange rate flexibility (often in the context of inflation targeting regimes) suggests that these features of market response under stress may be observed in future episodes of market turbulence. Indeed, the behavior of global financial markets during February–March 2007—and subsequently during June–August, although these episodes were still unfolding at the time of writing—would seem broadly consistent with this hypothesis (see IMF (2007) for a review of events during February–March 2007).

Conclusions

This chapter investigated the linkages between the United States and Latin America for stock, currency, and bond markets from 1997 to 2006. We proceeded in four steps. First, we identified periods of market volatility or "turbulence" in the United States, based on a criterion linked to implied stock market volatility in the United States, as a measure of global market turbulence. Second, impulse response functions and variance decompositions allowed us to examine whether the sensitivity of Latin American financial markets to U.S. shocks changed during turbulent periods. Third, after documenting that cross-country linkages indeed seemed to differ in tranquil times and turbulent times, we investigated whether financial linkages between the United States and Latin American countries have changed over time, following Forbes and Rigobon (2002). Finally, we compared our last sample episode of volatility in the United States (the one during May–June 2006) with previous episodes, and analyzed whether the last bout of turbulence was "abnormal."

We singled out 13 episodes of market turbulence. We found evidence that, during turbulent times, market behavior was generally different than during tranquil times. In particular, there was increased sensitivity of financial markets in Latin America to shocks in the United States. In stock markets, the amount of volatility in Latin American markets explained by U.S. market volatility doubled on average during turbulent over tranquil times.

The examination of adjusted pairwise correlations, using the Forbes-and Rigobon (2002) methodology, showed that currency markets were more prone than other asset markets to experiencing shifts in linkages with U.S. markets during periods of turbulence. Moreover, the last two episodes of market turbulence stood out from preceding ones because they were characterized by increased sensitivity of Latin American stock markets to U.S. stock market shocks, in contrast to previous episodes that had shown a trend of weakening linkages. On the other hand, currency markets in Latin America exhibited a decrease in linkages with the United States, which could be consistent with greater exchange rate flexibility in the region than in the earlier part of the sample. Compared with other financial markets, the sovereign bond markets in Latin America appeared only weakly linked with U.S. corporate bonds, although their sensitivity to movements in other emerging market bond markets appears to have recently increased.

The evidence in this chapter suggests that financial linkages between the United States and Latin America were different during periods of financial volatility in the United States. A natural extension and an avenue for future research is to identify potential transmission channels for these spillovers and to analyze if these channels have changed in importance over time.

[13] This result is consistent with our earlier findings using the adjusted correlations analysis and is consistent with results presented in IMF (2006c, Box 1).

Appendix. Turbulent Episode Dates

#1: from 10/27/1997 to 12/03/1997

#2: from 07/21/1998 to 10/15/1998

#3: from 04/04/2000 to 05/17/2000

#4: from 02/20/2001 to 04/19/2001

#5: from 09/12/2001 to 10/07/2001

#6: from 01/29/2002 to 02/15/2002

#7: from 06/03/2002 to 11/15/2002

#8: from 01/24/2003 to 04/07/2003

#9: from 09/22/2003 to 10/14/2003

#10: from 03/10/2004 to 04/12/2004

#11: from 04/15/2005 to 05/19/2005

#12: from 01/20/2006 to 02/23/2006

#13: from 05/12/2006 to 06/27/2006

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Chapter 9

Real Implications of Financial Linkages Between Canada and the United States

Vladimir Klyuev

The ongoing turmoil in global financial markets has underscored the importance of financial linkages between countries as well as the impact of financial conditions on real economic activity. This chapter develops a simple empirical framework to explore these issues, using the example of two closely integrated economies: Canada and the United States.

With over three-quarters of Canadian merchandise exports destined for the United States, the implications of trade linkages between the two countries for Canada's business cycle have been studied extensively (see, for example, Ambler, Cardia, and Zimmermann, 2004). Much less examined are the implications of financial linkages, even though they are also quite substantial. This chapter documents the extent of financial linkages and explores the impact of changes in U.S. financial conditions on financial conditions and real economic activity in Canada.

We consider three ways in which a tightening in U.S. financial conditions could have an impact on real GDP growth in Canada. First, tighter financial conditions would slow the U.S. economy, leading to a reduction in demand for Canadian exports. We call this a *trade* channel. Second, tighter financial conditions in the United States tend to lead to tighter financial conditions in Canada. This could result from Canadian monetary policy following that of the United States, or from capital mobility between the two countries. Tighter financial conditions in Canada make it more expensive for Canadian firms to raise funds for investment and for working capital, resulting in slower economic activity. We term this an *indirect financial* channel. Finally, Canadian firms raising capital in the United States will be directly affected by tighter financial conditions there. This is a *direct financial* channel.

The empirical methodology we use to study these responses is based on structural vector autoregression (SVAR). In our baseline we employ a widely used three-variable system (inflation, real GDP growth, short-term interest rate) for each country. Unlike in single-country work, we link these systems through a *block exogeneity* assumption, under which U.S. variables can affect Canadian variables, but not the other way around, which appears to be a reasonable approximation given the relative size of the two economies. We find a substantial impact of changes in U.S. real GDP growth and interest rates on both real GDP growth and interest rates in Canada. The impact of tighter U.S. financial conditions on Canada's output growth is effected primarily through the financial channel, with the direct channel more important in the short term and the indirect channel in the medium term. A number of extensions show the robustness of these findings and yield several other interesting results.

This chapter is organized as follows. The next section examines the extent to which Canadian corporations rely on the United States for funding. We then lay out an econometric framework for exploring real and financial linkages between the two countries and present the results of our basic specification. Next we explore the transmission mechanism of U.S. financial shocks to Canadian real activity, focusing on the decomposition of the impulse response into the three channels, and then we provide several extensions and robustness checks. The last section concludes.

Financial Linkages

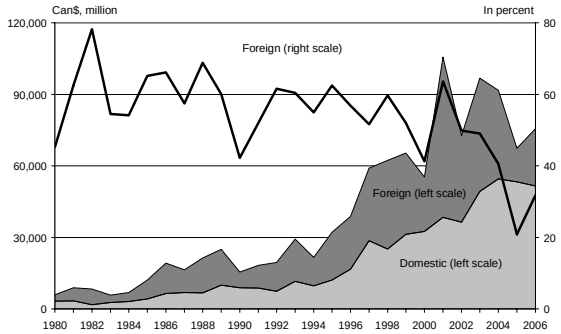
Given their geographic proximity, the extent of financial flows between Canada and the United States is hardly surprising. The stock of U.S. claims

on Canadian assets equaled 53 percent of Canada's GDP at the end of 2006. The commonalities of language, culture, and business environment as well as openness to trade in goods, services, and assets facilitate cross-border flows of capital. In addition, the size and sophistication of U.S. financial markets make them an attractive source of capital, because they may offer features and liquidity not available in Canada.[1]

In Canada, banks are the main source of short-term corporate credit, whereas long-term financing is dominated by equity (38 percent of long-term corporate liabilities outstanding at the end of 2006) and bond financing (34 percent), with the rest accounted for by trust units, rapidly growing securitization, and other vehicles.[2] The reliance of Canadian nonfinancial corporations on U.S. financing is documented in Freedman and Engert (2003), who show that in the early 2000s just under 40 percent of outstanding Canadian corporate bonds were issued in the United States, while the share of foreign (primarily U.S.) placement of new Canadian stocks was about 20–25 percent.

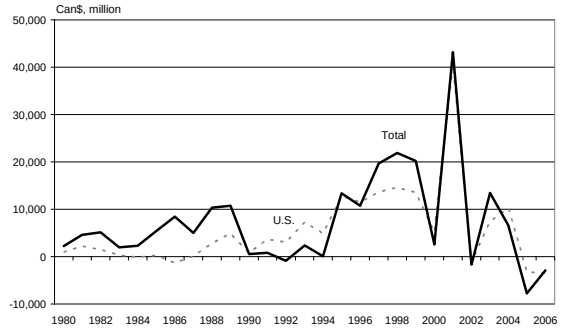
More recent data confirm these findings. Figure 9.1 shows that, in the 2000s, Canadian corporations relied on foreign markets for 20 to 60 percent of their bond issuance. Of course, "foreign" does not necessarily mean "U.S.," but it is a received wisdom that for Canada it largely does—a fact that is confirmed by a close correspondence between the net issuance of U.S. and all foreign bonds by Canadian corporations, particularly since the mid-1990s (Figure 9.2). The percentage of Canadian stocks held by U.S. residents has stayed between 15 and 20 percent in recent years (Figure 9.3). According to Bank for International Settlements data, foreign loans account for 20 to 40 percent (depending on whether mortgage lending is included or excluded) of total bank loans to the Canadian nonbank sector (Figure 9.4), although the share of U.S. banks in that number is not clear.

Figure 9.1. Canadian Corporate Bonds: Gross New Issues



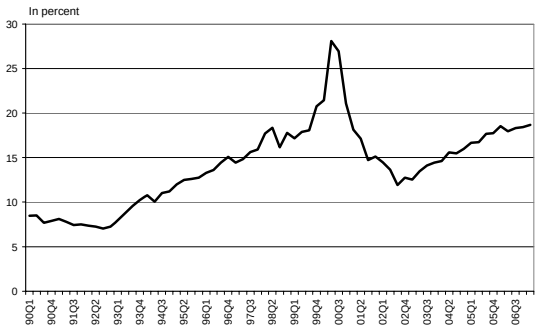
Sources: Bank of Canada; and IMF staff calculations.

Figure 9.2. Net Issuance of Foreign Bonds by Canadian Corporations



Sources: Bank of Canada; and IMF staff calculations.

Figure 9.3. Shares of Canadian Companies Held by U.S. Residents

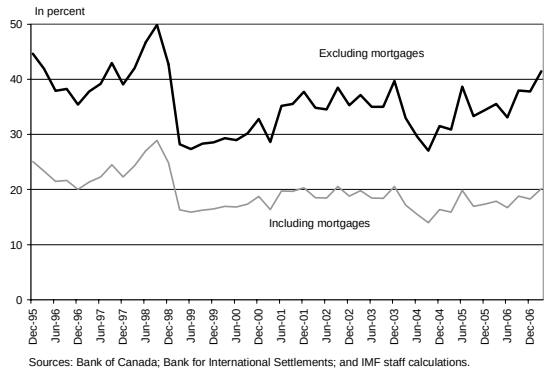


Sources: Haver Analytics; and IMF staff calculations.

[1] For example, the market for high-yield bonds is virtually nonexistent in Canada (Calmès, 2004).

[2] Income trusts are flow-through entities that became popular in Canada in the late 1990s and particularly early this decade because of their tax advantages.

Figure 9.4. Foreign Share in Loans to the Canadian Nonbank



Sources: Bank of Canada; Bank for International Settlements; and IMF staff calculations.

All in all, it appears that about one-quarter of Canadian corporations' financing is raised south of the border. This sizable dependence on U.S. funding sources gives rise to the vulnerability of Canada's real economy to changes in U.S. financial conditions.[3] Canadian firms and households may also be exposed to U.S. financial conditions through their holdings of U.S. assets, which have increased in recent years.

Empirical Analysis

We now proceed to examine empirically the links between financial conditions in the United States and real activity in Canada. We start by running a simple six-variable SVAR that includes the consumer price index (CPI) inflation rate, the real GDP growth rate, and the three-month treasury bill rate for each country. The interest rate is our measure of financial conditions. The growth rate and the inflation rate are the measures of economic activity that both affect (including through the monetary policy reaction function) and are affected by the interest rate.

Given the relative economic size of the two countries, we assume that Canadian variables do not have an effect on U.S. variables, either simultaneously or with lags. This *block exogeneity* assumption (Hamilton, 1994, p. 309), similar to the approach taken by Cushman and Zha (1997) and by Dungey and Pagan (2000), reduces the number of parameters that require estimation and thus allows more precise estimates.

Within each block, we make the standard assumption of the following ordering of the variables: inflation, real growth, and the interest rate. Inflation is the most inertial variable. The interest rate, as a financial variable, moves the fastest. It reflects, among other things, monetary policy or anticipation thereof, based (at least in part) on growth and inflation. Given the lags in monetary policy transmission, the interest rate reacts faster to the shocks to output and inflation than the latter react to changes in the interest rate. This ordering is quite popular in the literature, although it is by no means unique or without critics.[4]

In terms of cross-linkages, we allow U.S. variables to have a simultaneous impact on corresponding Canadian variables as well as on the Canadian variables that come later in the ordering. So, for example, a shock to the U.S. real GDP growth will simultaneously affect the U.S. interest rate, Canada's real GDP growth, and Canada's interest rate, but not U.S. or Canada's inflation rate. There are no restrictions on the impact of lagged U.S. variables on U.S. or Canadian variables.

We use quarterly data from the first quarter of 1983 through the first quarter of 2007, aiming to have as many observations as possible, but confining our sample to within the epoch of the "great moderation" (Stock and Watson, 2003), because the macroeconomic environment was quite different in the preceding period. Inflation and output growth are annualized quarterly growth rates of seasonally adjusted CPI and real GDP series. With quarterly data, four is a natural choice for the number of lags in the vector autoregression (VAR).[5]

The impulse responses of U.S. variables to U.S. shocks follow a familiar pattern. A shock to the inflation rate leads to a spike in inflation, a drop in

[3] Klyuev (2008) presents a simple model of a link between U.S. financial conditions and Canadian output.

[4] See Christiano, Eichenbaum, and Evans (1999) for a discussion of various identification schemes.

[5] The results for the six-variable model were very similar when only three lags were used.

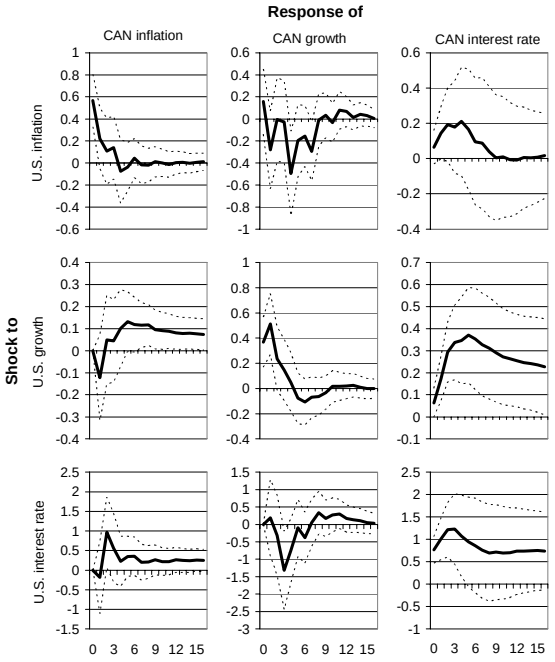
output, and higher interest rates. A shock to GDP growth pushes inflation, output growth, and interest rates up. A spike in the interest rate is quite persistent and leads over time to lower output growth. The only perverse response is a rise in inflation in reaction to a positive interest rate surprise, but this price puzzle is by no means unique to this chapter. All in all, this set of impulse responses conforms with our priors and gives us fair confidence that U.S. shocks are identified reasonably well (see Klyuev, 2008, for a full set of VAR results).

