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THE TRANSMISSION OF US SHOCKS TO LATIN AMERICA

FABIO CANOVA*

Universitat Pompeu Fabra, Barcelona, Spain, IGER and CEPR

SUMMARY

I study whether and how US shocks are transmitted to eight Latin American countries. US shocks are identified using sign restrictions and treated as exogenous with respect to Latin American economies. Posterior estimates for individual and average effects are constructed. US monetary shocks produce significant fluctuations in Latin America, but real demand and supply shocks do not. Floaters and currency boarders display similar output but different inflation and interest rate responses. The financial channel plays a crucial role in the transmission. US disturbances explain important portions of the variability of Latin American macrovariables, producing continental cyclical fluctuations and, in two episodes, destabilizing nominal exchange rate effects. Policy implications are discussed. Copyright © 2005 John Wiley & Sons, Ltd.

I have the means to make myself deadly, but that by itself, you understand, it is absolutely nothing in the way of protection. What is effective is the belief those people have in my will to make use of the means. That's their impression. It is absolute. Therefore, I am deadly.

J. Conrad, The Secret Agent

1. INTRODUCTION

Macroeconomists have been concerned with the structure of business cycle fluctuations and their sources for at least 50 years. Many studies have tried to disentangle the contribution of internal and external sources and to identify the channels of international transmission in G-7 or OECD countries (see, e.g., Amhed *et al.*, 1993; Canova and Marrinan, 1998; Prasad, 1999; Canova and De Nicoló, 2000, 2003; Kim, 2001) but the success has been mixed.

In less developed countries (LDC) the question of which source (internal vs. external) and which transmission mechanism (common shocks, goods or asset markets interdependencies, contagion) is responsible for cyclical fluctuations becomes crucial in two respects. First, when discussing the sustainability of certain exchange rate regimes, the literature has often emphasized that asymmetric shocks (both in the sense of being idiosyncratic and of not showing any lagged spillover across countries) can make the task hard, if not impossible. For example, the recent troubles experienced by Argentina are often attributed to asymmetric shocks. Hence, detecting whether shocks are common and, if they are not, whether external shocks dominate and through which channel they are propagated, may indicate whether, e.g., the lack of monetary independence would create imbalances leading to the abandonment of a currency board arrangement. Second, in the 1970 and early 1980s, LDC countries had autarkic financial markets so that transmission, if any,

* Correspondence to: Fabio Canova, IGER Bocconi, Via Salasco 5, 20136 Milan, Italy.
E-mail: fabio.canova@uni-bocconi.it

occurred through the trade balance and real exchange rate adjustments. The last decade, however, has witnessed a remarkable process of financial liberalization in many LDC countries and a substantial increase in the financial interdependencies of Latin America with the USA. One is therefore curious as to whether this integration has altered the main channels of propagation of US shocks to the region. Clearly, different transmission mechanisms may require different actions to stabilize the economy.

In this paper I examine the extent and the features of the transmission of US shocks to Mexico, Panama, Brazil, Chile, Ecuador, Argentina, Uruguay and Peru. These countries are chosen for several reasons. First, they include both large and small nations, with large and small trading ties with the USA. Second, financial interdependencies with the USA are important for all them. Third, these countries provide a wide spectrum of experiences, as far as domestic and international monetary arrangements are concerned, covering situations with flexible rates, partial inflation targeting and no dollarization (Chile, Mexico) at one extreme, complete dollarization (Panama, and starting from 2000 Ecuador) at the other extreme, and intermediate cases with partial dollarization, significant currency substitution and a variety of exchange rate regimes. Fourth, some countries experienced crises in the 1990s, other did not. Last but not least, these were the Latin American countries for which it was possible to construct a consistent data set for a reasonable period of time.

It is worth mentioning that this study is concerned with 'normal times'. That is, I do not address questions concerning sources of hyperinflations, currency crises and massive recessions which have repeatedly plagued Latin American economies over the last 30 years. Studying the propagation of shocks in 'normal times' is important for two reasons. First, there are large and interesting economic variations besides those associated with crisis episodes. Second, since crises do not emerge in vacuum the analysis may suggest whether unstable dynamics are intrinsic to Latin American economies and whether 'small' external shocks can be transformed into explosive paths of prices, deep recessions, etc.

Three questions are addressed. First, I would like to study whether transmission occurs through the interest rate or the trade channel; whether it is similar to the one documented in developed countries; and whether there are significant comovements in the USA and Latin America following US shocks. Second, I wish to quantitatively measure the contribution of US shocks to domestic fluctuations in Latin America. While common wisdom suggests that internal conditions play the most significant role, the majority of analyses employ non-structural disturbances to reach such a conclusion. This clearly impedes a causal interpretation of the outcomes and does not allow us to distinguish US from other worldwide sources of fluctuations. Third, I would like to shed light on whether the choice of domestic and international monetary arrangements matters for the transmission of shocks. I am particularly concerned here with the transmission of US monetary disturbances and with whether partial or total absence of national monetary policy may result in destabilizing movements of domestic macrovariables.

Several papers have partially addressed some of these issues (see, e.g., Agenor *et al.*, 1999; Fackler and Rogers, 1995; Hoffmaister and Roldos, 1997; Prasad, 1999; Amhed and Loungani, 1999; Arora and Cerisola, 2000; Goldfajn and Olivares, 2000; Cooley and Quadrini, 2001; Schmitt-Grohe and Uribe, 2001; Mendoza, 2001; Mackowiak, 2003). This work adds to the literature in several dimensions. First, I identify and extract multiple sources of US structural disturbances and measure their effects on a number of Latin American economies. Second, I simultaneously examine the importance of trade and financial channels in transmitting US shocks. Third, I measure comovements of US and Latin American macrovariables exploiting the causal link running from

US shocks. Finally, I provide estimates of domestic responses which use the information present in the entire cross-section of countries.

The analysis proceeds in two steps. First, I identify supply, real demand and monetary disturbances in the USA using the approach of Canova and De Nicoló (2002). The identifying restrictions I employ are embedded in a large class of dynamic stochastic models, are broadly robust to the parametrization of preferences and technologies, and produce economically interpretable disturbances. Second, using a prior specification which exploits cross-sectional information, I construct estimates for both the response of a 'typical' Latin American country and for certain country-specific responses, which efficiently combine the information contained in the panel.