The responses of Canadian variables to Canadian shocks are also consistent with the literature, albeit slightly different from the responses of U.S. variables to U.S. shocks. Inflation shows less persistence than in the United States, and the impact of inflation shocks on output growth and the interest rate is small. The magnitude of inflation and interest rate responses to output shocks is also insignificant. This may reflect the open character of the Canadian economy—domestic shocks play a relatively minor role— and inflation expectations being well anchored for most of the sample period by the inflation-targeting regime. The price puzzle is present but much less pronounced than in the United States. The output response to changes in the interest rate appears somewhat more sluggish.

However, the focus of our attention is on the responses of Canadian variables to U.S. shocks presented in Figure 9.5. The solid lines represent impulse responses, and the dashed lines confine analytically constructed 95-percent confidence bands.[6] The magnitude of a shock is one unit of the corresponding variable, that is, one percentage point. The responses are calculated for 16 quarters.

Confirming the conventional wisdom, we find a strong response of Canada's real GDP to a shock to the U.S. GDP growth (Figure 9.5, row 2, panel 2), peaking at about one-half of the size of the U.S. impulse. We can also see that tighter financial conditions in the United States tend to lead to tighter financial conditions in Canada (bottom right panel), in line with anecdotal evidence. An increase in the U.S. interest rate leads to an approximately equal rise in the Canadian rate. This does not mean that the Bank of Canada follows the stance of the U.S. Federal Reserve irrespective of the cyclical positions of the two economies—the interest rate shock in our system is orthogonal to the systematic response of monetary policy to fluctuations in output and inflation. A key finding, which we probe more deeply in the next section, is the fact that a tightening of financial conditions in the United States leads to a statistically significant reduction in real GDP growth in Canada (bottom row, panel 2).

Figure 9.5. Impulse Response Functions in the Basic Model Cross Block



Source: Author's calculations.
Note: Solid line - impulse response functions; dashed lines - 95 percent confidence bands.

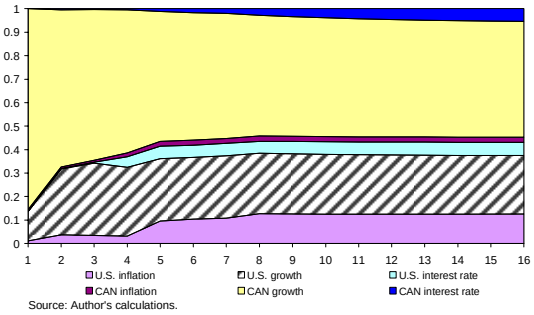
Variance decomposition analysis (Figure 9.6) demonstrates that foreign shocks are an important source of variation in Canada's real GDP growth, accounting for more than 40 percent of forecast error variance at horizons longer than a year. Within that group, shocks to U.S. output growth are the most significant.

"Gratuitous" interest rate volatility—changes that are not identified as responses to demand or supply

[6] Confidence bands constructed using parametric bootstrap are virtually indistinguishable from analytical ones.

shocks and hence captured as interest rate shocks in the econometric model—was quite low in the sample period.[7] U.S. interest rate shocks account for slightly more than 5 percent of the forecast error variance for Canada's real GDP growth at horizons over one year. At the same time, as our results indicate, a large financial shock in the United States would have a substantial impact on the Canadian economy.

Figure 9.6. Shares of Forecast Error Variance of Canada's Real GDP Growth



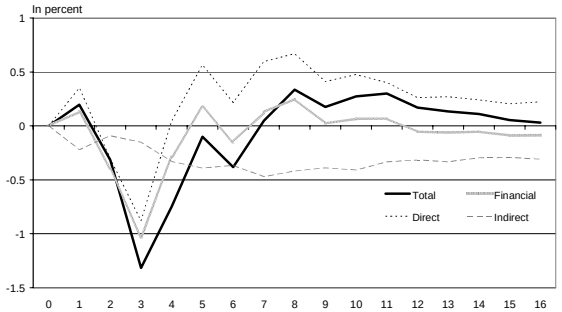
Source: Author's calculations.

Transmission of U.S. Financial Shocks to Canada

As discussed earlier, the negative response of the Canadian real GDP growth to an increase in the U.S. interest rate may come through a trade channel as well as direct and indirect financial channels. In our simple model (see Figure 9.5), we can characterize the *trade channel* by the reaction of Canadian GDP to lower growth in the United States, mainly through lower demand for Canadian exports (row 2, panel 2). Higher interest rates in the United States also tend to lead to higher interest rates in Canada, which in turn dampen output (*indirect financial channel*). The *direct financial channel* would primarily reflect a reduction in investment by Canadian firms using U.S. financing and represent a slowdown in Canada that is not ascribed to lower U.S. growth or higher Canadian interest rates.

In Figure 9.7, we decompose the total response of Canada's growth to a 1 percentage point shock to the U.S. interest rate (Figure 9.5, row 3, panel 2) into these individual channels. To isolate the financial channels, we shut down the trade channel by setting to zero the coefficients of Canadian variables on contemporaneous and lagged U.S. growth in the SVAR.[8] The result is shown by the solid gray line. We can observe that the bulk of the impact of higher U.S. interest rates on Canadian growth, particularly in the short run, comes through the financial rather than the trade channel.

Figure 9.7. Decomposition of Impulse Response of Canada's Real GDP Growth to One Percentage Point Increase in U.S. Three-Month T-Bill Rate in Baseline Regression



Source: Author's calculations.

To isolate the direct financial channel (the dotted line in Figure 9.7), we shut down the indirect channel by holding the Canadian interest rate constant.[9] The indirect channel (the dashed line) is then obtained as a residual. The direct channel accounts for most of the short-run decline in output growth but switches to positive over the medium term. Given the way our experiment is set up, we interpret this as follows: facing constant U.S. demand, unchanged Canadian interest rates, but higher U.S. interest rates, Canadian firms that rely primarily on the United States for their funding initially reduce their output and investment; later, however, they can switch to alternative sources of finance (domestic credit or retained earnings) and make up some of the lost ground. The indirect

[7] Whereas the standard deviations of the U.S. interest rates and real GDP growth rates were very close in the sample period (2.3 percentage points and 2.2 percentage points, respectively), the standard deviation of the *shocks* to the U.S. interest rate was estimated at 0.3 percentage point—quite a bit lower than 1.8 percentage points for U.S. real GDP growth.

[8] Shutting down the trade channel by setting the coefficients of only Canada's GDP growth on U.S. growth to zero or by holding U.S. growth constant yields nearly identical results.

[9] Disallowing only the response of Canada's interest rate to the U.S. interest rate results in a virtually identical decomposition.

channel is relatively small but quite persistent, keeping growth near the trend in the medium term by offsetting the rebound in the direct channel.

We conclude that U.S. financial conditions are quite important for Canada—a 1percentage point increase in the short-term interest rate in the United States leads to a decline in real GDP growth in Canada of up to 1¼ percentage points. The impact is largely fed through the financial channel, in the first instance affecting the firms relying on U.S. funding, and with more lingering effects through tighter financial conditions in Canada.

Sensitivity Analysis and Extensions

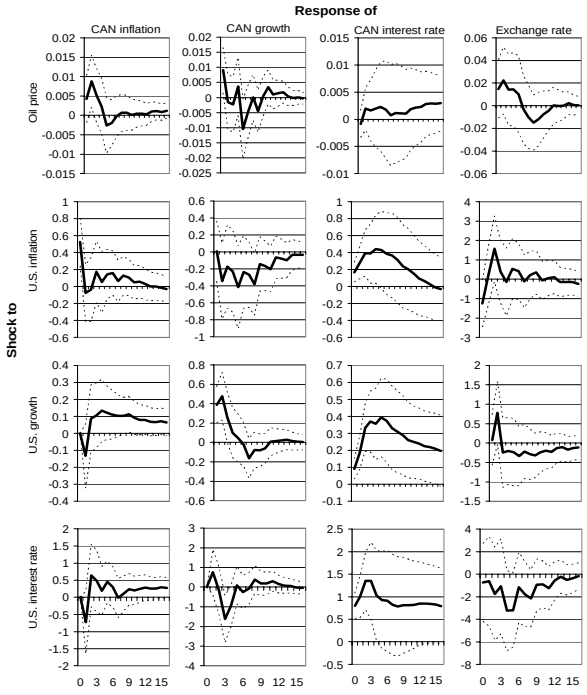
Including the Oil Price and the Exchange Rate

We expand our system to include two macroeconomic variables that are particularly relevant for an open, commodity-exporting economy like Canada: the oil price and the exchange rate. The oil price is an important driver of inflation in both Canada and the United States. It can also affect output. Sims (1992) suggested that including oil prices in VARs can improve the identification of monetary shocks. The value of the freely floating Canadian dollar plays the role of a shock absorber for Canada, reacting to commodity price movements and other developments differentially affecting Canada and the United States.

We include in our model the annualized quarterly growth rates of the West Texas Intermediate oil price and the price of the Canadian dollar in U.S. dollars. The oil price is placed in the U.S. block, first in the ordering, and assumed to be able to affect simultaneously all Canadian variables as well as all U.S. variables, and not to be affected by Canadian variables. On the assumption that the exchange rate is the fastest-moving variable, it is placed last in the Canadian block. As before, we show only the impulse response functions of Canadian variables to shocks originating in the U.S. shock. For a full set of charts, see Klyuev (2008).

The inclusion of oil prices does not change substantially the impulse responses of the other variables. It does reduce the magnitude of the price puzzle (an upward jump in inflation in response to a positive interest rate shock) by almost a half, but does not eliminate it completely. As expected, a positive demand shock in the United States pushes oil prices up. Higher oil prices lead to higher inflation and interest rates in both the United States and Canada.[10] They also push down real GDP growth in the United States, while the impact on Canada is close to zero on average, reflecting Canada's endowment in hydrocarbon resources (Figure 9.8).

Figure 9.8. Cross Block with Oil Price and Exchange Rate Included



Source: Author's calculations.
Note: Solid line - impulse response functions; dashed lines - 95 percent confidence bands.

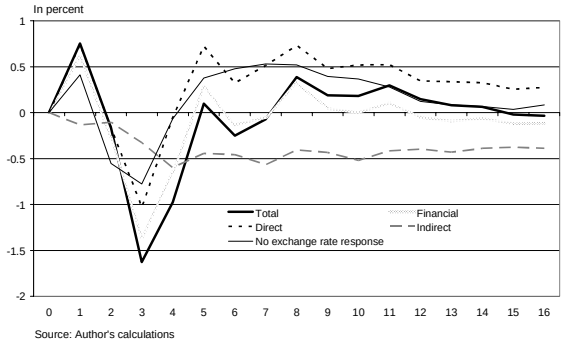
The impulse responses involving the exchange rate also look largely as expected. The Canadian dollar appreciates after a shock to the Canadian interest rate (although after an initial drop) and after positive shocks to output or inflation (probably reflecting

[10] The effect on Canada is smaller, probably because of higher gasoline taxes in that country and the tendency of its currency to appreciate on higher oil prices.

expectations of tighter monetary policy in response). It also appreciates in response to a rise in oil prices, which is a terms of trade improvement for Canada. A shock to the U.S. interest rate leads to a depreciation of the Canadian dollar. A positive shock to the exchange rate (an appreciation) leads on average to a slight decrease in Canada's interest rate (consistent with the Bank of Canada policy of counteracting exchange rate movements not caused by changes in the demand for Canadian goods and services) and depresses Canadian output. Perversely, inflation appears to pick up in Canada in response to currency appreciation—another manifestation of the price puzzle.

The profile, magnitude, and decomposition of the impulse response of Canada's GDP growth to a 1 percentage point shock to the U.S. interest rate is very similar to the case without oil (Figure 9.9).

Figure 9.9. Decomposition of the Impulse Response of Canada's Real GDP Growth to One Percentage Point Increase in U.S. Three-Month T-Bill. Oil Price and Exchange Rate Are Added to Baseline Regression



Source: Author's calculations

The thin solid line shows the effect of the direct financial channel, with the response of the exchange rate suppressed. If the U.S. interest rate goes up without a subsequent rise in the Canadian interest rate (the mental experiment we use to define the direct financial channel), the Canadian dollar will likely depreciate against the U.S. dollar. This, in turn, would stimulate Canada's GDP by boosting net exports. That mechanism may partly offset the direct financial effect and lead to it being underestimated. As can be seen, however, the effect is minor—fixing the exchange rate barely affects the location of the line showing the propagation of the interest rate shock via the direct channel.

Including Stock Prices

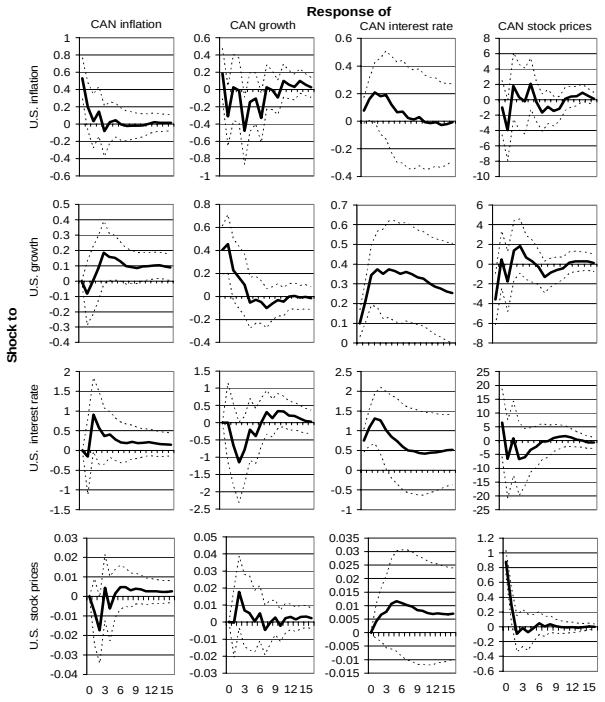
Borrowing is not the only way to raise capital. We extend our baseline regression by including the growth rates of stock price indices for the United States and Canada (S&P500 and TSX/SP300, respectively). We put the stock indices last in each country's block, assuming they are the most reactive variables.[11]

The results suggest that, in the United States, stock prices go down on inflationary surprises but do not appear to react strongly to output or interest rate. A jump in stock prices pushes up the interest rate and predicts higher output growth and, after about three quarters, inflation. In Canada, stocks exhibit a pronounced negative response to higher interest rates and a pronounced positive response to higher output. They also appear to go up, with about a year's delay, on inflation. One could speculate that the concurrence of higher inflation and higher stock prices may reflect a heavy representation of energy companies in Canada's stock market, although the timing of the response makes this rationalization not very probable. Higher output follows a positive stock market surprise, whereas the response of the interest rate and inflation is small.

The extent of real and financial linkages between the United States and Canada is confirmed in Figure 9.10. Higher output growth in the United States leads to higher output growth in Canada. Canadian stocks go up when U.S. stocks go up (and nearly as much), and Canadian interest rates rise in response to higher U.S. interest rates. Regarding the importance of U.S. financial conditions for Canada's real economy, we note as before that a shock to U.S. interest rates pushes the Canadian GDP growth rate down; and we can also see that higher stock prices in the United States, which imply easier financial conditions, lead to higher output growth in Canada.

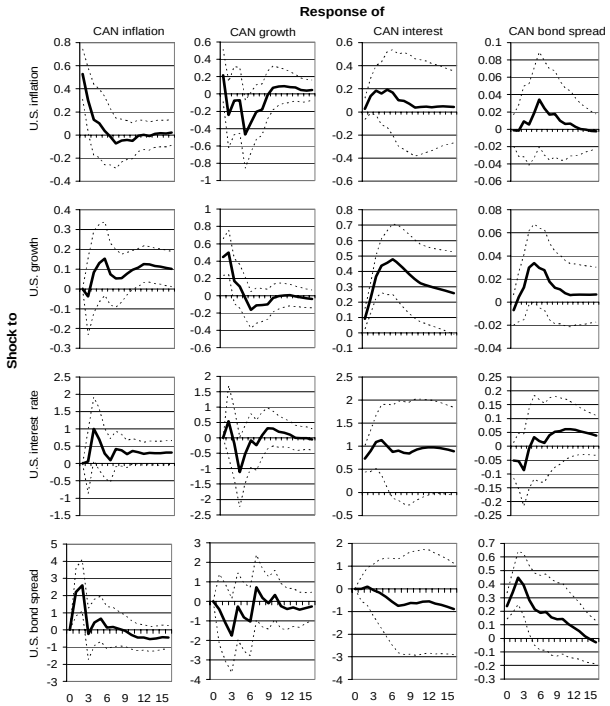
[11] The forward-looking nature of financial variables complicates identification, and evidence drawn from VARs that include stock prices should be interpreted cautiously. See Sellin (2001) for an informative survey.

Figure 9.10. Cross Block with Stock Price Included



Source: Author's calculations.
Note: Solid line - impulse resopnse functions; dashed lines - 95 percent confidence bands.

Figure 9.11. Cross Block with Spreads on Long-Term Corporate Bonds Added



Source: Author's calculations.
Note: Solid line - impulse response functions; dashed lines - 95 percent confidence bands.

Including Spreads on Long-Term Corporate Bonds

As a complementary measure of financial conditions in both countries, we include the spreads of U.S. and Canadian corporate long-term bond yields over corresponding 10-year treasury rates. As can be seen from Figure 9.11, wider corporate spreads in the United States appear to have a negative impact on Canadian GDP growth, although the results are not statistically significant. Wider U.S. spreads also trigger wider spreads in Canada. The impact of higher three-month t-bill rate on Canadian real GDP growth, interest rate, and inflation in this specification is close to that in the baseline.

Including Financial Conditions Indices

Our baseline measure of financial conditions—the yield on the three-month treasury bill—is obviously incomplete. Adding other financial variables to the baseline specification alleviates that concern only partially because many others remain left out. The problem should also not be exaggerated, however, because asset prices often tend to be highly correlated. Still, a more encompassing and at the same time parsimonious approach would be to use a single, comprehensive measure of financial conditions.

Fortunately, researchers at both central banks and private sector institutions have been working on developing financial conditions indices (FCIs) and using them for some time. Unfortunately, the task of capturing financial conditions in one index is quite complex and can be solved only imperfectly, and both the construction and use of FCIs have been subject to numerous criticisms. Gauthier, Graham, and Ling (2004) provide a comprehensive survey and suggest several new FCIs for Canada. Incidentally, they find that FCIs that use U.S. stock prices and high-yield bond spreads are better predictors of Canadian output than are indices that include Canadian financial variables—a result consistent with the main theme of this chapter.

Recognizing the weaknesses, we use FCIs to perform robustness checks for our basic model specification. The indices we use are similar to the Goldman Sachs FCIs for Canada and the United

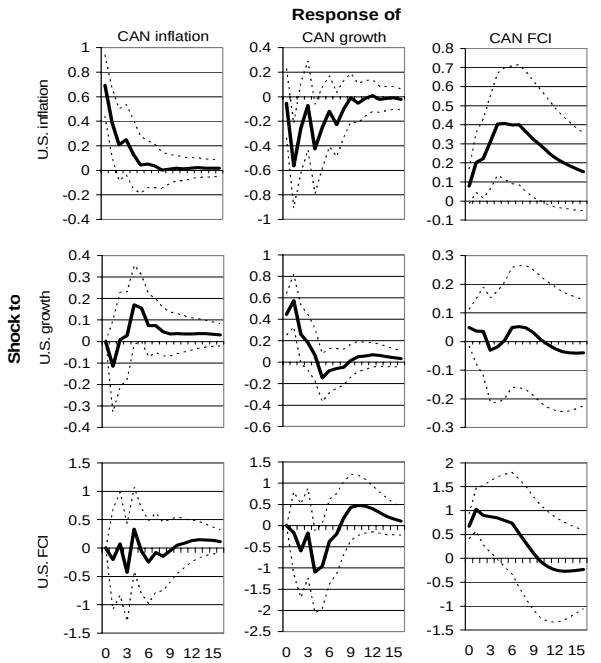
States. Both indices include measures of real short-term market interest rates, real exchange rate, and equity valuation. The U.S. index also incorporates the real yield on long-term corporate bonds, while the Canadian index adds the slope of the yield curve. Higher values represent tighter financial conditions. The construction of the indices is discussed in Klyuev (2008).

The model results with FCIs are largely similar to those in the baseline, but a few differences emerge, particularly in the U.S. block. For one, the price puzzle disappears—tighter financial conditions are associated with lower inflation. Second, the output responds more sharply to a tightening in the FCI than to an increase in the three-month rate. This is not surprising, given that FCIs are explicitly designed not only to reflect current financial conditions, but also to be able to predict GDP growth at short horizons (Dudley and Hatzius, 2000). Third, the responses of the FCI to inflation and output shocks are more front-loaded and less persistent than are those of the interest rate, and shocks to the FCI itself also induce less persistent movements in the index than is the case for the interest rate.

Similar findings emerge in the Canadian block. Notably, inflation surprises elicit a sharp tightening of financial conditions as measured by the FCI. At the same time, a positive shock to output appears to loosen financial conditions. This may reflect our ordering assumption, where comovements between real GDP growth and the FCI are attributed to growth moving first and the FCI reacting. If, in fact, looser financial conditions can stimulate real GDP growth within the quarter, this correlation would be misinterpreted in our identification scheme. This simultaneity problem may be more severe for the FCI than for the interest rate if stock prices and exchange rates (variables included in the FCI) are more forward-looking than the short-term interest rate and if the economy reacts faster to them. Both conditions may well be true.

In the cross block (Figure 9.12), we still observe that a tightening of financial conditions in the United States leads to a substantial decline of real GDP growth in Canada, lasting about two years. Tighter financial conditions in the United States also lead to tighter financial conditions in Canada (although with less persistence than for interest rates), and growth shocks in the United States move Canadian growth in the same direction and with about half the magnitude. In the forecast error variance decomposition, shocks to U.S. financial conditions account for 6–8 percent of variance in Canada's real GDP growth at the horizons of 6 to 16 quarters, compared with the 5 percent share of U.S. interest rate shocks.

Figure 9.12. Cross Block with FCI as a Measure of Financial Conditions

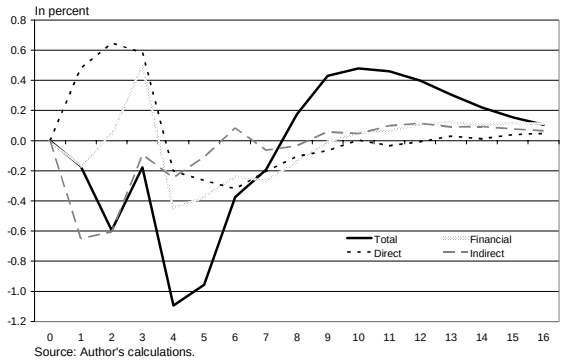


Source: Author's calculations.
Note: Solid line - impulse response functions; dashed lines - 95 percent confidence bands; FCI - financial conditions index.

Although these results are broadly similar to our baseline, the decomposition of the impact of the U.S. financial shock on Canadian output is not. As can be seen from Figure 9.13, with the trade channel switched off, Canadian growth does not appear to respond in a coherent fashion to U.S. financial conditions, as the impulse response oscillates around the zero line. One could conclude on the basis of that picture that the financial transmission channel does not work, and that all the impact of tighter U.S.

financial conditions on Canada comes through slower growth in the United States.

Figure 9.13. Decomposition of Impulse Response of Canada's Real GDP Growth to One Unit Increase in the U.S. FCI



Source: Author's calculations.

A further decomposition of the financial channel suggests that the indirect channel behaves in the expected way, but the direct channel exhibits a perverse swing, with growth accelerating in Canada if financial conditions tighten in the United States but not north of the border. One could rationalize that by noting the forward-lookingness of financial variables included in the FCI. Divergence between U.S. and Canadian FCIs, on which this exercise is predicated, could arise if there were bad news for U.S. growth and good news for Canadian growth, which would be incorporated into the respective FCIs—for example, via stock prices. In addition, given the FCI's intended use as a predictor of GDP growth several quarters ahead, its composition may be biased in a way that overstates the impact of financial conditions on GDP growth, hence exaggerating the significance of the trade channel in our decomposition.

In summary, taken at face value, SVARs that include financial conditions indices instead of interest rates confirm the importance of U.S. financial conditions for growth and financial conditions in Canada, but do not confirm the importance of the direct financial channel in the transmission of U.S. shocks to Canada. However, given how controversial the use of financial condition indices is, both the confirmation and the rejection should be taken with a grain of salt.

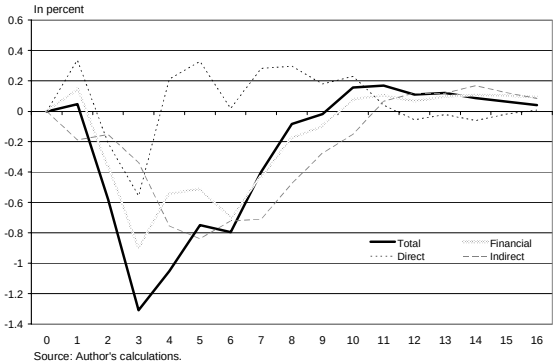
Filtering Data

One may be concerned that the degree of cyclical interdependence in our regressions may be exaggerated if Canada and the United States followed similar long-term trends—such as common productivity shocks or simultaneous disinflations. To address these concerns, we detrend the data using the Hodrick-Prescott (HP) filter and apply our SVAR to detrended data.[12]

The impulse response functions from this SVAR look similar to those obtained on unfiltered data. The price puzzle appears smaller in the detrended data, and the interest rate shocks are less persistent. The response of the Canadian output to a shock to the U.S. output is a bit smaller in the short run and changes sign in the medium run. The decline of Canada's real GDP growth in response to a tightening in U.S. financial conditions remains large and statistically significant. The share of U.S. interest rate shocks in the variance decomposition of Canada's real GDP growth rises to 10 percent in this specification.

It should be noted, however, that with detrending, the significance of the direct financial channel appears to decrease, while that of the indirect financial channel rises substantially (Figure 9.14).

Figure 9.14. Decomposition of Impulse Response of Canada's Real GDP Growth to One Percentage Point Increase in U.S. Three-Month T-Bill Rate



Source: Author's calculations.

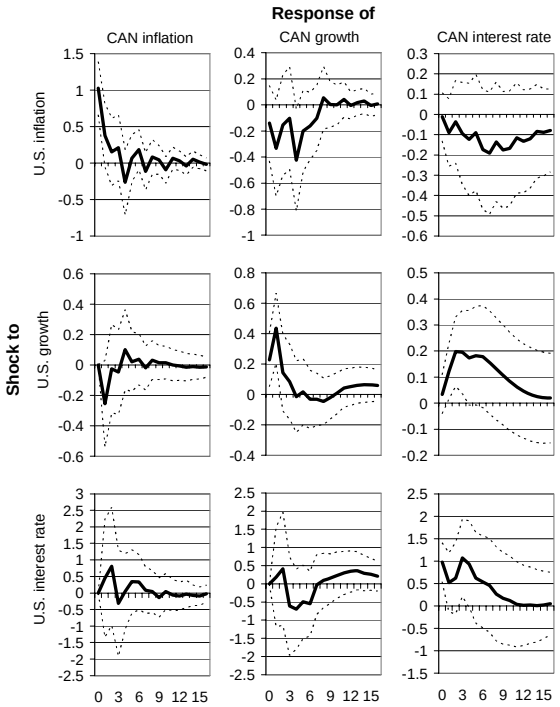
[12] Specifically, we apply the HP filter with a smoothing parameter of 1600 to the logs of CPI and real GDP and to the interest rates. The growth rates of the cycle components of CPI and GDP and the cycle component of the interest rates then enter the regression.

Changing Time Period

The monetary regime in Canada was changed in February 1991 with the introduction of inflation targeting (IT). To eliminate the possibility that our results are influenced by structural breaks after the switch in the monetary policy regime, we rerun the baseline SVAR on the period 1991Q1–2007Q1.

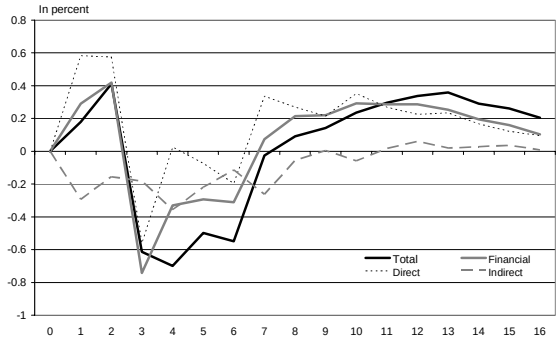
Qualitatively, the picture looks similar to that obtained over the longer period (Figure 9.15). However, with the shorter sample and less variability, the shocks and responses are more difficult to identify, and the confidence bands are wider. The response of Canadian growth to U.S. interest rates is somewhat smaller but more protracted. The decomposition (Figure 9.16) looks similar to the full period, although the direct effect appears smaller. The response of Canadian GDP growth and interest rates to corresponding U.S. variables is also a bit smaller, and the interest rate reaction is also noticeably less persistent. Canadian interest rates appear to go down rather than up in response to an inflation shock in the United States. We have too few degrees of freedom to make conclusive comparisons between the IT and the pre-IT periods, but our results are consistent with the notion that Canada has perhaps become less dependent on the United States in the past decade.

Figure 9.15. Cross Block: Inflation Targeting Period



Source: Author's calculations.
Note: Solid line - impulse response functions; dashed lines - 95 percent confidence bands.

Figure 9.16. Decomposition of Impulse Response of Canada's Real GDP Growth to One Percentage Point Increase in U.S. Three-Month T-Bill Rate



Source: Author's calculations.

Conclusions

In this chapter we have established that, in addition to substantial trade linkages, Canada and the United States are closely connected through financial markets. Canadian corporations raise about one-quarter of their financing south of the border, with bonds playing a particularly important role. As a result, financial conditions in the United States have substantial influence over both financial conditions and real economic activity in Canada.

Using an SVAR approach, we have confirmed that shocks to U.S. real GDP growth have a considerable impact on Canadian GDP growth, with a transmission coefficient of about one-half. We have also found that financial shocks are transferred almost one-to-one from the United States to Canada. Finally, a tightening of financial conditions in the United States leads to a statistically and economically significant slowdown in Canada's real GDP growth. The direct financial channel, affecting Canadian firms raising funds in the United States, is particularly important in the short run. The indirect financial channel, where the impact on real activity is fed through the influence of U.S. financial conditions on those in Canada, exhibits smaller

magnitude but more persistence. The finding that U.S. financial shocks have a major impact on financial conditions and real GDP growth in Canada and, to a somewhat lesser extent, the decomposition of the latter effect are robust to a number of specification changes, with various measures of U.S. financial conditions affecting financial conditions and real activity in Canada.