Several interesting facts emerge from the analysis. First, while US real demand and supply shocks generate insignificant fluctuations in the typical Latin American economy, US monetary disturbances induce large and significant responses in several macroeconomic variables. The interest rate channel is a crucial amplifier of US monetary disturbances, while the trade channel plays a negligible role. Transmission, when it occurs, is almost instantaneous, with Latin American variables peaking within a couple of quarters of the shocks. Second, the patterns of propagation differ from those documented in developed countries. Here a contractionary US monetary shock induces a significant and instantaneous increase in Latin American interest rates which, in turn, are accompanied by capital inflows, price increases, depreciation of the real exchange rate and improvements in the trade balance. Increases in aggregate demand following capital flows then produce a delayed and significant positive output effect. Third, US disturbances account for an important portion of the variability of Latin American macrovariables; they also induce significant comovements in US and Latin American output and inflation and, at least for Brazil in 1998 and Argentina in 2001, play an important destabilizing role on nominal exchange rates. Fourth, while there are differences in the responses of countries with floating vs. non-floating exchange rate, these differences have more to do with the magnitude of the effects than with the transmission mechanism. Fear of floating (as in Calvo and Reinhart, 2000), which induces central banks to use reserves to limit fluctuations in nominal exchange rates, may be the reason for the insignificant difference in output responses for the two groups and why domestic interest rate movements are only partially muted in floating countries. However, the presence of a mix of regimes, the poor quality of the data or the small differences between the two regimes could also be part of the explanation.

The policy implications of the results are clear: putting the house in order does not guarantee the elimination of cyclical fluctuations in Latin America. Given that the majority of domestic fluctuations in the continent are of foreign origin, Latin American policymakers are required to carefully monitor international conditions and to disentangle the informational content of US disturbances in order to properly react to external imbalances. Also, since US monetary policy has important external effects and the Fed's decisions may have undesirable consequences on Latin American exchange rates, mechanisms to internalize these repercussions may produce better continental outcomes. Finally, since the exchange rate regime and/or the degree of dollarization of the economy appear not to matter for the response of Latin American real variables, the output costs of dollarization seem to have been overemphasized. However, the financial costs may be significant and the sustainability of the arrangement may crucially depend on the type of shocks experienced in the USA.

The rest of the paper is organized as follows. The next section describes the specification of the reduced form, the procedure used to extract US shocks, the issues connected with the selection of

the model for each Latin American country and the estimators of structural responses. Section 3 discusses the results. Section 4 concludes, highlighting the policy implications of the results.

2. THE SPECIFICATION OF THE EMPIRICAL MODEL

To thoroughly study the transmission of US shocks, it is necessary to specify a multicountry model where contemporaneous and lagged feedbacks among countries are simultaneously accounted for. Although there are attempts in this direction (see Canova and Ciccarelli, 2004; Ciccarelli and Rebucci, 2000) the task is unfeasible here for several reasons. First, the quality of the data is debatable and only in the last decade has there been an effort to harmonize the collection and the definitions with OECD standards. Second, hyperinflations, currency and exchange rate crises are common episodes in Latin America and this makes domestic time series hardly representative of those normal situations one would like to examine in discussing the international transmission of shocks. Third, and connected to the previous one, a robust examination of interdependencies requires somewhat 'regular' cycles and given the short time series, degrees of freedom restrictions prevent any reasonable multicountry specification.

To study the issues of interest I proceed on a bilateral basis with the USA on one side and one Latin American country at a time on the other. This, in practice, eschews from the analysis any possible feedback within Latin American economies or via third countries (such as European ones). In this setup any correlation between the USA and Latin America is likely to be unidirectional. If this were the case, the specification and the estimation of the statistical model could be significantly simplified. To verify this hypothesis I run a VAR for each country–US pair and examine the exogeneity of the US block with respect to the block of Latin American variables. Confirming *a priori* expectations, the null hypothesis that current and lagged values of Latin American variables have zero coefficients in the US block is not rejected for any of the eight countries.

Given this outcome, I break the estimation process in two. First, I estimate a reduced form model for the USA and identify structural shocks. Second, I set up an empirical model for each Latin American country, taking as exogenous the estimated US structural shocks, and I measure the magnitude, direction and persistence of the typical Latin American responses to identified US shocks and the differences in the responses across countries with different characteristics.

Formally, consider a bivariate block VAR model

$$\begin{bmatrix} y_{it} \\ w_t \end{bmatrix} = \begin{bmatrix} A_{11}^i(L) & A_{12}^i(L) \\ 0 & A_{22}(L) \end{bmatrix} \begin{bmatrix} y_{it-1} \\ w_{t-1} \end{bmatrix} + \begin{bmatrix} A_{13}^i(L) \\ A_{23}(L) \end{bmatrix} x_t + \begin{bmatrix} \varepsilon_{it} \\ e_t \end{bmatrix} \quad (1)$$

where $(\varepsilon_{it}, e_t)' \sim (0, \Sigma_i)$, $\Sigma_i = \text{blockdiag}\{\Sigma_{\varepsilon_i}, \Sigma_e\}$ and let the underlying structural model be

$$\begin{bmatrix} G_0^i & A_0^i \\ 0 & H_0 \end{bmatrix} \begin{bmatrix} y_{it} \\ w_t \end{bmatrix} = \begin{bmatrix} B_{11}^i(L) & B_{12}^i(L) \\ 0 & B_{22}(L) \end{bmatrix} \begin{bmatrix} y_{it-1} \\ w_{t-1} \end{bmatrix} + \begin{bmatrix} B_{13}^i(L) \\ B_{23}(L) \end{bmatrix} x_t + \begin{bmatrix} u_{it} \\ v_t \end{bmatrix} \quad (2)$$

where $(u_{it}, v_t)' \sim (0, I)$. Here w_t represents the block of US variables, y_{it} the block of country i 's variables and x_t world variables, capturing continental comovements not due to developments in the US economy.

While there is a growing interest in examining time-varying coefficient VAR models which display heteroskedastic shocks (see, e.g., Sims and Zha, 2001; Cogley and Sargent, 2003), I restrict attention to time-invariant structures for two reasons. First, the sample I use is short. Second, the

sensitivity analysis I conduct on the model specification shows that accounting for these features does not qualitatively affect the results.

To obtain estimates of $B_{22}^i(L)$ and of v_t , given estimates of $A_{22}(L)$ and e_t , it is typical to impose zero restrictions on H_0 (short-run restrictions) or on $B_{22}(1)$ (long-run restrictions). These restrictions are only very loosely connected to economic theory, mostly conventional and often justified with circular arguments (Uhlig, 1999; Canova and Pina, 2001). To avoid severe inferential distortions, I employ a two-step approach. First, I orthogonalize e_t using an arbitrary statistical approach. Second, I use theoretical restrictions to examine whether any of the components of the orthogonal innovation vector has a meaningful economic interpretation. Let $\Sigma_e = PV'P' = \hat{P}\hat{P}'$ where P is a matrix of eigenvectors and V is a diagonal matrix of eigenvalues. This decomposition does not necessarily have any economic content, but produces uncorrelated shocks without imposing any zero restrictions on \hat{P} . For each of the resulting orthogonal shock I then check whether theoretical restrictions are satisfied. If shocks with the required properties are found, the process terminates. If no shock satisfies the identifying restrictions, I use the non-uniqueness of the above decomposition to provide alternative candidate structural shocks. To be specific, for any orthonormal $J : JJ' = I$, I construct $\Sigma_e = \hat{P}JJ'\hat{P}' = \tilde{P}\tilde{P}'$ and check whether shocks with the required characteristics exist using the \tilde{P} decomposition. There are many ways to parametrize the space of J matrices. Here I follow Canova and de Nicoló (2002), set $J = J(\omega)$, $\omega \in (0, 2\pi)$ with

$$J_{m,m'}(\omega) = \begin{pmatrix} 1 & 0 & 0 & \dots & 0 & 0 \\ 0 & 1 & 0 & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \cos(\omega) & \dots & -\sin(\omega) & 0 \\ \vdots & \vdots & \vdots & 1 & \vdots & \vdots \\ 0 & 0 & \sin(\omega) & \dots & \cos(\omega) & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

where m, m' indicates the rows of the decomposition which are rotated by sine and cosine functions and search the space of $J_{m,m'}$, $m, m' = 1, \dots, M$ by varying ω on a grid.

Existing dynamic macroeconomic theory provides a wealth of restrictions which can be used to identify shocks. Rarely, however, these restrictions take the form of zero constraints on the impact or on the long-run multipliers as assumed by conventional identification schemes. Instead, DSGE models typically possess robust conditional types of restrictions involving the sign of the responses of certain variables to shocks. Canova and De Nicoló (2002, 2003) present mainstream DSGE models where, regardless of the parametrization, a technology (supply) shock produces negative comovements between domestic output and domestic inflation while domestic real government expenditure and monetary shocks produce positive comovements in domestic output and domestic inflation. They also show that government expenditure and monetary shocks produce opposite comovements in real balances and inflation. Therefore, the pairwise correlations of output, inflation and real balances can be used to disentangle 'supply', 'real demand' and 'monetary' shocks in the data. Theory is typically vague about the timing of these comovements. One has therefore some freedom in choosing where to place these restrictions. Here I use contemporaneous pairwise correlations of output, inflation and real balances since this was sufficient to identify shocks with the required characteristics.

Once structural shocks are found, solving for US variables we have

$$w_t = (1 - H_0^{-1}B_{22}(L))^{-1}(H_0^{-1}B_{23}(L))x_t + (1 - H_0^{-1}B_{22}(L))^{-1}H_0^{-1}v_t \quad (3)$$

Substituting into the block of country i 's variables we have

$$y_{it} = \zeta_{i1}(L)y_{it-1} + \zeta_{i2}(L)v_t + \zeta_{i3}(L)x_t + \eta_{it} \quad (4)$$

where $\zeta_{i1}(L) = G_0^{-1}B_{11}(L)$, $\zeta_{i2}(L) = (G_0^{-1}(A_0 + B_{12}^i(L)L))(1 - H_0^{-1}B_{22}(L))^{-1}H_0^{-1}$, $\zeta_{i3}(L) = (G_0^{-1}(A_0 + B_{12}^i(L)L))(1 - H_0^{-1}B_{22}(L))^{-1}H_0^{-1}B_{23}(L) + G_0^{-1}B_{13}(L)$, $\eta_{it} = G_0^{-1}u_{it}$. Interest here centres on the $\zeta_{i2}(L)$'s, which are complicated functions of the parameters of the structural model.

Given the relatively short sample, $\zeta_{i2}(L)$ are likely to be very imprecisely estimated. One way to improve their quality is to construct estimators which efficiently combine cross-sectional information. For example, one could impose a prior on $A_0^i, B_{12}(L)^i$ or both and derive the posterior distribution for the $\zeta_{ji}(L)$ numerically. Alternatively, one could impose restrictions of the reduced form parameters $A_{12}(L)^i$ and derive the posterior for $\zeta_{ji}(L)$ numerically. As Sims and Zha (1998) have argued, if the system is just identified, it makes no difference which route one takes. Here I follow a third approach, which imposes restrictions directly on (4). One advantage of this approach is that closed form analytic solutions for the posterior of the quantities of interest exist. Rewrite (4) as

$$y_{it} = D_{1i}y_{it-1} + D_{2i}v_t + D_{3i}x_t + \eta_{it}$$

where $D_{ji} = [\zeta_{ji}(0), \zeta_{ji}(1), \dots]$ and let $D_i = [D_{1i}, D_{2i}, D_{3i}]$. I assume the D_i are related across i according to the following unit invariant specification:

$$D_i = D + v_i \quad v_i \sim N(0, \Sigma_v) \quad (5)$$

where D represents the vector of cross-sectional means and Σ_v its dispersion. I assume a vague prior on D , $g(D) \propto \text{constant}$. Furthermore, I set $\Sigma_v = \text{diag}\{\Sigma_{v_1}, \Sigma_{v_2}, \Sigma_{v_3}\}$, $\Sigma_{v_i} = \tau_i \times I$, $i = 1, 2, 3$ and estimate τ_i maximizing the predictive density of the model using pre-1990 data. Finally, I assume the η_{it} are normally distributed and that Σ_{η_i} has an inverted Wishart distribution with scale $S = 10^{-4} \times I$ and $s = 4$ degrees of freedom.¹