These results imply that a substantial financial shock emanating from the United States—like the U.S. subprime crisis—may have severe implications for the Canadian economy. Despite tentative indications that Canada has become somewhat less dependent on its southern neighbor in the recent period, the extent of both real and financial linkages between the two countries remains large, and their interplay creates a transmission mechanism for foreign shocks that should not be overlooked.

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Part IV

Annotated Literature

Chapter 10

Business Cycle Linkages and Western Hemisphere Countries: A Literature Review

Shaun K. Roache

Spillover/Cyclical Linkage Trends

- Peaked in 1970s
- Strengthened since mid-1990s
- Strengthened most within the North American Free Trade Agreement (NAFTA)
- Increased for Central America within region and the United States
- Tightened modestly within South America, but still weak
- Some links between Europe and South America

Spillovers/Cycles/Shocks from G-7

- From United States, relationship more significant and stable since mid-1990s
- From Europe, some evidence of linkages for South American countries
- Trade and financial integration matters
- Emerging evidence of a near one-for-one pass-through of U.S./global shocks

New Asia Linkages Emerging

- Rising correlations
- Demand for commodities
- Competition in third markets

Empirical approaches have included 1) correlations, 2) synchronization, 3) factor modeling, 4) single-equation models, 5) vector autoregressions, 6) common cycle models, and 7) calibrated models.

Descriptive Statistical Approaches				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
Fiess (2007)	Correlations of band-pass filtered GDP data for Central American (CA) countries and the U.S. from 1965 to 2002	Close relationship between Costa Rica, El Salvador, Guatemala, and Honduras. Correlations with the U.S. for this group are high. Nicaragua and Panama exhibit low, or even negative, correlations with the U.S. and other CA countries in most cases. Controlling for the common effect of the U.S. reduces correlations.	Business cycle correlations were highest between Costa Rica and the U.S. (0.69), Honduras and the U.S. (0.68), Costa Rica and El Salvador (0.60), Costa Rica and Guatemala (0.63), and Costa Rica and Honduras (0.52).	Other results suggest caution in taking too much from the results using long-run data; for example, the correlation between Mexico and the U.S. using the same data is particularly low (0.09), compared with Canada and the U.S. (0.77).
Fiess (2007)	Spectral analysis (coherence) over assumed business cycle frequencies of 6 to 32 quarters for Central America using industrial production and other monthly indicators from the 1995–2003 period	High coherence vs. the United States for most countries In a comparison of the Central America Free Trade Agreement (CAFTA) trade blocs with others, it was shown that intra-CAFTA coherence was lower that that seen within NAFTA and the European Union but similar to that within Mercosur.	Business cycle synchronization was highest between Costa Rica and El Salvador (0.53), El Salvador and Guatemala (0.53), El Salvador and Nicaragua (0.51), and Honduras and Nicaragua (0.55).	
Mejía-Reyes (2004)	Business cycle dating and synchronization methodology proposed by Artis, Kontolemis, and Osborn (1997). Covered the United States, Canada, Brazil, Chile, Colombia, Mexico, and Peru and used monthly industrial production indices over a maximum period of 1960–2001.	The results show that peaks and troughs in the United States corresponded to those in Canada and Latin America. Latin America experienced a greater number of fluctuations than did the two advanced economies.	Synchronization was measured nonparametrically, using a Pearson contingency statistic. This ignores the magnitude of changes and concentrates on only the direction, using a binary classification.	
Chiquiar and Ramos-Francia (2004)	Spectral analysis (coherence) to assess the extent to which manufacturing production indices move together in Mexico and the U.S.	• Much closer relationship during the post-NAFTA period at most frequencies • The largest difference in the two sample periods		

Descriptive Statistical Approaches				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
	Their measure of coherence at various frequencies compared a pre-NAFTA period of 1980–93 to a post-NAFTA period of 1996–2003.	was a much higher degree of coherence at low frequency (i.e., long-run cycles) following NAFTA.		
Cashin (2006)	Eastern Caribbean currency union economies (ECCU) and G-7 Real GDP 1963–2003 New frequency domain filtering technique from Corbae and Ouliaris (2003) Concordance statistic from Harding and Pagan (2002)	• Synchronization between ECCU and developed economies are much lower than simple correlations. • Strong synchronization within ECCU • Caribbean classical cycles are longer-lived than are those of developed countries and non-Caribbean developing countries.	• Average concordance statistics using log GDP against a sample of economies including Canada, Germany, U.K., U.S., and the other members of the ECCU were Antigua and Barbuda, 0.95; Dominica, 0.88; Grenada, 0.93; St. Kitts and Nevis, 0.95; St. Lucia, 0.95; and St. Vincent and the Grenadines, 0.95 • Average concordance statistics using filtered GDP against a sample of economies including Canada, Germany, U.K., U.S., and the other members of the ECCU were Antigua and Barbuda, 0.51; Dominica, 0.59; Grenada, 0.59; St. Kitts and Nevis, 0.59; St. Lucia, 0.56; and St Vincent and the Grenadines, 0.49	• Concordance measures the extent to which the cycles in two series are synchronized, and is the proportion of time that the outputs of two countries are concurrently in the same phase (i.e., concurrently in a boom (expansion) period or concurrently in a slump (contraction) period).
Cerro and Pineda (2002)	Correlations using the cyclical component of the Hodrick-Prescott (HP) filter for 11 countries over 1960–2000.	• Correlations were relatively high during the 1960s, peaked during the 1970s, and have been lower (albeit rising) since then.	• Highest correlation pairs for entire sample include Ecuador–Bolivia, 0.58; Paraguay–Bolivia, 0.73; and Peru–Bolivia, 0.52. • Correlations within the region were lowest for Mexico.	• Used imports as a proxy for GDP where quarterly data were not available

Common Factor Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
Roache (2008)	Common cycle model of Vahid and Engle (1993) Central America and the United States Annual GDP data for 1950–2006	• The economies of Central America share a close relationship with the United States, with considerable comovement of GDP growth over a long period. • The CA business cycle is dominated by the U.S.; region-specific growth drivers tend to be long-lasting shocks rather than temporary fluctuations. • The most cyclically sensitive countries include Costa Rica, El Salvador, and Honduras.	• Average correlation of the common cyclical components of GDP between CA countries (excl. Nicaragua and Panama) and the U.S. was over 0.8, much higher than correlations based on growth rates or HP-filtered cycles. • Elasticities of cyclical component of GDP of CA countries to the U.S.: Costa Rica, 0.9; El Salvador, 1.1; and Honduras, 0.6. In all cases significant at the 1% level. • Elasticities of trend component of GDP of CA countries to the U.S., with the exception of Honduras, were statistically insignificant.	• Common results to Fiess (2007), particularly in terms of the countries found to be most sensitive
Kose, Otrok, and Whiteman (2003), IMF (2007)	Bayesian dynamic factor model in which a cross-country panel of economic time series is a function of one world factor, a set of regional factors, a larger set of country factors, and idiosyncratic errors, using data on real per capita output, private consumption, and investment over the 1960–2005 period in 93 countries	• The influence of the global factor has declined over time, while that of regional factors has risen. • NAFTA countries: 1) over the entire sample period, regional factors account for over 50% of the fluctuations; 2) regional influences increased strongly for the second half of the sample, with the variance contribution rising to nearly two-thirds. • Latin America: country-specific factors are dominant, with this tendency seemingly increasing over the later sample period, a finding that contrasts sharply with the results from simple correlation analyses.	• North America, 1986–2005, percentage of variance explained by factors: global (5%), regional (63%), country (8%), and residual or indicator-specific (24%). • Latin America, 1986–2005, percentage of variance explained by factors: global (8%), regional (9%), country (52%), and residual or indicator-specific (32%).	• Result attributed to a decline in the incidence of major global common shocks, such as the oil price shocks of the 1970s, and increasing regional trade and financial integration • Contradicts other studies that suggest that global linkages have been strengthening since the early to mid-1990s • Possible reasons for the Latin American (LA) results: 1) 1960–85 period picks up

Common Factor Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
				two strong common shocks for the region: the oil price shocks and the debt crisis in the early 1980s; 2) broad classification of regions, with Latin America and the Caribbean grouped together.
Aiolfi, Catão, and Timmerman (2006)	Construct business cycle indicators for Argentina, Brazil, Chile, and Mexico by extracting common dynamic factors from a comprehensive set of annual economic data which, in some cases, stretch back to 1870	• Relatively high degree of business cycle synchronization, with the four economies in the same state of the cycle (upturn or downturn) most of the time • Concordance statistics appear not to have moved consistently in any one direction, implying that regional synchronization, though high given limited intraregional trade linkages, has neither increased or decreased over the longer term.	• For the 1988–2004 sample period, the Harding and Pagan (2002) concordance statistic (percentage of time cycles are in the same state) ranged from 0.41 (Argentina and Brazil) to 0.82 (Argentina and Chile).	
Justiniano (2005)	Bayesian dynamic factor model used a panel of 44 variables for the period 1984–2004, using 18 U.S. variables, 24 Canadian, and the world oil price and a commodity index. Identifying assumptions included that domestic factors affect only the Canadian economy.	• Trade, rather than the financial sector, is the key transmission mechanism.	• The factor interpreted as the U.S. real business cycle accounted for about 50% of the variance of Canadian GDP, industrial production, imports, and exports. • The U.S. business cycle factor also explained about 36% of variation in Canada's policy interest rate, although the link with inflation was much weaker.	
Hecq (2005)	Six LA economies with annual GDP 1950–2003	• Three common trends, three common cycles		• A paper more about the method than the results

Common Factor Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
Cardarelli and Kose (2004)	Bayesian dynamic factor model for Canada, the United Stated, Japan, and Germany using GDP and other data for 1960Q1–2002Q4	• Common factors have played an increasingly important role in explaining Canada's output variance.	• Common factor explains 14% of Canada's output volatility over 1960Q1–2002Q4 (lower than in Japan or Germany). • From 1981Q3, the common factor explains more than 42% of output variance. • Country-specific and idiosyncratic factors explain 10% and 45% of the business cycle.	
Mansour (2003)	Application of a generalized dynamic factor model of Forni and others (2000) to real annual GDP growth in 113 countries over the 1961–89 period	• Common components appear to be important for overall fluctuations; they seem less important for periodic business cycle variation.	• Percentage of output variance explained by the common components: Central America, Chile, Colombia, and Venezuela, between 27% and 42%; North America, Mexico, and Brazil, between 14% and 27%; and for Argentina, Bolivia, and Peru, below 14%.	
Cuevas, Messmacher, and Werner (2003)	Static factor rotation model using quarterly real output growth in nine countries, including the U.S., Canada, Chile, and Mexico, over the period 1981–2001	• "U.S." factor important for LA countries • Sensitivities change dramatically using a shorter post-NAFTA sample.	• Post-NAFTA implementation, the percentage of Mexican output variance explained by the U.S. factor rising from below 10% to over 90% • The proportion of variance explained by the U.S. factor declined for Canada (from 4% to 1%) and Chile (from 45% to 4%).	• Exclusion of dynamic effects may also understate the extent of linkages. • Results were sensitive to, and in some cases very difficult to interpret with, the inclusion of Argentina and Brazil in the shorter sample. • Difficulty in interpreting the

Common Factor Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
				factors suggests that this method should be applied cautiously.
Hernández (2004)	Common cycle model of Vahid and Engle (1993) Mexico and the United States Quarterly GDP data for 1993–2001	• Mexico very sensitive to cyclical U.S. fluctuations, less so to long-run structural shocks.	• Mexico elasticity of output to U.S.: o long-run (common trend) 0.8 o short-run (common cycle) 3.8	
Loayza, Lopez, and Ubide (2001)	Error components model using real value-added annual growth data for agriculture, industry, and services for a group of countries of Latin America, East Asia, and Europe over 1970–94	• LA cycles have been driven largely by country factors. • Synchronization appeared to decline through the 1980s and into the early 1990s.	• As a proportion of short-run fluctuations, the international business cycle was estimated to account for a relatively low 23% for LA economies, compared with 33% and 27% for Europe and Asia respectively. • Country-specific factors drove two-thirds of LA short-run fluctuations, compared with one-half in Asia and one-third in Europe.	• This static factor model does not take account of lagged effects or autoregressive processes in the factors.

Single-Equation Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
IMF (2007)	Panel of 130 countries. Annual data for 1970–2005. Dependent variable: per capita GDP growth (purchasing power parity, PPP) Independent variable: per capita GDP growth (PPP) for U.S., euro area, Japan Interacted with trade linkages measure, financial integration measure Controls include exchange rate regime, country fixed-effect, initial GDP population growth, growth in the terms of trade.	• Evidence that the magnitude of spillovers from U.S. growth is significantly larger into those countries that are more financially integrated with the U.S.	• 1 percentage point decline in U.S. growth associated with average 0.16 percentage point decline in growth across the sample • U.S. effect substantially larger than the spillovers from the euro area or Japan • If a country's total trade with the U.S. increases by 10 percentage points of GDP, impact of a 1 percentage point increase in U.S. growth is a rise of about 0.1 percentage point in domestic growth.	
Chiquiar and Ramos-Francia (2004)	Cointegration analysis of monthly manufacturing production indices in the United States and Mexico over the periods 1980-1993, 1986-1993, and post-NAFTA 1996-2004.	• Long-run relationship between U.S. and Mexico manufacturing post-NAFTA • There was also evidence for cointegrating relationships between Mexico and the U.S. for a range of different industries.	• Post-NAFTA implementation period, long-run elasticity of production in Mexico with respect to the U.S. during this period was found to be very close to one and stable.	• Some indication of a structural break in the relationship at the end of the sample; in particular, the sensitivity of Mexican production to U.S. production appeared to have weakened through the recovery that began in 2003.