The model (4), the prior structure (5) and the assumptions made imply that the joint posterior distribution for $(D_i, D, \Sigma_{\eta_i})$ has a normal Wishart structure. In particular, the posterior distribution of country-specific responses $(D_i | D, \tau, \Sigma_{\eta_i}, y_i) \sim N(\tilde{D}_i, \tilde{V}_D)$ where $\tilde{D}_i = \tilde{V}_D(Z_i' \Sigma_{\eta_i}^{-1} y_i + \Sigma_v^{-1} D)$; $\tilde{V}_D = ((Z_i' \Sigma_{\eta_i}^{-1} Z_i)^{-1} + \Sigma_v^{-1})^{-1}$ and $Z_i = [y_{it-1}, v_t, x_t]'$. The posterior mean \tilde{D}_i is therefore a weighted average of the prior mean D and the GLS estimate \hat{D}_i with weights given by their precision. It collapses to a standard OLS estimator of D_i , unit by unit, when there is no information in the cross-section, and to a pooled estimator when the cross-sectional information dominates. Furthermore, $(D | \tau, \Sigma_{\eta_i}, y) \sim N(\tilde{D}, \tilde{V}_D)$ where $\tilde{D} = \tilde{V}_D(\sum_i^M (Z_i' \hat{\Sigma}_{\lambda_i}^{-1} y_i))$, $\tilde{V}_D = \sum_i^M (Z_i' \hat{\Sigma}_{\lambda_i}^{-1} Z_i)$ and $\lambda_{it} = \eta_{it} + v_i z_{it}$. Hence, the posterior mean of D is an average of GLS estimates. Finally, the posterior distribution for the variance-covariance matrix of the errors $(\Sigma_{\eta_i} | \tau, y) \sim IW(S + (y_i - D_i Z_i)(y_i - D_i Z_i)', T + s)$ where IW stands for inverted Wishart.

¹ I have also experimented with a multivariate t distribution for the η to account for heteroskedastic VAR errors. None of the results presented are altered by this alternative prior assumption.

2.1. Measuring US Shocks

The unrestricted VAR model for the US economy includes a measure of the log of real activity, of inflation, of the slope of the term structure of the nominal interest rates (Slope) and of real balances. The sample covers quarterly data from 1980:1 to 2002:4; all series are seasonally adjusted and obtained from the FRED databank of the Federal Reserve Bank of St. Louis.

Reduced form VAR models which include real activity, inflation and measures of interest rates and money have been used frequently in the literature (see, e.g., Sims, 1980; Farmer, 1997). In addition to standard measures of output and CPI inflation, I employ the slope of the term structure, because of its higher predictive power for real activity and inflation relative to a single measure of short-term interest rates. Note also that the slope of the term structure has information about nominal impulses that other variables, such as unemployment or real wages, may not have. I use real balances to be able to distinguish monetary from other types of real demand disturbances. Visual inspection of the linearly detrended data shows no compelling evidence of non-stationarities. Furthermore, the impulse responses shown in Figure 1 indicate that there are sufficient cointegrating restrictions in the linearly detrended data to take care of stochastic trends. For a model with (linearly detrended) log output, inflation, slope of the term structure and real balances, both the Akaike and Schwarz criteria indicate that the dynamics are well described by a VAR(2).

Beside the four domestic variables, the VAR also includes variables which may capture the state of the world economy or those influences, independent of the US and Latin American developments, that may cause comovements in the two regions (e.g. because of contagion effects). In the vector x_t I include an index of commodity prices, the emerging market bond index (EMBI) and the emerging market equity index (EMEI). The data is from Bloomberg and corresponds to end of quarter sampling of daily figures. All three variables enter the system only contemporaneously.

Figures 1 and 2 present, respectively, the impulse response to structural innovations and the time path of the estimated structural disturbances for the selected orthogonalization.

Figure 1 shows that identified disturbances have the expected effects on output, inflation and real balances. In response to a contractionary supply shock the slope of the term structure declines first and then increases, indicating that the response of short-term nominal interest rates is hump-shaped, probably as a result of liquidity and expected inflation effects dominating at different horizons. Short-term interest rates instantaneously increase also with expansionary real demand shocks and with contractionary monetary shocks. The magnitude and the persistence of these responses however differs, with monetary shocks producing significantly smaller effects.

Different shocks produce their maximum impact on output and inflation at different times. For example, the peak response of output to real demand shocks is instantaneous, while the output effects of supply and monetary shocks take time to materialize (minimum response after about six quarters). Similarly, supply and real demand shocks have their peak effect on inflation within a quarter, while the through response to monetary shocks is somewhat delayed. Hence, the degree of sluggishness in the system may depend on the sources of shocks.

The shocks I recover appear to be reasonable according to various metrics. For example, supply shocks are the overwhelming source of inflation variability (roughly 80%) while demand shocks explain a large portion of output variations (with real demand shocks accounting for about 70% and monetary shocks for about 15% at 24-step horizons). Interestingly, monetary disturbances

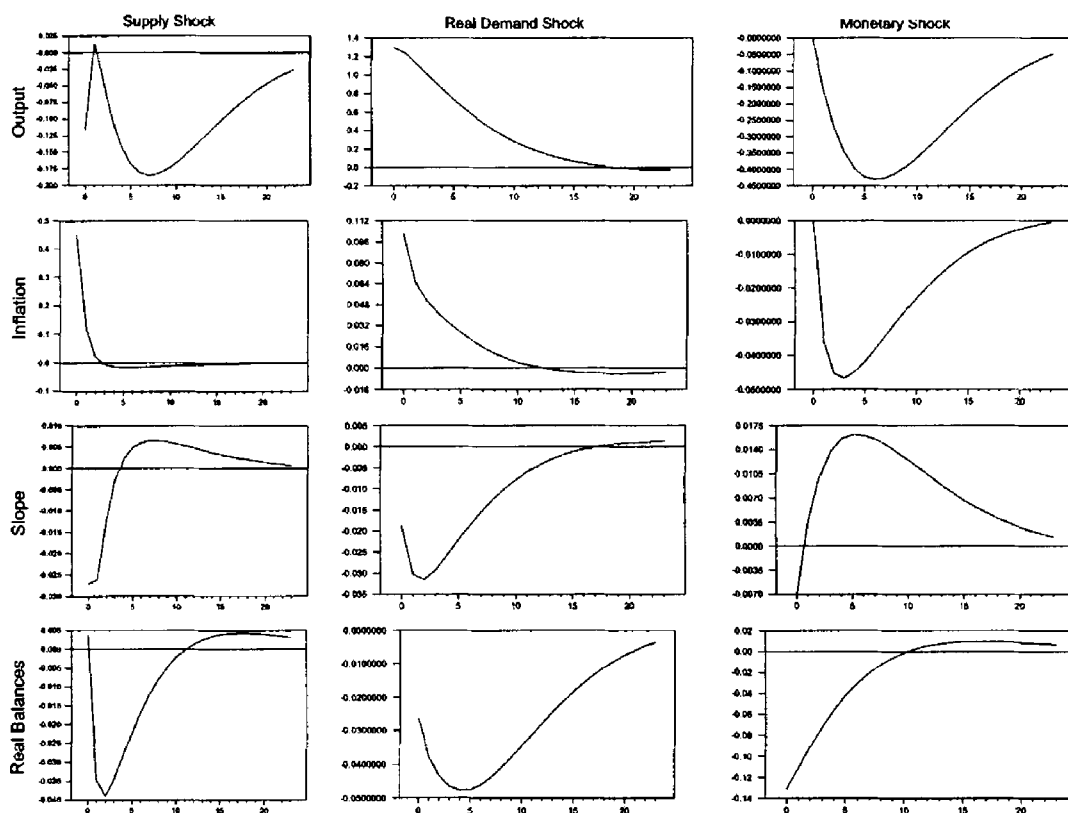


Figure 1. US impulse responses

have not been a source of price instability in the sample—they only explain 4–5% of inflation variability at the 24-step horizon and are highly correlated with those extracted from federal funds futures (0.80) and eurodollar rates (0.71) for the same period.

The time path of identified shocks appears to be reasonable (see Figure 2). For illustration, I concentrate on three episodes: 1980–1981, 1985, 2000–2001. The beginning of the 1980s was characterized by high inflation and nominal interest rate variability: consistent with the conventional wisdom the identification approach attributes those movements to monetary and supply disturbances. 1985 witnessed a large appreciation of the US dollar with a substantial worsening of its terms of trade: such a pattern is captured here by the supply shocks, which show large negative values in that year. The 2000–2001 period was characterized by a large fall in investments following the burst of the stock market bubble: the identification scheme produces persistent and significant negative real demand disturbances and no unusual supply disturbances in the period.

In sum, the identification approach recovers disturbances which are structurally interpretable and have a time path which accounts for selected historical episodes reasonably well. The next section examines whether and how these shocks are transmitted to Latin American economies.

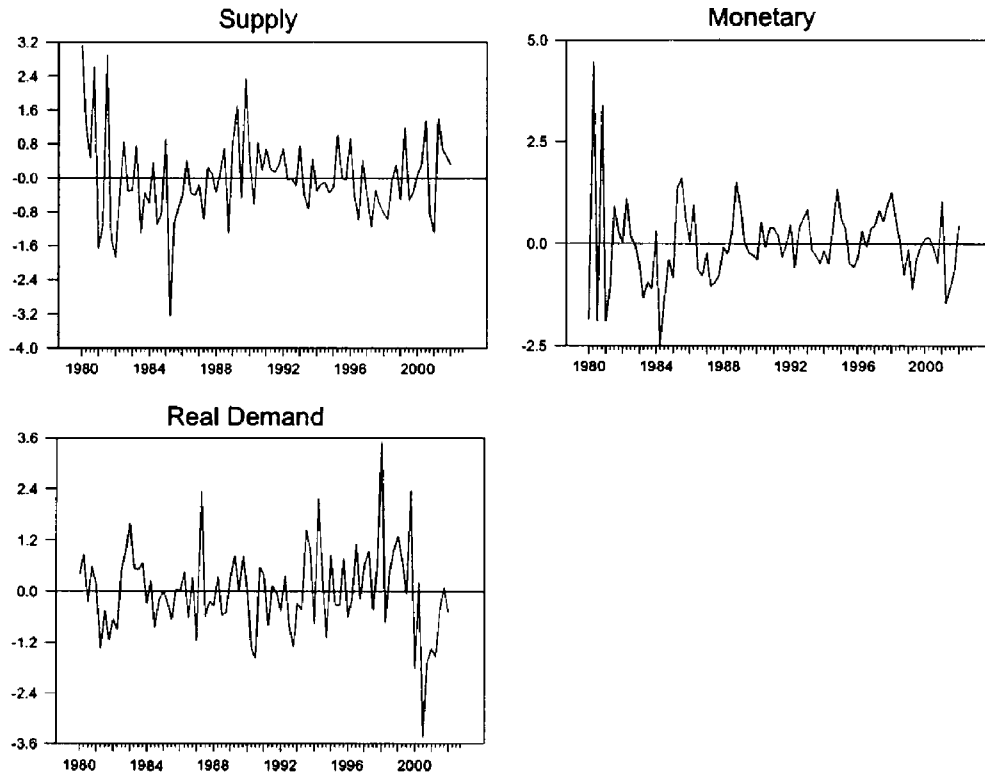


Figure 2. US structural shocks

3. THE LATIN AMERICAN RESPONSE TO US SHOCKS

3.1. The Data and a Few Empirical Issues

The sample period differs slightly across countries depending on data availability: it typically goes from the first quarter of 1990 to the second quarter of 2002 except for Argentina and Brazil whose data starts from the first quarter of 1991. The majority of the variables are obtained from the IFS databank. Reserves, real and nominal effective exchange rates are from the Bank of Spain and compiled using IFS, JP Morgan and own data. I consider five basic variables in the model measuring real activity, inflation, interest rates, trade and the international competitiveness. For real activity the log detrended GDP is used except for Uruguay and Panama where, lacking GDP data, manufacturing production in employed.² For inflation, detrended CPI inflation is employed; for trade, the detrended ratio of exports to imports and for international competitiveness, the real effective exchange rate are used (and supplemented with terms of trade measures when they exist). For interest rates I use 90-day market rates when available or lending/deposit 90–180-day rates as an alternative. Because of data shortages, only one lag is used in the VAR. In the x_t vector I include the same three variables I employed for the USA—an index of world commodity

² Ecuador GDP is from the Bank of Ecuador. For Brazil GDP data are available from 1996. Previous data are reconstructed using industrial production data.

prices, and the indices of bond and equity in emerging markets—and allow them to enter only contemporaneously.

I study the dynamics of propagation in Mexico (MX), Argentina (AR), Brazil (BR), Peru (PE), Uruguay (UR), Chile (CH), Ecuador (EC) and Panama (PA). These countries have different trade links with the USA (see Table I) and therefore provide an interesting benchmark for examining the importance of the trade channel in propagating US shocks. However, all the countries have reasonably large financial links with the USA, and this justifies our interest in treating them as a group. These countries experienced different exchange rate regimes (see the Appendix for a summary of the exchange rate regimes in the 1990s) and span a wide spectrum of experiences regarding domestic and international monetary arrangements. For example, Chile and Mexico are exchange rate floaters, close to inflation targeters; Panama and Ecuador are dollarized (the latter since 2000:1) and the other countries represent intermediate and variable cases.