Single-Equation Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
Garcés Díaz (2003)	Cointegration analysis of United States and Mexico quarterly economic data from 1980 to 2000	• Long-run relationship between Mexican GDP and two exogenous variables, U.S. industrial production and the real bilateral exchange rate	• Industrial production outperformed U.S. GDP in the estimations. • An error correction model estimated long-run elasticities of 0.83 (U.S. industrial production) and –0.30 (real bilateral exchange rate), respectively, suggesting episodes of appreciation are associated with output growth. • Each of the components of GDP was also cointegrated with long-run elasticities on U.S. production ranging from 0.43 for public expenditure to 3.10 for imports and exports (using a sample from 1990 for the latter).	• No evidence of structural breaks
Cuevas, Messmacher, and Werner (2003)	A range of simple one-equation models for each country regressed real output growth onto U.S. GDP growth. Four LA countries and Canada, using quarterly data from 1981 to 2001	• U.S. effect significant for Canada, Chile, and Mexico	• Coefficients on U.S. growth: Mexico over 1.0 and significant; Canada close to 0.6, significant, and unaffected by a post-NAFTA time dummy variable; and Chile 0.6	

Multi-Equation Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
Österholm and Zettelmeyer (2007)	Quarterly Bayesian vector autoregression (VAR) with a period 1994–2006 Variables include vector of domestic variables, Δ world GDP, Δ LA GDP, U.S. short-rates, U.S. high-yield spread, net export commodity price index, the Lation America Emerging Market Bond Index (LAEMBI) stripped spread Lag length two Estimated in deviations from steady state (which are informed by priors) Two versions estimated, using world and U.S. growth	• About 50% to 60% of the variation in Latin American GDP growth is accounted for by external shocks. • Conditional forecasts for a variety of external scenarios suggest that LA growth is robust to moderate declines in commodity prices and U.S. or world growth. • LA growth is sensitive to more extreme shocks, particularly a combined external slowdown and tightening of world financial conditions. • The overall impact of a world or U.S. growth shock on Latin America is roughly one-for-one over time.	• 52% of LA output variance explained by external factors • 34% of LA output variance explained by U.S. financial conditions • A 0.3% world growth shock leads to an increase in (four-quarter) LA growth by about 0.4 percentage point after four quarters. • A standard deviation (90 basis point), rise in the U.S. high-yield bond spread has a very strong effect, leading to a decline of four-quarter growth in Latin America by about 0.9 percentage point after three quarters. • A 115 basis point rise in the Latin Emerging Markets Bond Index (EMBI) is associated with a drop in four-quarter growth by 0.5% after four quarters. • The alternative model, which includes U.S. growth and inflation instead of world growth, has very similar effects for the commodities and EMBI shocks, whereas the reaction to a shock to the U.S. high-yield bond spread is slightly more muted, with LA6 (Argentina, Brazil, Chile, Colombia, Mexico, and Peru) growth decreasing by about 0.8 percentage point after 3 quarters.	• VAR models suffer from drawbacks such as heavy parameterization, which, in combination with small or moderate samples, can result in poor forecasting performance. • As a potential solution to this problem, Villani (2005) suggests a Bayesian VAR approach with an "informative prior" on the steady state of the process. • Overall results are similar to those obtained by IMF (2007) using a traditional VAR (see below).

Multi-Equation Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
IMFa (2007)	Six-variable quarterly structural VAR Period 1991–2005 Exogenous foreign block and a country-specific block Foreign block: Δ PPP output per capita for U.S., euro area, Japan Country block: Δ domestic PPP output per capita, Δ consumer price index, Δ real effective exchange rate Exogenous: Δ terms of trade (ToT), LIBOR (London Interbank Offered Rate), various crisis dummies Cholseky ordered from U.S. → euro area & Japan → Δ domestic output → inflation One lag chosen from a small business investment company	• Changes in U.S. growth have a clear impact on growth in Latin America. • The spillovers peak after one quarter, and are estimated to die out after three to four quarters, slightly later than the underlying growth shocks. • The dynamic effects of U.S. growth disturbances explain only about 20% of the variation in LA growth at horizons of four or more quarters ahead. U.S. spillovers greatest in Latin America	• A cumulative four-quarter decline in U.S. growth of 1 percentage point leads to a decline in LA growth, which troughs out at –0.6% during the first quarter. • Shock dies out after three to four quarters. • Effects greatest in Brazil and Mexico, with impact on growth peaking with a decline of more than 0.5% after one quarter.	• The (structural) shocks to growth in the U.S. are normalized to yield a cumulative decline in U.S. growth after four quarters amounting to 1 percentage point. • Relatively short samples available for some countries, combined with the need for a comparable specification across a broad range of economies, limit the accuracy with which individual effects can be estimated. • Hence, it would be unwise to place excessive emphasis on country-specific results.
Izquierdo, Romero, and Talvi (2007)	Restricted vector error correction model with one lag Quarterly GDP growth for the seven largest Latin American countries (LAC7), which include Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. External factors include G-7 industrial production, ToT, U.S. high-yield bond spreads, and U.S. treasury bond yields.	• External factors account for a significant share of the variance of LAC7 GDP growth. • External shocks exert significant responses in LAC7 GDP growth. • Growth performance, the strength or weakness of macroeconomic fundamentals, and the impact of domestic macro and micro policies on growth can be properly appraised only by first filtering out the effects of external	• A one standard deviation shock to the following external variables led to the following short-run response of LAC7 GDP growth: o G-7 industrial production (increase of about 0.6%) leads to 0.4% increase in LAC7 GDP one quarter after the shock. o ToT (increase of almost 2 percentage points) leads to 0.2% increase in LAC7	• Robustness exercises indicate that impulse response results vary only slightly for different orderings of external variables.

Multi-Equation Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
	Restrictions include 1) lagged changes in LAC7 GDP not allowed to affect external variables, although lagged changes in LAC7 GDP can affect current changes in GDP; 2) error correction terms are absorbed only by LAC7 GDP. Sample 1990–2006	factors.	GDP two quarters after the shock. o High-yield spreads (increase of 61 basis points) lead to –0.2% decline in LAC7 GDP two quarters after the shock. o U.S. bond yields (increase of 36 basis points) lead to –0.1% decline in LAC7 GDP two quarters after the shock.	
Canova (2005)	Quantifies the transmission of U.S. shocks to eight Latin American countries using quarterly data from 1990 to 2002. VAR for each LA country, with endogenous country variables including real domestic activity, inflation, real interest rates, trade, and international competitiveness	• U.S. monetary shocks had the largest influence on output, but perhaps in a counterintuitive direction. • U.S. supply and "real" demand disturbances appear to have little effect on LA economies. • Distinctions in the responses of countries with differing exchange rate regimes—compared with "floaters," "nonfloaters" display larger and more significant interest rate and trade balance effects. However, output responses were broadly similar.	• A contractionary U.S. monetary shock causes average regional output to *rise,* peaking at nearly 1% after two quarters, but again dying out fairly quickly. • Negative U.S. supply shocks reduce output by about half a percentage point, but the effect is extremely short-lived. Positive real demand shocks increase output by less than 0.5 percentage point over two quarters, with the effect dying out almost immediately. • U.S. shocks accounted for 23% to 53% of the variance of the domestic variables.	• It is suggested that as U.S. short-term interest rates rise, regional interest rates must also increase, in part because of an increased risk premium, and also to stabilize the exchange rate. With regional interest rates rising by more than U.S. rates, a return differential in favor of Latin America is produced, inducing a capital inflow, higher aggregate demand, and higher output. • Result contrasts sharply with those obtained in similar (and not-so-similar) studies of the transmission of U.S. monetary policy to output in other countries. For example, Kim (2000) and Arora

Multi-Equation Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
				and Cerisola (2000).
Kose and Rebucci (2005)	Country-specific VARs for five Central American economies, the Dominican Republic, and Mexico estimated for the 1964–2003 period. Multicountry VARs using GDP growth rates for the U.S., Mexico, and the same six regional economies above, with a block recursive structure placing the U.S. and Mexico in the first block, five Central American countries in the second, and the regional economy of interest in the final block.	• Country-specific VARs: external shocks, on average, accounted for one-third of output variance, but there was a wide range across economies. • Multicountry VARs: regional shocks were most important, explaining on average half of output variance, with the range across countries much tighter.	• Country-specific VARs: output variance decomposition ranged from Costa Rica (67%) and Guatemala (55%) to the Dominican Republic (10%) and Nicaragua (18%). • Multicountry VARs: as a proportion of output variance, NAFTA effects were highest for Honduras (34%) and Costa Rica and El Salvador (both at 26%). • Multicountry VARs: as a proportion of output variance, country-specific shocks were highest for the Dominican Republic and Nicaragua.	

New Asian Linkages				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
Lederman, Olarreaga, and Rubiano (2006)	Synopsis of a number of background papers assessing "Latin America and the Caribbean's Response to the Growth of China and India"	• Rising correlation between Asia and LAC driven mainly by demand externalities. • Concerns regarding displacement of LAC by China-India in foreign direct investment (FDI), export, and innovation markets are misplaced.		
Calderón (2006)	147 countries (23 industrial economies and 124 developing countries) Annual data for 1965–2004 broken into four decade periods Panel regression of correlation coefficient of Baxter-King (1999) filtered real output growth on 1) bilateral trade intensity, 2) intra-industry trade intensity, and 3) production structure asymmetry	• Stronger trade links = higher output comovement • Output specialization (asymmetry in the production structure among countries) = more asynchronous business cycles	• For LAC region, model-predicted rise in correlation with Asia is due to demand spillovers (65%) and bilateral trade intensity and asymmetries in production structures (35%)	
Suescún (2006)	General equilibrium model with perfect foresight. Key features including three regions (advanced, China-India, LAC); high-tech and low-tech tradable goods; region 1 imports FDI to the two other competing net FDI-importing regions	• Trade liberalization in China and India would o Cause a slight deterioration of the LAC region's ToT o Improve the LAC trade balance to GDP ratio marginally o Cause little crowding out of FDI		

Calibrated Models				
Authors	**Method**	**Key Messages**	**Empirical Estimates**	**Notes**
Ivaschenko and Swiston (2005)	Two-country model (U.S., Canada) Three country equations: an IS curve, which represent the locus of all equilibria where total spending equals an economy's total output; an expectation-augmented Phillips curve; and a monetary policy reaction function. Canada open, U.S. closed Quarterly data 1996–2004 Bayesian estimation uses priors for parameter values.	• Real U.S. shocks have large effects on both Canada's GDP and inflation • Main transmission mechanism is trade	• 1 percentage point increase in U.S. GDP (temporary demand shock) increases Canada's GDP by 0.5 percentage point and inflation by 0.5 percentage point within one to two quarters. • 1 percentage point decline in U.S. potential GDP (negative supply shock) leads to a reduction in Canada's GDP by 1.5 percentage points and inflation by 1 percentage point over six quarters.	• Based on Berg, Laxton, and Karam (2006)
Kose and Rebucci (2005)	Three-country dynamic stochastic general equilibrium model: U.S., representative Central American economy, and the rest of the world	• Significant increases in trade linkages post-CAFTA	• Effects of temporary 1% positive productivity (supply) shock in the U.S.: o Pre-CAFTA scenario, the effect on the CA economy's GDP was very small o Post-CAFTA scenario (transport costs ↓ 35%) CA economy GDP deviation +3% after 10 years, while the export deviation peaked at over 30% in the year following the shock	• Adds trading frictions (tariffs and transport costs) and international financial autarky to the two-country free-trade model of Backus, Kehoe, and Kydland (1994).

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Chapter 11

Commodity Linkages in Latin America: A Literature Review

Lisandro Abrego, Stephanie Eble, and Zlatko Nikoloski

Key Findings

1. ***Stylized facts***. Commodities are very important for Latin America and seem to have been a *key driver of macroeconomic performance*. In particular, in recent years countries with higher terms of trade (ToT) gains have tended to 1) grow faster, 2) record lower inflation, 3) experience real currency appreciation, and 4) strengthen their fiscal positions. An exception to all this is Venezuela.

2. ***Key commodities***. Oil and gas are the main commodities, followed by copper and metals, but also included is a wide set of agricultural products (beef, coffee, soybeans). Overall, Latin America is *one of the most non-oil commodity-dependent regions in the world.*

3. ***Winners and losers***. In general, *oil and metal exporters* (e.g., Chile, Ecuador, Peru, Venezuela) are the ToT winners and importers of these products are the losers.

4. ***Empirical literature***. The *empirical literature on the macroeconomic impact of commodity price movements in Latin America is scant*. This is somewhat surprising given the region's high reliance on export commodities, but could be linked to the fact that 1) growth regressions tend to focus on supply factors that affect long-run growth, 2) commodities have become less important for inflation as countries have adopted inflation-targeting regimes, and 3) the fiscal impact is generally difficult to detect because of structural breaks.

5. ***Findings of the literature***. Whereas the elasticity of GDP with respect to the ToT is modest (about 0.1), large ToT gains in some commodity-dependent countries suggest that a substantial share of their recent *growth* could be explained by ToT gains. ToT improvements have also been an important factor in recent *real currency appreciation* in the more commodity-dependent economies. Empirical findings on *inflation* are less clear, while the impact on the *fiscal position* differs widely across countries, depending on the policy regime in place.

Conclusions and Areas for Further Research

- The fiscal regime in place seems to be a very important determinant of the extent to which ToT affect the macroeconomy.
- Greater focus on how monetary and fiscal policies should respond to ToT shocks is needed.
- Future research could fill important gaps on the macroeconomic effects of ToT changes: 1) growth impact in more diversified but still commodity-dependent countries, 2) impact on inflation, and 3) effect on structural fiscal positions

Authors	Method	Key Messages	Empirical Estimates	Notes
Cashin, Cespedes, and Rahay (2002)	Panel regression with 46 countries, including 15 Latin American countries, 1980–2002 (monthly data)	There is strong evidence of a long-run relationship between the real exchange rate (RER) and real commodity prices for about two-fifths of sample countries, including Bolivia, Ecuador, and Paraguay (which have "commodity currencies"). The behavior of the RER for commodity currencies is independent of the nominal exchange rate regime. The RER is more volatile than real commodity prices (commodity currencies are not RER targeters). Highly significant causality running from real commodity prices to the RER	For commodity currencies, the average half-life adjustment of the RER to commodity-price-augmented purchasing power parity (PPP) is about eight months.	The half-life adjustment of RER to commodity-price-augmented PPP found here is much shorter than Rogoff's (1996) consensus estimates of three to five years.
Edwards (2003)	Conventional econometric model for El Salvador, 1962–2001 (annual data)	ToT shocks have contributed to recent modest growth in El Salvador.	A 10% improvement in TOT raises GDP by 0.5% to 1%.	This estimate is in line with general literature for Latin America. It is much lower than that found in Perez and Moreno-Brid (2000).
El-Anshasy, Bradely, and Joutz (2006)	Traditional vector autoregression (VAR) for Venezuela, 1960–2001 (annual data)	ToT shocks have substantial macroeconomic effects in Venezuela.	In the long run, a 10% improvement in ToT raises GDP by 0.84%, or the GDP growth rate by 1.7%.	
Gallego and Loayza (2002)	Panel regression with 46 countries (22 developed and 24	ToT changes played an important role in Chile's change in	ToT account for more than one-fourth of the growth rate	

Authors	Method	Key Messages	Empirical Estimates	Notes
	developing, including 14 Latin American countries), but focus is on Chile	economic growth rate between 1971–85 and 1986–98.	increase explained by the model (one-fifth of actual growth differential). ToT is the third most important factor contributing to higher growth in 1986–98 (after "policies" (36%) and human capital (31%)).	
Gracia (2006)	Structural VAR for Bolivia, 1990–2005 (quarterly data)	ToT account for a large share of economic growth variations in Bolivia.	A 10% improvement in ToT raises GDP by about 0.8%. TOT explain about 50% of the medium-term variance of GDP.	
Larrain (2002)	Conventional econometric model for El Salvador, 1960–2000 (annual data)	ToT are not a relevant variable to explain growth in El Salvador.		The estimated coefficient is small and statistically insignificant.
Misas and Posada (2000)	Standard VAR for Colombia, 1950–97 (annual data)	ToT do not have a particularly significant role in Colombian growth.	A 10% improvement in the ToT increases GDP by about 0.7% after four years. TOT account for about 13% of the GDP variance in Colombia.	
Morales (1998)	Convencional econometric model for El Salvador	Growth in El Salvador does not respond to changes in the ToT.		The estimated coefficient is statistically insignificant.
Österholm and Zettelmeyer (2007)	Bayesian VAR with informative steady state priors estimated for six Latin American countries (LA6: Argentina, Brazil, Chile, Colombia, Mexico ,and Peru) over 1994–	The contribution of commodity prices to growth in LA6 is quite small.	A one standard deviation shock to commodity prices (6% change) increases four-quarter GDP growth by 0.4 percentage point after two quarters.	Results presented are for the group of countries as an aggregate, not for individual countries. The latter results are available from the authors.