In a study which tries to examine the channels of ‘normal’ transmission of US shocks, the presence of exchange rate regime switches, currency and other type of crises and contagion effects is problematic. While theoretically relevant, the presence of commodity prices, EMBI and EMEI appears to be sufficient to capture the majority of the fluctuations induced by these factors. In fact, the residuals obtained after a preliminary regression on the x_t vector are well-behaved and show no evidence of outliers or structural breaks.

3.2. The International Transmission of Shocks

In theory, one should expect US shocks to be transmitted for at least three reasons. First, shocks may be common. I have attempted to control for this channel using the x_t variables in both the USA and in each of the Latin American countries. The presence of unidirectional causality from the USA to Latin American countries in the residuals of the VAR suggests that the x_t 's effectively soak up this type of propagation. Second, US shocks may be transmitted through integrated goods markets. Third, they may be transmitted through integrated financial markets.

Intuitively, transmission via trade works as follows (see, e.g., Backus *et al.*, 1994; Mendoza, 1991; Kim, 2001 for this pattern of comovements). Suppose that there is a shock which positively affects the US price level. Then Latin American terms of trade should worsen as the price of imports increases relative to the price of export. This should increase exports and output, decrease imports and positively affect their trade balance. The domestic price level may either increase

Table I. Trade shares with the USA

	1990		1999	
	Export	Import	Export	Import
Argentina	0.09750	0.22992	0.11206	0.19571
Ecuador	0.48106	0.72092	0.41137	0.59132
Mexico	0.83099	0.71201	0.88069	0.74098
Panama	0.34177	0.36792	0.43849	0.35666
Peru	0.20882	0.29785	0.28873	0.31238
Uruguay	0.09119	0.09673	0.06900	0.11260
Brazil	0.25607	0.20412	0.24567	0.23748
Chile	0.17456	0.19036	0.17846	0.18473

Note: The data for Brazil and Chile refer to 2000.

or stay constant, depending on whether the increase in US prices passes through the exchange rate or not, and on whether the boost in aggregate demand affects prices or production more. Movements in interest rates and money depend on the details of domestic monetary policy: if it is accommodative, money will follow domestic output; if inflation is targeted, interest rates should increase. To the extent that US price changes are not translated into price changes in Latin America, either nominal or real exchange rates will adjust to maintain equilibrium. The importance of this channel for real fluctuations obviously depends on the trade links with the USA. From Table I, one *a priori* expects this type of propagation to be important for Mexico, Ecuador and Panama but less crucial for the other countries.

Transmission via financial markets works as follows. Suppose that there is a shock which decreases US interest rates (for example, an expansionary monetary shock). Then Latin American currencies should appreciate (see, e.g., Kim and Roubini, 2000) and when this is not possible, because of fixed rates or currency board agreements, the price level of Latin American securities should increase making local interest rates decline. If the exchange rate adjusts fully and instantaneously, no changes in macroeconomic variables should be observed. When this is not the case, Latin American output and prices may increase. Money supply may increase, if local central banks react positively to output expansion, or contract, if either a currency board agreement is in place (with money supply linked to the returns on US T-bills) or if price concerns drive monetary policy. *A priori*, the importance of this channel depends on at least two factors: the degree of financial integration with the USA and the exchange rate regime in place, with more integrated countries or countries with a fixed exchange rate regime responding more strongly through this channel.

Since the three structural US shocks affect both US inflation and US interest rates contemporaneously, one should *a priori* expect both channels of transmission to play a role. However, their relative importance may have changed over time, given the process of financial liberalization that took place in the 1990s in many Latin American economies. Finally, since the pattern of responses of US interest rates and US inflation differ depending on the shocks, one should expect certain shocks to have larger international repercussions than others.

3.3. The Dynamics of Transmission

I first analyse the dynamics of transmission of US disturbances for a typical Latin American country. Figure 3 presents posterior 68% bands in response to US shocks at steps from 0 to 12. The graphs are constructed numerically, drawing VAR parameters and covariance matrices from their posterior distribution, ordering the results and extracting the 16th and 84th percentiles of the simulated impulse response distribution. Responses are scaled by the size of the US shock.

There are four important features worth discussing. First, US supply and demand disturbances have little effect on Latin American economies: contractionary US supply shocks significantly reduce output after seven quarters and interest rates after two quarters, but both effects are short-lived. Expansionary real demand disturbances significantly increase prices and interest rates three quarters after the shock but, also in this case, the effect lasts one quarter only. Second, the response of Latin American economies to US monetary shocks is typically large and significant. In this latter case, dynamics are stable and well-behaved.

Third, although the mechanics of propagation depend on the shocks, financial market transmission seems to be dominant. In fact, US monetary shocks induce large perturbations in Latin

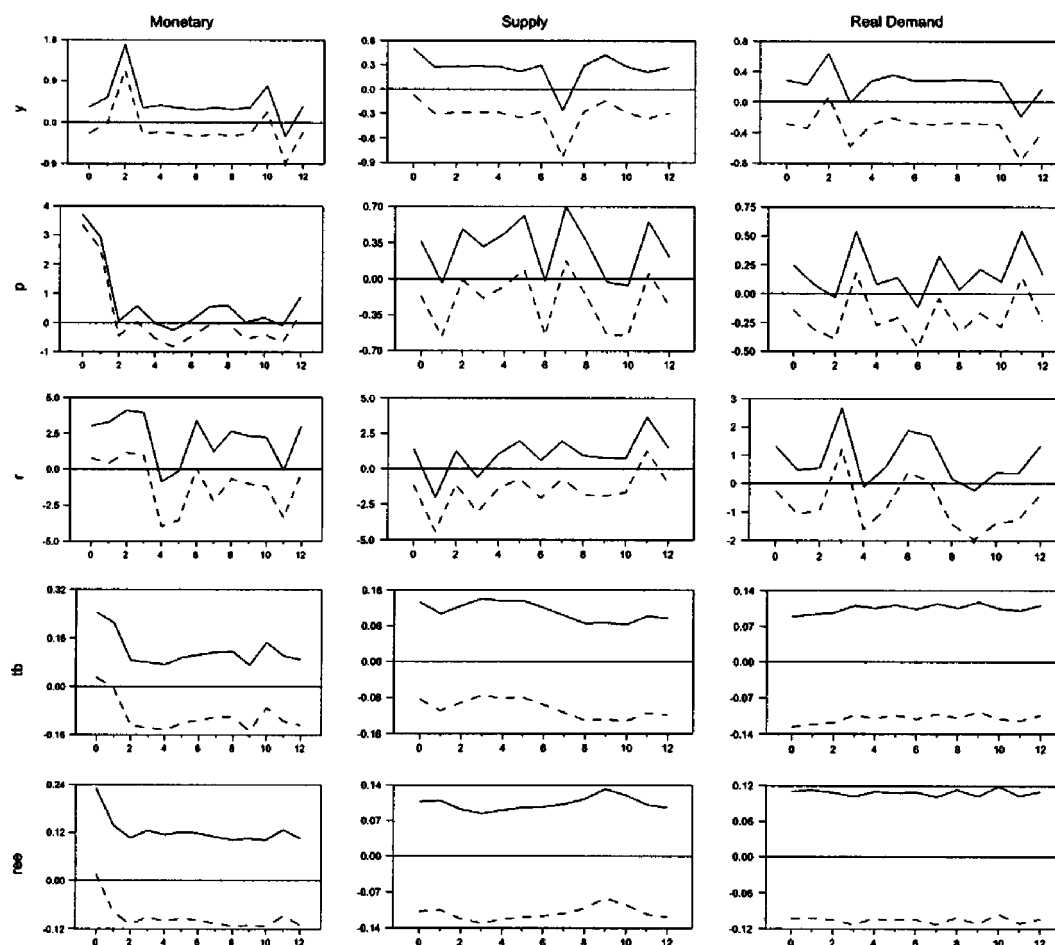


Figure 3. Response to US shocks, typical country

America interest rates and some trade effect (and this is consistent with Kim's, 2001 evidence for G-7 countries) while the other two shocks produce small interest rate repercussions and negligible trade consequences. Fourth, the mechanics of transmission differ somewhat from those observed in developed countries (see, e.g., Eichenbaum and Evans, 1995; Cushman and Zha, 1997; Kim and Roubini, 2000): a US contractionary monetary disturbance significantly and simultaneously increases Latin American interest rates. One can think of three reasons for this large and instantaneous effect: financial markets may force this increase following an increase in the default risk of these countries; local central banks adjust rates to limit exchange rate movements; contractionary monetary policy in the USA increases world interest rates. The first two channels are probably dominant since a large interest rate differential in favour of Latin America is produced. As a result, capital flows to these countries, central bank reserves are improved and local aggregate demand increases. Since the nominal exchange rate is unaffected and consumer prices increase, one may guess that the inflow of capital is primarily spent on non-tradable goods and services. With a two-quarter delay, the inflow of capital then boosts domestic production. Hence, because

of capital inflows, contractionary US monetary disturbances are turned into good output news in Latin America. Note also that while the nominal effective exchange rate is statistically unaffected, the real effective exchange rate (REER) depreciates and this induces a temporary improvement in the trade balance and enhances the output effects of capital inflows. Finally, after the initial period, interest rates in the USA and Latin America track each other reasonably well. Hence, as in Mackowiak (2003), uncovered interest parity seems to hold in the typical country.

As mentioned, one should expect countries with floating exchange rate regimes to be less exposed to the transmission of US shocks than countries with currency boards or similar arrangements. In the sample I consider, it is difficult to distinguish exactly between the two regimes because of the numerous changes occurring and because floaters may suffer ‘fear of floating’ (see Calvo and Reinhart, 2000). Bearing in mind these difficulties, and after some experimentation, I included Chile, Mexico, Brazil and Peru among the floaters group and the other four countries among the non-floaters group. The average responses for the five variables for the two groups of countries in response to US monetary disturbances appear in Figure 4. I concentrate on monetary disturbances because the responses to other disturbances are almost never significantly different from zero and practically identical across the two groups.

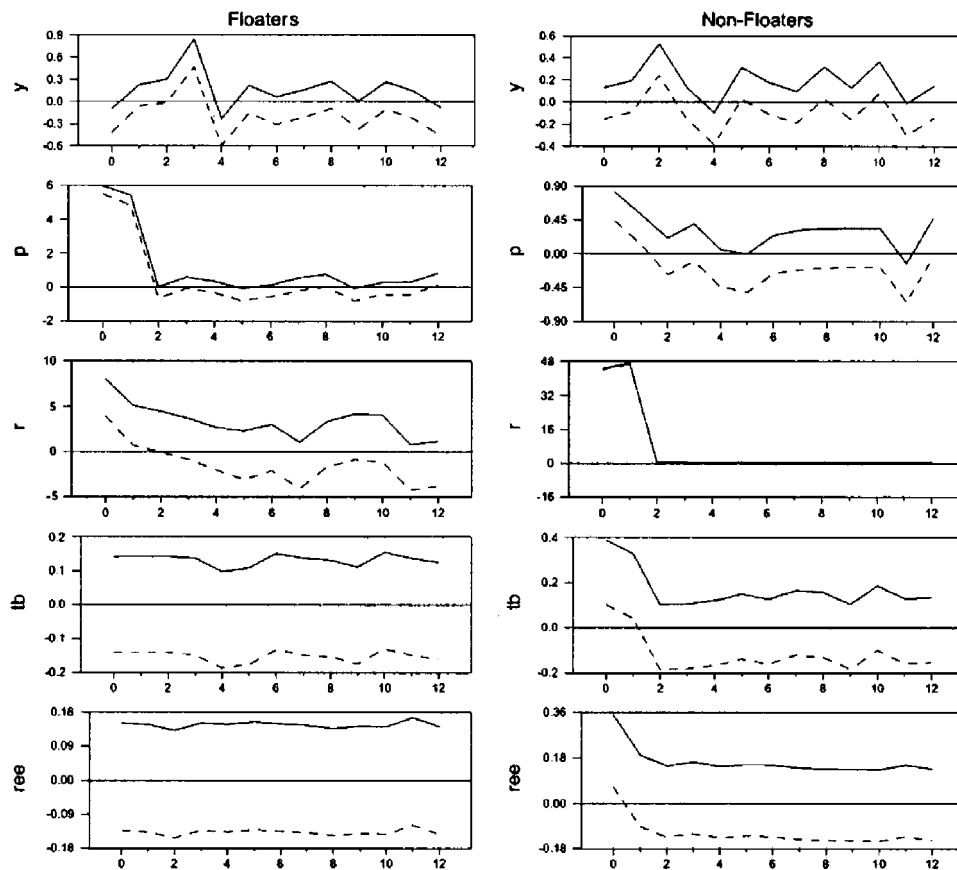


Figure 4. Responses to US monetary shocks

There are important differences between floaters and non-floaters, both in terms of timing and magnitude of the responses, but the pattern of propagation appears to be similar. Non-floaters display large and strongly significant interest rate responses, significant positive trade balance and real effective exchange rate movements, and a reduced domestic inflation effect. Floaters, on the other hand, display a somewhat smaller and less significant interest rate response, no change in the trade balance and in the real exchange rate, and large, positive and significant inflation responses.