Authors	Method	Key Messages	Empirical Estimates	Notes
	2006 (quarterly data).		Commodity prices account for 7% of medium-term variance of LA6 GDP growth.	
Moreno-Brid and Perez (2000)	Vector Error Correction (VEC) models estimated separately for six Central American countries, Dominican Republic, and Haiti, 1950–97 (annual data)	ToT have not played a role in the growth experience of Central American and some Caribbean countries.	ToT are insignificant, except for El Salvador, for which a very large elasticity (0.72) is found.	The old Thirwall-Hussien model is tested. The only significant coefficient seems very large compared with the findings in the literature for Latin America.
Pieschacon (2007)	Structural VAR and Dynamic Stocastic General Equilibrium (DSGE) models for Mexico, 1980–2004 (quarterly data). Estimate separate impulse responses for non-oil-traded sector and oil trade sector from oil price shock.	Oil price shocks have significant macroeconomic effects in Mexico.	VAR model: the estimated impulse responses imply that a 10% increase in the real prices of oil increases nontraded output by 0.4% and nonoil traded output by 1% by the fourth quarter. The RER appreciates, reaching a peak of just under 5% by the sixth quarter. DSGE model: a version of it replicates the VAR results for output, consumption, and the RER.	
Reichold (2006)	VEC model for Colombia, 1962–2005 (annual data)	ToT are a fundamental determinant of the RER in Colombia.	A 10% increase in export commodity prices appreciates the RER by about 15% in the long run.	Speed of adjustment of RER to deviations from long-run relation is relatively high: about half of the deviation is reversed in only one year.
Tovar-Rodriguez and Chuy-Kon (2000)	Conventional econometric model for Peru, 1950–98	ToT have played a role in Peruvian economic growth.	A 10% increase in ToT raises GDP growth rate by 0.8 to	

Authors	Method	Key Messages	Empirical Estimates	Notes
	(annual data)		1.0 percentage point.	
Zalduendo (2006)	VEC model for Venezuela to assess the role of oil prices in the determination of the equilibrium RER	Oil prices have played a significant role in determining a time-varying RER, but other factors have also been important (e.g., productivity changes).	A 10% increase in oil prices leads to an appreciation of the real effective exchange rate that ranges between 5% and 14%, depending on model specification. The specification behind the 5% estimate adjusts the RER by the exchange rate premiums in the parallel market, and is presumably the preferred one.	The speed of convergence of the exchange rate to its equilibrium is higher if the VEC model is estimated using market rates instead of official rates, suggesting that the government has been able to maintain sharp deviations between the official and the equilibrium rate.

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Chapter 12

A Survey of Financial Linkages

Martin Cerisola, Geoffrey Bannister, Gaston Gelos, and Fabian Valencia

Literature on Interest Rates and Other Factors

Summary of Literature and Main Policy Conclusions

The bulk of the literature has examined the effects of foreign interest rate shocks on emerging markets under the premise that in an open economy with no capital account restrictions, only two of the following three objectives are feasible to pursue: 1) fixed exchange rate, 2) open capital account, and 3) autonomous monetary policy. Therefore, the common approach has involved estimating the interest rate pass-through, conditioning on the exchange rate regime, and capital account restrictions. In addition, the literature has also studied the impact of foreign interest rate shocks on spreads and equity markets returns.

What is the role of the exchange rate regime? The literature has explored the transmission of interest rate shocks to domestic interest rates by comparing countries with floating versus pegged exchange rate regimes. Though some researchers have found little distinction between the two sets of countries, overall, the literature seems to be leaning toward finding a rapid and strong transmission in pegged exchange rate regimes—with estimates of interest rate pass-through sometimes exceeding 1—and a slower and weaker transmission in floaters—with a range of estimates between 0 and 0.4. A remaining challenge in the empirical literature is to design a methodology to properly identify the "de facto" exchange rate regime.

What is the role of capital controls? The empirical evidence regarding the effectiveness of capital controls is mixed. Some authors have found that they significantly reduce the interest rate pass-through, but others have not. This lack of agreement is attributed to the difficulty of measuring capital account restrictions and to their short-lived effectiveness, which is difficult to capture unless using high-frequency data.

Is the risk premium affected by foreign interest rate shocks? A positive correlation between the risk premium and foreign interest rates could generate an overreaction of emerging market (EM) interest rates, following a shock in their external counterparts. The latter implication has emerged in several empirical studies, and some authors have reconciled it with the theory by providing evidence in support of a significant and positive correlation between spreads and foreign interest rates.

What are the effects of foreign interest rates on equity markets? A different branch of the literature has examined the effect of foreign interest rate shocks on equity markets returns in emerging economies. Most authors have found important effects such as in the case of Brazil, where the estimated response to a U.S. monetary policy innovation is 4 to 1. Though there is no disagreement that foreign interest rate shocks matter, there is some divergence regarding which transmission channel is more important. Some authors have found that the response is stronger when the shock is transmitted through long-term interest rates, whereas others argue that the effects stemming from short-term rates are more relevant.

Key Policy Implications

- There seems to be room for autonomous monetary policy in emerging markets, as countries with flexible exchange rate regimes exhibit a slower and weaker transmission of foreign interest rate shocks.
- The effectiveness of capital controls has not been solidly corroborated by the empirical literature.

U.S. monetary policy shocks matter for business cycles in emerging markets, but other external shocks seem to be more important.

Literature on Linkages with Latin American Equity Markets

Summary of Literature and Main Policy Conclusion

The literature has singled out U.S. markets in particular as the main driver of global market comovements. More recent literature concentrates on links between mature (or global) and emerging equity markets. The literature concentrates on a number of broad questions:

How important is the effect of market spillovers in emerging equity markets relative to other factors that drive returns? During calm times, there are statistically significant spillovers from mature markets (mostly the United States) to Latin American markets and among Latin American markets themselves. However, these spillovers are small. For example, Ehrmann and Fratscher (2006) estimate that a 25 bps change in the federal funds rate leads to a 1% decline in Brazilian equities and a 0.25% decline in Mexican equities. The main message during calm times is that though spillovers exist, the main drivers of Latin American equity returns are country-specific or global factors. This is also true when measuring volatility spillovers.

How important are pure financial linkages as opposed to real sector linkages such as trade or migration in determining the spillovers? And, within financial linkages, how important are portfolio investment versus bank lending and foreign direct investment (FDI)? In general, studies have found (not surprisingly) that the intensity of spillovers is linked to the degree of openness and liquidity of financial markets, and the degree of financial and real integration (Ehrmann and Fratscher, 2006). Forbes and Chinn (2004) examine four different mechanisms: import demand, trade competition, bank lending, and FDI, and find that direct trade links appear to be the most important determinants but that financial linkages also matter.

What is the regional distribution and causality? Most studies have found that spillovers are stronger within regions (Latin America, Asia, and Europe) than between regions, and that major developed markets in each region significantly affect emerging markets in that region. Within Latin America, some authors find that Mexico leads changes in other regional stock markets (Brazil, Argentina, and Chile) with a one-period lag, and across regions, Latin American markets lead Asian markets with a one-period lag.

How have spillovers changed over time? Attempts to explain changes in the intensity of spillovers across countries and over time find that with growing financial integration spillovers have become stronger and comovements increased. Nevertheless, in calm times they still explain only a small part of the variation in returns. One study (Diebold and Yilmaz, 2007) finds stronger spillovers in returns but a decline in volatility spillovers over the past few years (to September 2005), but this may be a function of the very low volatility in all financial markets over the past few years.

Literature on Credit Risk and Spreads in Emerging Markets

Summary of Literature and Main Policy Conclusions

A central issue in the literature is emerging market creditworthiness (EMC), its main determinants, and how it has evolved over time. Three key questions are addressed in the literature: What is an appropriate measure of EMC? What main fundamental determinants of EMC were identified? What has been the relative importance of these fundamentals in affecting EMC?

What is an appropriate measure of EMC? The focus has been largely on sovereign bond spreads, while the earlier literature focused on the role of credit ratings as proxies for EMC. More recent literature aimed at eliciting market-based indicators, such as distance to default to proxy EMC.

What main fundamental determinants of EMC were identified? Two types: macro- and investor-sentiment related. For macro: country-specific and global. For country-specific, include macroeconomic (inflation rate, terms of trade, exchange rate system) and liquidity-solvency indicators (reserves to debt or imports, and debt to exports). Key global factors include U.S. interest rates, international oil prices, and global and regional equity prices. As for investor-sentiment factors, the literature makes distinctions between foreign and domestic investors, herding behavior, and so on.

What has been the relative importance of these fundamentals in affecting EMC? Most of the literature in the 1990s has emphasized the importance of liquidity-solvency indicators, U.S. interest rates, and investor sentiment. More recently, the focus has broadened to reflect the importance of unexpected changes in fundamental determinants ("surprises matter").

There has been limited consensus in the literature on the relative importance of fundamental determinants, most notably on foreign interest rates and the relative importance of global vs. domestic factors. Some papers (Arora and Cerisola, 2000; and Grandes, 2002) emphasized the direct relationship between short-term U.S. interest rates and EM spreads; others (Eichengreen and Mody, 1998) have found a negative relationship. Most papers (Gonzalez Rosada and Levy Yeyati, 2005; and Diaz Weigel and Gemmill, 2006) have attributed more importance to global rather than domestic factors.

Key Policy Implications

- Grandes (2002): Permanent improvements in country-specific fundamentals matter.
- Dooley (1996): Prudent policies (fiscal reform, privatization, debt reduction) help with creditworthiness.
- Cantor and Packer (1996): Credit ratings lag fundamentals.
- Global factors affect debt management.
- Arellano (2006): Incentives to default rise with persistence of adverse shocks.
- U.S. monetary policy surprises matter.

Literature on Contagion and Sudden Stops in Latin America

Summary of Literature and Main Policy Conclusions

Latin America has been frequently hit by financial market spillovers and sudden stops over the past 15 years. The Mexican, Asian, Russian/Long-Term Capital Management (LCTM), and—to a lesser extent—the Brazilian crisis in the 1990s had substantial repercussions in the region. Contagion episodes are typically preceded by a surge in capital inflows, which tend to come to a sudden stop during the crisis (Kaminsky, Reinhart, and Vegh, 2003). This

volatility in capital flows has been particularly high in Latin America.

Is shock transmission different during crises? Forbes and Rigobon (2003) argue that, once correcting for the impact of higher financial market volatility during jittery times, correlations across bond and equity markets did not increase. In their view, the repercussions of crises simply reflect the high degree of interdependence. Others argue that relationships are fundamentally different during crises. Most authors argue that Latin America has been subject to such "true" contagion effects.

The Role of Fundamentals

Trade linkages are more important than macroeconomic similarities when it comes to the transmission of shocks. Financial market spillovers tend to show regional patterns, partly because of the importance of intraregional trade (Claessens and Forbes, 2004). Nevertheless, trade linkages are far from sufficient to explain the pattern of financial shock transmission during crises (Kaminsky and Reinhart, 2000)—for example, the effects on Brazil during the Russian crisis (Baig and Goldfajn, 2004).

More open countries seem to be less vulnerable to sudden stops. Although trading with a crisis country makes a country more likely to be affected by contagion, at the same time being open to trade reduces vulnerabilities. Empirical work by Cavallo and Frankel (2004) supports the notion that having a large tradable sector reduces the contraction necessary to adjust to a given cutoff in funding. This would help explain why Latin America is more vulnerable to crises than Asia.

Financial buffers such as high reserves help protect countries from contagion. See, for example, Caramazza, Ricci, and Salgado (2000). Caballero and Panageas (2005) argue that accumulation of international reserves is expensive and incomplete and recommend insuring through other mechanisms.

Financial Linkages

The existence of common creditors appears to help explain contagion patterns. Beyond traditional fundamentals, there is increasing consensus that financial linkages are important in the transmission of shocks. For example, a country is more at risk of suffering from contagion from a crisis in another country if there are investors that are overexposed to both markets (Broner, Gelos, and Reinhart, 2006). The importance of different types of investors differed across crises. International banks, however, do not seem to be the main culprits of shock transmission in Latin America (Martinez Peria, Powell, and Vladkova-Hollar, 2005).

Herding by foreign investors is not the main cause. During crises, herding in Latin America was more widespread than in Europe or the Middle East and Africa region, but less so than in Asia. Nevertheless, herding was moderate (Borensztein and Gelos, 2003a; and Kaminsky, Lyons, and Schmukler, 2004).

Key Policy Implications

- Cavallo and Frankel (2004): Open up to trade, including outside the region.
- Gelos and Wei (2005): Transparency may help reduce vulnerability to crises. In Latin America, macro transparency is high but corporate transparency is low.
- Need to monitor worldwide exposure of major investors using micro data.
- Didier, Mauro, and Schmukle (2006) and Kaminsky, Reinhart, and Vegh (2004): Recent crises had fewer contagion effects because investors were less leveraged and because these crises unfolded in slow motion. But contagion is unlikely to have vanished.

Literature on Interest Rates and Other Factors

Authors	Method	Key Messages	Empirical Estimates	Notes
Canova (2005)	Vector autogressions (VARs) on U.S. and eight Latin American countries	• U.S. monetary policy and supply disturbances induce large and significant responses in several macroeconomic variables, whereas demand shocks in U.S. do not induce strong responses. • Exchange rate regime matters only for magnitude of responses, not for the transmission channel. Interest rate responses in floaters are smaller than those of nonfloaters.	• Between 23% and 53% of variability in macro variables in Latin America is explained by U.S. shocks. • There is also an important fraction of variability (27%–70%) explained by external, non-U.S. shocks. • On average, U.S. shocks explain 43% of variance of domestic interest rates and 29% of non-U.S. external shocks. • Estimated interest rate pass-through is 0.08 for floaters and 0.48 for nonfloaters.	• Interest rate channel much more important than trade channel
Frankel, Schmukler, and Serven (2004)	Panel regressions and cointegration analysis in a sample of 18 industrial and 28 developing countries, in addition to the U.S.	• Convergence across regimes in the 1990s toward full transmission of foreign interest rates • Some floating-regime developing countries showing overadjustment • Speed of adjustment is a lot faster in hard pegs than in floated regimes.	• Adjustment coefficient for Argentina is 0.66, whereas for Chile it is 0.09 and Mexico 0.15. • In the 1990s, pass-through for pegs is 1.09, and 0.82 for nonpegs.	• Interest rate channel
Bekaert, Harvey, and Lumsdaine (1999)	VARs with 20 emerging markets including six Latin American (LA) countries	• Interest rate decreases do generate strong but very short-lived increases in stock returns. • Equity flow shocks have a strongly positive effect (contemp.) on returns, which dies out quickly although reversal is not complete.	• A 1% decrease in the world interest rate leads to a cumulative three-year 0.24% increase of U.S. holdings of the local LA equity market. • For an average dividend yield level of 3.5%, an increase in U.S. flows of 1% of market capitalization is associated with a 1.32% drop in the dividend yield after 12 months in Latin America.	• Key channel is portfolio rebalancing. Evidence suggests that investors are driven by momentum.

Authors	Method	Key Messages	Empirical Estimates	Notes
Ehrmann and Fratzscher (2006)	Panel regressions with 50 countries, including U.S., Canada, and seven LA countries	• Response of local equity markets to U.S. monetary policy shocks crucially depends on degree of financial integration, the degree of response of U.S. short-term rates to shocks, and the response of local interest rates and exchange rates to U.S. monetary policy shocks.	• Equity markets fall by about 3.8% in response to a 100 basis points (bps) tightening of U.S. monetary policy. The response is twice as large when U.S. short-term rates respond strongly to monetary policy shocks. • A 1% increase in U.S. equity returns is on average associated with a 0.30% change in foreign equity returns.	• Changes in U.S. interest rates affect borrowing costs of firms with direct access to U.S. credit markets. • Similarly, equity value of firms is affected when foreign asset prices react to monetary policy shocks.
Di Giovanni and Shambaugh (2006)	Panel regressions in a sample of 160 countries, including 20 LA countries, U.S., and Canada. Ten base countries.	• Foreign interest rates affect GDP growth of small economies, but only in pegged countries. • Pegged countries react only to changes in interest rate of base country.	• An increase of 5 percentage points in base country interest rates lead to a 1 percent decline in GDP growth in pegged countries as opposed to no change in countries with floats. • Pass-through to pegs, 0.40, and 0 for floaters	• Interest rate channel is primary transmission channel in pegged countries. • No evidence of significant capital markets channel spreads channel, exchange rate channel, or exports channel
Goldberg (2001)	Panel regressions with U.S. bank-level data and 29 countries, including 11 LA countries	• U.S. banks' international claims on Latin America are sensitive to U.S. real interest rate and GDP growth but not to local conditions. • Most of the results are driven by large banks.	• A 100 bps change in U.S. real rates leads to a 4.2% increase in claims to Latin America. A 1% increase in U.S. GDP growth leads to a 6.3% increase in foreign claims to Latin America.	
Goldberg (2005)	Panel regressions with U.S. bank-level data and 29 countries, including 11 LA countries (follow-up of 2001 paper)	• Results shown in 2001 paper hold up to 2001. When sample is extended, no stable relationship between foreign claims and local or U.S. macroeconomic conditions is established. • It shows that up to 2001, flows were sensitive to U.S. macroeconomic conditions and not to local conditions, but primarily through local		

Authors	Method	Key Messages	Empirical Estimates	Notes
		branches and not through cross-border claims.		
Miniane and Rogers (2003)	VARs with 29 countries, including Canada, Chile, Colombia, and Mexico	• Capital controls do not matter for the transmission of U.S. monetary shocks, presumably because they are difficult to enforce. • Other factors, such as exchange rate regime, degree of dollarization, and trade integration with the U.S., are more important than capital controls.	• Following a 25 bps U.S. monetary shock, interest rates increase by o 15 bps in fixers vs. 5 bps in floaters o 5 bps in low dollarization countries vs. 10 bps in high dollarization countries o 5 bps in low trade integration countries vs. 13 bps in high ones	
Mackowiak (2007)	Structural VARs with U.S. and eight emerging markets including Chile and Mexico	• External shocks are important for emerging markets. • U.S. monetary shocks are important, but significantly less so than other external shocks. • U.S. monetary policy shocks explain a larger fraction of variability in most emerging market macro variables than in U.S. macro variables.	• External shocks explain (on average) 30% of variance of interest rates, 46% of exchange rate, 40% of price level, and 36% of real output. • U.S. monetary policy shocks explain less than 10% of variability in macro variables.	
Kaminsky and Schmukler (2001)	Correlations at different frequencies using spectral analysis	• Equity prices seem more connected than interest rates. • Little evidence that capital controls insulate economies from global spillovers	• Correlation between domestic and foreign interest rates is higher at lower frequencies, hovering between 10% and 20%.	
Shambaugh (2004)	Panel regressions and cointegration analysis	• Significant evidence in support of stronger pass-through in pegged countries than in floaters • Speed of adjustment is much faster in pegs than in floaters.	• Interest rate pass-through in pegs oscillates between 0.5 and 0.74, whereas in nonpegs it is 0.05 but statistically insignificant.	Interest rate channel
Borensztein, Zettelmeyer, and Philippon (2001)	VARs and event studies	• In Hong Kong SAR and Singapore, results support the open economy trilemma's	• Overreaction for Argentina, 1–3 bps per 1 bps in U.S.	

Authors	Method	Key Messages	Empirical Estimates	Notes
		logic, but not in the case of Mexico and Argentina.	• Mexican response is smaller but statistically insignificant.	
Frankel (1999)	Panel regressions	• LA interest rates seem to be more sensitive to U.S. rates when the country has a loose dollar peg than when it has a tight peg.		Interest rate channel and spreads channel
Calvo, Leiderman, and Reinhart (1993) :	Principal components analysis	• Capital inflows to Latin America in the early 1990s were largely driven by external factors, mainly developments in the U.S.: declining interest rates, wide current account deficit, lower equity and other assets returns, and recession.	• 50% of forecast error variance in real exchange rate is explained by external factors.	
Obstfeld, Shambaugh, and Taylor (2004)	Panel regressions	• Strong evidence in support of higher pass-through in pegs than in nonpegs • Strong evidence of nonzero pass-through for floaters post-1931	• Interest rate pass-through for pegs estimated at 0.6, for nonpegs at about 0.1, but not significantly different from zero.	Interest rate channel
Obstfeld, Shambaugh, and Taylor (2005)	Panel regressions comparing gold standard period with Bretton Woods and modern era	• Strong transmission of interest rate shocks in pegged economies during the gold standard and in the modern era, but not during Bretton Woods. Evidence of nonzero transmission for floaters • Capital controls matter for the transmission of interest rate shocks.	• Post–Bretton Woods interest rate pass-through for pegged economies 0.46, for nonpegs 0.27 • Pass-through in countries with capital controls is 0.26, and 0.56 in countries without them.	Interest rate channel
Hausman and Wongswan (2006)	Panel regressions	• Estimates impact of monetary surprises in the U.S. on EM interest rates finding that that type of surprise matters • Long-term interest rates and exchange rate respond mainly to path surprises (revision to	• On average, 25 basis points (bps) cut in U.S. federal funds rate is associated with a decline of 5 bps in foreign short-term interest rates. • 25 bps downward revision in path of future monetary policy	

Authors	Method	Key Messages	Empirical Estimates	Notes
		future path of monetary policy), whereas short-term rates respond to path surprises and target surprises (unexpected changes in federal funds target).	generates a 0.5% appreciation of exchange rates against the dollar. It also causes a 5 bps decline in foreign short-term interest rates, and an 8 bps decline in long-term interest rates.	
Bluedorn and Bowdler (2006) :	Panel regressions and cointegration analysis	• U.S. monetary shocks being anticipatable and endogenous to economic conditions matters for their transmission to foreign interest rates.	• Anticipated and endogenous shocks cause a less-than-1 pass-through for pegs, whereas it is greater than 1 when the shock is unanticipated and exogenous. • For nonpegs the pass-through is similar across regimes: 0 on impact and peaks at 0.4, four months later.	Interest rate channel

Literature on Linkages with Latin American Equity Markets

Authors	Method	Key Messages	Empirical Estimates	Notes
Ehrmann and Fratszscher (2006)	Event study: ordinary least squares (OLS) panel regressions of daily returns on an indicator of U.S. monetary policy shocks and controls, correcting standard errors. Decomposition by country and sector. Regress results on macro factors 1994 to 2004	• Substantial effect on average, though interestingly, LA countries (Mexico and Brazil) are not strongly affected. Market response is related to the reaction of domestic interest rates and exchange rates. Linked to open and liquid financial markets, and real and financial integration	• 100 bps change in federal funds rate leads to 4% decline in Brazil, 6% decline in Canada, and 1% decline in Mexico. Hong Kong SAR, Indonesia, Korea, and Turkey react the most (more than 10%).	• Measure the transmission of U.S. monetary policy shocks to world equity markets; identify the channels (through changes in U.S. asset prices or reaction of foreign asset prices, including interest rates and exchange rates); link to macroeconomic determinants.
Diebold and Yilmaz (2007)	Variance decomposition of a VAR model measuring the forecast error variance for assets in	• 30% of forecast error comes from spillovers. Shows significant spillovers from U.S. to major LA markets, and between LA markets.	• Innovations in U.S. returns are responsible for 7.5% of forecast error in Argentina, 12.8% in Brazil, 8.2% in Chile, and	• Propose an index to measure international spillovers in equity markets, in terms of both returns

Authors	Method	Key Messages	Empirical Estimates	Notes
	country *i* coming from shocks to assets in country *j*. For both returns and volatility 1992 to September 2005	Over time, spillovers in returns are stable, but spillovers in volatility have fallen.	18.1% in Mexico.	and volatility. Test how spillover intensity changes over time.
Forbes and Chin (2004)	Stage 1: Factor model of returns controlling for global, sectoral, and cross-country factors. Stage 2: Decompose cross-country factor loadings into bilateral linkages: import demand, trade competition, bank lending, and FDI. 1986 to 2000	• U.S. returns are significant for explaining most LA returns; significance has increased over time (to 2000). Direct trade links appear to be the most important determinants of cross-country return comovement, but financial linkages also matter. These findings are consistent in both stocks and bonds.	• Factor loadings for country returns on U.S. returns: Argentina, 0.54; Brazil, 0.41; Chile, 0.2; Colombia, 0.09 (not significant); Mexico, 0.44; Venezuela, 0.12 (not significant).	1. Measure relative importance of financial linkages (as opposed to global factors) in explaining returns. 2. Can trade flows, trade competition, bank lending, and investment exposure explain linkages? 3. How has this changed over time? 4. In stocks vs. bonds?
Bekaert and Harvey (1997)	Calculate conditional correlations, which depend on world volatility and variables tracking the degree of integration	• Equity market liberalization leads to a small increase in correlations of EM stock market returns with world markets over time and a small decrease in dividend yield.		• Measuring diversification benefits of holding EM equities
Fujii (2005)	1. GARCH model of returns and volatility. 2. Extract disturbance terms and inspect their cross-correlations at various lags to identify causality using formal Cross-Correlation Function tests (Cheung and Ng, 1996). 1990 to 2001	• Significant links within Latin America: In general Mexico causes others (Argentina, Brazil, Chile) with a one-period lag. Across regions Latin America leads and Asia markets follow. Significance of links increases dramatically during times of crisis.		• Investigate causal linkages among stock markets in Asia and Latin America both intra- and inter-regional. Do these relationships vary significantly at times of crisis?
Gebka and Serwa (2004)	1. GARCH model of returns and volatility including global stock market effects. 2. Extract disturbance terms and inspect their	• Intraregional spillovers within Latin America (and other regions) are stronger than inter-regional spillovers. Most inter-regional spillovers originate in	• Correlation coefficients of excess returns between LA markets vary from 0.2 to 0.3.	• Investigate linkages between EM stock markets, controlling for effects of global stock markets.

Authors	Method	Key Messages	Empirical Estimates	Notes
	cross-correlations at various lags to identify causality using formal Cross-Correlation Function tests (Cheung and Ng, 1996). 1998 to 2003	LA markets and flow to other regions.		
Robitaille and Rousch (2006)	Event study, using Federal Open Market Committee (FOMC) announcements and distinguishing between effects of those announcements (i.e., are they a sign of monetary tightening or rapid growth?); uses the surprise component. Regression of intraday changes in C-bond spreads and Bovespa equity returns on indicators of announcements 1999–2005	• For bonds: surprise content of FOMC announcements has a significant and small effect on C-bond spreads; longer term U.S. interest rates changes (indicating expectations for M-policy) have a more significant and larger effect. For equities: returns decline in reaction to surprise FOMC tightening, but are affected more by surprise rises in long-term rates (10-year treasury). Main message: expectations about the future path of interest rates matter. Overall, however, FOMC surprises explain a small proportion of the variation in Brazilian asset prices.	• Bonds: 100 bps surprise in federal funds rate leads to an increase of 43 basis points in the C-bond spread over the first hour of trading. 4.1 bps increase in 10-year U.S. treasury leads to an increase of 4 bps in the C-bond spread over the first hour. • Equity: 100 bps increase in 10-year U.S. Treasury yields leads to 7-percentage-point decline in stock price index.	• How do FOMC announcements affect Brazilian external bond spreads and local currency equity returns?
Bekaert, Harvey, and Ng (2005) Spillovers and Contagion over Time	Define contagion as excess correlation of residuals in a two-factor asset pricing model that explains returns controlling for global, regional, and country-specific fundamentals. Volatility is modeled in an asymmetric GARCH framework. 1980–1998	• There is no evidence of contagion in the Mexican crisis, but there is in Asia, during the Asian crisis. • Over time the excess correlations increase, suggesting greater market integration both with the U.S. and between Latin American countries.		• Measuring contagion in stock market prices; testing for the effect of global factors (contagion) vs. increased volatility in local fundamentals
Wongswan (2005)	Standard event study framework.	• Small, statistically significant effect.	• 100 bps of monetary tightening in the U.S.	• The impact of U.S. monetary policy

Authors	Method	Key Messages	Empirical Estimates	Notes
	Regressing returns in country *x* on indicators of U.S. policy (short- and long-run) and other controls 1998–2004	Equity returns respond to short-run FOMC surprise, but not to long-run expectation of U.S. policy. • Cross-country variations in response seem to be related to degree of financial integration rather than to real integration or exchange rate flexibility.	related to a decline of 6% in Argentina, 7.15% in Brazil, and 6.13% in Mexico.	announcement surprises on equity indices in 16 countries

Literature on Credit Risk and Spreads in Emerging Markets

Authors	Method	Key Messages	Empirical Estimates	Notes
Arellano (forthcoming)	Stochastic General Equilibrium (GE) model on default risk, interest rates, and income fluctuation, with application to Argentina's 2001 default	• Incomplete asset markets deliver default events in recessions, because borrower cannot roll over debt. • After a prolonged recession, debt holdings grow markedly so that the economy experiences capital outflows, which makes default more attractive.	• GE model able to account for the high volatility of interest rates and the negative correlation of output and consumption with interest rates. • Main anomaly of paper is that it generates a low average spread consistent with default probability.	
Arellano and Ramanarayanan (2006)	Dynamic GE model of borrowing and default to study the term structure of sovereign bonds, with an application to Brazil	• Spread curve is upward sloping during tranquil times and downward sloping when probability of default is high. • When interest rates are low, the economy borrows mostly long-term.	• Examine 46 sovereign bond issues by Brazil in international markets. • Average maturity of bond issues comoves negatively with short spreads.	
Arora & Cerisola (2000)	Times series model of EM spreads for 11 countries to assess relative importance of U.S. monetary policy, country-specific	• Stance and predictability of U.S. monetary policy, as well as country-specific fundamentals,	• Mean group elasticity of U.S. rates on spreads at about 0.82, with standard error of 0.35 • Higher estimated impact	

Authors	Method	Key Messages	Empirical Estimates	Notes
	fundamentals, and global conditions	are important.	from federal funds rate than from U.S. 10-year yield	
Cantor & Packer (1995)	Discuss the role of sovereign credit ratings and their relationship with sovereign and corporate market yields. Regress credit ratings on economic variables identified as influencing the level of sovereign rating.	• Credit rating influence on market yields appears limited. • Markets usually require larger risk premiums for sovereign debt than for similarly rated corporate bonds. • Sovereign spreads over comparable corporates are not only positive but also highly volatile.	• High ratings associated with high per capita income, low inflation, more rapid growth, low ratio of foreign exchange debt to exports, and no default history • No statistically significant impact from fiscal position and the external on ratings	• One implicit message is that credit ratings tend to lag changes in macroeconomic fundamentals.
Cline & Barnes (1997)	Four approaches to distinguish between improved country fundamentals and market sentiment as the source of sovereign bond spread compression between 1995 and 1997. Model for spreads estimated for 1992–96.	• Run-up in sovereign bond prices between 1995 and 1997 outpaces improvements in borrower fundamentals, including credit ratings. • Spread compression was more severe in bonds than in bank loans.	• U.S. interest rate (+, insignificant); debt/exports (+); reserves-to-imports (–); inflation (+)	
Diaz Weigel & Gemmill (2006)	Distance to default (DTD) model for sovereign bond spreads in Argentina, Brazil, Mexico, and Venezuela	• Global and regional factors are far more important than country-specific factors in determining changes in creditworthiness. • DTD hugely affected by stock-market returns in the U.S. and region. • Tendency for bond markets to move together, without link to fundamentals.	• ***Global:*** U.S. interest rates not significant, slope of yield curve (+). U.S. stock market return (+ on DTD). Oil prices (+ DTD) for Mexico and Venezuela • ***Regional:*** Stock market returns (+); stock market volatility (–); investor sentiment (–) • ***Country-specific:*** stock-market returns (+); volatility and inflation (none); reserves (+) • ***Variance of the DTD:*** in separate regressions, global account for 25%,	

Authors	Method	Key Messages	Empirical Estimates	Notes
			regional 45%, and country-specific 8%.	
Dooley, Fernandez-Arias, and Kletzer (1994)	Panel regressions of secondary market prices (SMP) for sovereign debt on several domestic and international variables; 21 developing countries during 1986–92.	• Historical evidence suggests that prudent policies, including fiscal reform, privatization, and debt reduction, are useful in explaining creditworthiness. • International interest rates appear to be one of the most important determinants in the return of debtor countries to international borrowing.	• Elasticity of the U.S. 10-year yield on secondary market debt prices –0.87. • Elasticity of long-term debt to exports on SMP –0.5. • Elasticity of long-term debt to GNP on SMP –0.36.	
Eichengreen and Mody (1998)	OLS regression on pooled data for spreads of 998 emerging market primary corporate and sovereign bond issues, 1991–96	• Higher credit quality translates into a higher probability of issue and lower spread. • Changes in fundamentals explain only a fraction of the spread compression in the period leading up to the recent (1994) crisis in EM.	• International interest rates (10-year U.S. treasury bond yield at time of issue) (–). Elasticity at –0.39 for Latin America • Debt-to-GDP (+, 0.5 for Latin America); debt-service-to-exports (+, 1.24 for Latin America)	
Gapen and others (2005)	Contingent claims approach (CCA) to assess sovereign risk; derives a set of credit-risk indicators that serve as barometer of sovereign risk, applied to sovereign balance sheet risk for 12 EM economies Indicators include distance to distress, probability of default, credit spreads, and market value of risky foreign exchange debt. Fixed effects panel regressions to estimate relationship between some indicators and market-based credit	• CCA allows one to assess debt sustainability and optimal level of reserves under different scenarios. • The sovereign risk indicators incorporate both forward-looking market prices and nonlinear changes in values, thus improving predictability for sovereign credit risk. • Risk indicators are robust when compared with observed credit spreads.	• Risk-neutral credit spreads and observed CDS and Emerging Markets Bond Index (EMBI) spreads estimated with adjusted R-squared of 88% and 96%, respectively • Relationship between sovereign risk-neutral default probability and estimated actual default probability estimated • Sensitivity of spreads to change in distance to distress is a nonlinear relationship. CDS spread grows exponentially, as DTD declines.	

Authors	Method	Key Messages	Empirical Estimates	Notes
	risk measures			
Levy Yeyati (2005)	Reduced form panel data model for spread, in line with the rest of the literature, to estimate a long-run relationship between markets spreads, high-yield spreads, and international rates	• Global factors exert a strong influence on EM spreads. High-yield spreads in developed and developing countries have moved together. • Direct relationship between EM spreads and international liquidity, measured through different rates	• Global factors account for at least 50% of the variability of spreads. • A 100% increase in high-yield spreads raises the average emerging spread by 105%, while a comparable decline in high-yield-spreads reduces the EM spreads by only 47%.	• Agnostic approach on country fundamentals
Grandes (2002)	Time series analyses estimating long-term determinants of sovereign bond spreads for Argentina, Chile, and Mexico, 1994–2000. Splits fundamentals into permanent and transitory components. Vector Error Correction Model (VECM) used to explore debt sustainability in Argentina and Mexico.	• Permanent changes in fundamental variables weigh most while contagion effects remain significant. • Unsustainable public sector deficits (increasing interest burden) plus insufficient economic growth and excessive risk premiums are shown to have triggered explosive debt dynamics.	• Argentina's and Mexico's equations display robust coefficients in first differences, suggesting that spread responses to a permanent output shock have been more important. For each additional 1 percentage point (+0.01) in the Argentine industrial or Mexican global production index growth rate, sovereign risk falls nearly 11.3% and 10.5% respectively. • The current-account-to-GDP ratio is very significant for all countries. • Public sector accounts enter significantly into almost all the equations, in either permanent or cyclical magnitudes. Permanent fiscal deficit components are very significant in all but Chile (little variability in fiscal deficits).	
Jahjah and Yue (2004)	Log linear regression of spreads at issuance on fundamentals, with a view on the impact of exchange rate policy on sovereign bond spreads for 51 developing	• Choice of exchange rate regime is not neutral with regard to spreads. A hard peg does not necessarily lead to lower costs, especially if there is a	• Elasticity to U.S. treasury 10-year rate close to –1. • Elasticity to exchange rate misalignment close to 1. • Hard pegs "pay" about	

Authors	Method	Key Messages	Empirical Estimates	Notes
	countries during 1990–2001	risk of overvaluation. • Real exchange rate overvaluation increases bond issue probability and raises bond spreads, particularly for hard pegs. • Other macro variables enter significantly, such as GDP growth, debt/GNP, and debt service to exports.	0.034 more in terms of spreads.	
Kamin and von Kleist (1999)	Role of international interest rates and credit ratings on sovereign bond spreads for primary issues during 1991–97	• Credit ratings, maturity, and currency denomination drive changes in EM spreads. • Regional factors and short-term international interest rates have a minor impact on spreads.	• International interest rates (–/0)	
Min (1998)	OLS regression based on pooled data; spreads for 505 emerging market corporate and sovereign bond issues, 1991–95	• Macroeconomic variables matter and so does liquidity. • External shocks (international interest rates) do not appear to matter.	• Total external debt to GDP (+) • Foreign reserves/GDP (–) • Debt-service to exports (+) • Net foreign assets (–) • Consumer price index inflation rate (+) • Terms of trade (–)	
Neumeyer & Perri (2005)	Statistical analysis of business cycle (BC) in EM (Argentina, Brazil, Mexico, Korea, Philippines) with particular view to real interest rate shocks Real Business Cycle (RBC) model consistent with stylized facts; calibrated to Argentina 1983–2001	• ***For emerging markets:*** Real interest rates are countercyclical and lead the BC; high output and consumption volatility, relative to developed countries • Productivity and country risk shocks can account for most of the empirical	• Eliminating default risk in EM can reduce about 27% of their output volatility. • Eliminating international real rate fluctuations would lower volatility by less than 3%.	

Authors	Method	Key Messages	Empirical Estimates	Notes
		regularities. • Large fluctuations in country risk seem to be deeply connected with large fluctuations in economic activity.		
Nogues & Grandes (2001)	Time series analysis of Argentina's country risk, proxied by sovereign bond spreads	• Spread largely explained by 1) growth expectations, 2) fiscal deficits, 3) debt-service-to-export ratio, 4) contagion, and 5) external shocks. Interest rates shocks (such as 30-year U.S. bond yield) expected to have an ambiguous impact	• A 1% rise in the price of Mexican bonds produces a drop of 2.16% in Argentine risk. • A permanent increase of 1% in debt-service-to-export ratio increases Argentine risk by 0.67%. • The U.S. 30-year bond yield enters negatively. Possible explanation: investors fly to quality during times of stress.	
Rowland and Torres (2004)	Panel-data framework to identify determinants of 16 EM spreads (1998–2002) as well as creditworthiness (1987–2001).		• ***Spread determinants:*** economic growth rate (–); debt-to-GDP ratio (+); reserves-to-GDP (–), debt-to-exports ratio (+) • ***Creditworthiness:*** spread determinants (with opposite sign), inflation, and a default dummy	• Models explain only about 25% to 30% of spreads variability. Models explain 50% of creditworthiness, but with a default dummy.
Rowland (2005)	Time series analyses of sovereign bond spreads for Colombia; 1998–2003. Short-term and long-term determinants	• ***Short-term determinants:*** contagion (proxied by JP Morgan's Emerging Market Bond Index Global (EMBIG) Mexico), changes in U.S. stock markets, and Colombia's exchange rate • ***Long-term determinants:*** exports, the exchange rate, growth, and U.S. t-bill rate	• Coefficient of Colombia's spread on EMBI Mexico at 0.49 • Semi-elasticity of COL spread on S&P500: –166.9	Johanssen-based long-term coefficients are too large to justify methodology.

Authors	Method	Key Messages	Empirical Estimates	Notes
Sy (2005)	Univariate (unbalanced panel) model of bond spreads for 17 rated EM countries, from 1994 to 2001. Purpose is to determine significant differences between market's and rating agencies' views of country fundamentals.	• There is an asymmetric adjustment of spreads and ratings when deviations are significant. • When spreads are "excessively low," the rating upgrade effect dominates the spread-widening effect. When spreads are "excessively high," the spread-tightening dominates.		
Uribe & Yue (2003)	VAR panel model to assess the role of world interest rates and country spreads (CSs) in EM business cycles during 1994–2001. Countries included are Argentina, Brazil, Ecuador, Mexico, Peru, Philippines, and South Africa.	• U.S. interest rates and credit spreads affect EM's BC; CSs serve as transmission mechanism of world interest rates.	• U.S. interest rate shocks explain 20% of BC movements in EM. CS falls to an increase in U.S. rates but then overshoots. • CS shocks explain 12% of BC movements. • About 60% of CS changes are explained by CS shocks.	No country-specific results presented

Literature on Contagion and Sudden Stops in Latin America

Authors	Method	Key Messages	Empirical Estimates	Notes
Forbes and Rigobon (2000)	Statistical correlations across various markets	• No shift contagion • LA countries highly interdependent among each other and with rest of the world		
Bae, Karolyi, and Stulz (2003)	Examine co-exceedances.	• Contagion stronger in Latin America than elsewhere		
Bayoumi and others (2003)	Relate equity market correlations to distance between nations.	• Method is good at identifying "positive contagion," which helps predict future crises.		
Bekaert, Harvey, and Ng (2005)	Two-factor model, correlations among	• No evidence for contagion during Mexican	• 28% of variance of Argentina's and Brazil's	

Authors	Method	Key Messages	Empirical Estimates	Notes
	stock markets	crisis • Some evidence for contagion to Latin America during Asian crisis	stock market is explained by the U.S. factor. The percentage is lower for other LA markets.	
Chan-Lau, Mathieson, and Yao	Co-exceedances in equity markets	• Increase in contagion, particularly in Latin America • Bear market contagion increased steadily in 1990s.		
Dungey and others (2003)	Latent factor model of equity returns	• Strong contagion from Russia to Argentina in 1998. Strong contagion from the U.S. to Latin America during the LCTM crisis.	• During LCTM crisis period, contagion from the U.S. accounted for 63% of the total variance of equity returns for Argentina, 86.5% for Brazil, and 64.1% for Mexico.	
Baig and Goldfajn (2000)	Correlations, adjusting for bias	• Contagion from Russia to Brazil through offshore Brady markets	• Adjusted correlations between sovereign spreads of Brazil and Russia increase from 0.3 to close to 1 during crisis.	
Wongswan (2003)	Capital Asset Pricing Model (CAPM)	• Evidence for contagion and capital market integration		
Rothenberg and Warnock (2006)	Descriptive	• Half of sudden stop episodes are sudden flights. • True sudden stops are bunched.		
Frankel and Cavallo (2004)	Gravity model	• Openness reduces probability of sudden stops.	• An increase in trade openness of 10 percentage points decreases the likelihood of a sudden stop by 32%.	
Corsetti, Pericoli, and Sbracia (2005)	Factor model of stock markets	• Contagion from Hong Kong SAR for 5 out of 17 countries in 1997		

Contagion Channels and Models

Authors	Method	Key Messages	Empirical Estimates	Notes
Caramazza, Ricci, and Salgado (2000)	Probit regressions	• Financial linkages matter; exchange rate regimes and capital controls do not.	• If country A experiences a crisis, a country that has a common creditor linkage with A of about 1 standard deviation higher than the average market sees its crisis probability increased by 31%.	
Hernández and Valdéz (2001)	Regressions for different financial indicators	• Financial variables are very important in explaining sovereign spreads correlations; trade linkages are more important for stock markets.		
Didier, Mauro, and Schmukler (2006)	Look at mutual funds data	• Contagion is unlikely to have disappeared.		
Broner, Gelos, and Reinhart (2006)	Model and mutual funds data	• Explanation of contagion through common overexposed investors. During crises, investors move toward the benchmark portfolio.	• Index of financial interdependence alone explains 28% of stock market variation across EMs during Thai crisis, 15% during Russian crisis, and 8% during Brazilian crisis.	
Martinez Peria, Powell, and Vladkova Hollar (2005)	Examine foreign bank claims on the LA private sector	• Over time, banks have become less responsive to external factors. Foreign banks claims are not significantly curtailed during crises.		
Borensztein and Gelos (2003a)	Mutual funds data	• Individual investors are more fickle than fund managers. Open-end funds tend to lead the pack.		
Borensztein and Gelos (2003b)	Mutual funds data	• Some albeit limited evidence for herding behavior • More herding among underlying investors	• Herding measure for EM funds about twice as large as that found for U.S. institutional investors	

Authors	Method	Key Messages	Empirical Estimates	Notes
Kaminsky, Reinhart, and Vegh (2003)	Survey/descriptive	• Last crises were anticipated, therefore little contagion • Contagion tends to be preceded by strong capital inflows. • Different common lenders/investors were key during different crises.		
Claessens and Forbes (2004)	Survey/descriptive			
Gelos and Wei (2005)	Mutual funds data	• Investors tend to flee less transparent countries during crises.	• During Asian and Russian crisis, countries in the top 75th percentile of macroeconomic opacity saw an outflow of funds that exceeded that registered in the bottom 25th percentile by 1.6% of the initial asset holdings.	
Caballero and Panageas (2005)	Quantitative model	• Countries should not insure themselves against sudden stops by accumulating reserves but through international financial instruments that serve as a hedge.		
Kyle and Xiong (2001)	Model			
Kodres and Pritsker (2002)	Model	• Differentially informed investors transmit idiosyncratic shocks from one market to others by rebalancing their portfolios.		
Van Rijckeghem and Weder (2001)	Bank for International Settlements data	• Banks are important in transmitting shocks.		
Goldstein and Pauzner (2004)	Model	• Countries with independent fundamentals can suffer from contagion through interaction of agents in financial markets.		

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