These patterns partially fit theoretical expectations: with a currency board, nominal interest rates must react more strongly to shocks which move US interest rates while prices movements are limited by the corresponding price movements in the USA. However, several features of the responses are inconsistent with the conventional wisdom. For example, contrary to the predictions of Calvo (1999), the volatility of interest rates in response to US shocks appears to be larger for non-floaters while price movements are not more sluggish in floating economies. Moreover, output responses are broadly similar in the two groups although smaller in size for non-floaters. This seems to contradict Edwards (2001), who claims that there should be larger output costs for non-floaters, Rojas Suarez (1999), who argues that the loss of the exchange rate instrument limits the ability of monetary authorities to respond to (terms of trade) shocks, and the analysis that Goldfajn and Olivares (2000) have conducted for three small Central American countries. Note also that nominal effective exchange rate movements are insignificant for both groups. Since this fact is puzzling, we will return to this issue in a later subsection. Finally, the fact that the pattern of real effective exchange rate movements is unimportant in determining the size of output costs casts doubts on those analyses which examine terms of trade shocks to draw conclusions about alternative monetary arrangements (see, e.g., Schmitt-Grohe and Uribe, 2001).³

3.4. The Importance of US Shocks

Some of the US shocks seem to have important repercussions in Latin America, but how significant are they, for example, relative to other international shocks or to domestic disturbances? Table II presents the percentage of the forecast error variance of output (Y), inflation (P), nominal interest rates (R), real balances (M/P), the trade balance (TB), real and nominal effective exchange rates (REER and NEER) and reserves (RS) 12 steps ahead explained by US shocks for each country, together with the percentage of the variance explained by external factors (the x_t 's).

There are two important features that emerge from the table. First, there are interesting fluctuations associated with the normal transmission of US shocks. In fact, US shocks account for 19–56% of the variability of the eight macrovariables across countries and between 23% and 53% of the variability of the eight variables within each country. Argentina and Mexico are the countries more exposed to US shocks, and the trade balance and the inflation rate are the variables which fluctuate most. As expected, in countries with partial or complete currency board, movements in domestic variables explained by US shocks are typically larger. Second, international factors, not necessarily linked to developments in the US economy, account for an overwhelming portion of the variability of these eight variables. For example, on average, they account for 58% of the variability of output and for 71% and 75% of the variability of reserves and nominal exchange rates. Panama is the only country where these shocks have limited explanatory power. At the

³I have also computed responses separating countries by their trade ties with the USA and their size. I do not report the results since responses are insignificant for both groups in both experiments.

Table II. Relative contribution of foreign shocks

	Shock	MX	EC	AR	PE	UR	BR	CH	PA	Average
Y	External	0.92*	0.92*	0.26	0.80*	0.09	0.67*	0.88*	0.16	0.58*
	US	0.06	0.05	0.63*	0.14	0.69*	0.33*	0.08	0.78*	0.25
P	External	0.27*	0.23	0.14	0.66*	0.79*	0.35*	0.59*	0.02	0.38*
	US	0.57*	0.58*	0.83*	0.30*	0.15	0.57*	0.26	0.68*	0.48*
R	External	0.24	0.57*	0.20	0.80*	0.25	0.84*	0.21	0.92*	0.29
	US	0.68*	0.25	0.64*	0.57*	0.12	0.63*	0.05	0.56*	0.43*
M/P	External	0.48*	0.93*	0.69*	0.90*	0.55*	0.78*	0.28*	0.86*	0.68*
	US	0.42*	0.06	0.25*	0.08	0.35*	0.20	0.48*	0.11	0.24
TB	External	0.50*	0.12	0.36*	0.24	0.65*	0.54*	0.07	0.33*	0.35*
	US	0.43*	0.79*	0.59*	0.69*	0.35*	0.46*	0.93*	0.67*	0.56*
REER	External	0.45*	0.31*	0.03	0.32*	0.86*	0.48*	0.59*	N.A	0.50*
	US	0.47*	0.62*	0.92*	0.49*	0.11	0.45*	0.38*	N.A	0.43*
NEER	External	0.77*	0.90*	0.74*	0.57*	0.68*	0.65*	0.71*	N.A	0.75*
	US	0.20	0.08	0.23	0.23	0.19	0.30*	0.26	N.A	0.19
RS	External	0.78*	0.47*	0.71*	0.72*	0.86*	0.62*	0.79*	0.76*	0.71*
	US	0.15	0.48*	0.24	0.26*	0.11	0.32*	0.17	0.17	0.22
Average	External	0.51*	0.51*	0.40*	0.56*	0.70*	0.58*	0.64*	0.27	
	US	0.40*	0.39*	0.53*	0.34*	0.23	0.36*	0.29	0.33*	

Notes: The table reports the percentage of the variance of output (Y), prices (P), interest rate (R), real balances (M/P), the trade balance (TB), the real and nominal effective exchange rate (REER and NEER) and reserves (RS) in Mexico (MX), Ecuador (EC), Argentina (AR), Peru (PE), Uruguay (UR), Brazil (BR), Chile (CH), Panama (PA) explained by external and US shocks. An asterisk indicates that the 68% posterior band is entirely above the 10% threshold.

opposite extreme in Chile, Uruguay, Brazil and Peru over 55% of domestic fluctuations are due to these disturbances.

Overall, and excluding Panama, the two sources of external shocks account for 90% of the fluctuations in domestic variables. Hence, contrary to Hoffmaister and Roldos (1997) and in agreement with Calvo *et al.* (1993), Ahmed and Loungani (1999) and Mackowiak (2003), we find that domestic shocks play only a minor role in producing fluctuations in Latin American economies and the imported component of domestic fluctuations in all countries is substantial. This is consistent with analyses conducted in OECD countries. For example, Cushman and Zha (1997) find that for Canada approximately 75% of the variance of domestic variables is due to external shocks and Kim and Roubini (2001) show that external shocks are an important source of output fluctuations in non-US G-7 countries.

3.5. Continental Business Cycles?

Students of international business cycles and proponents of currency unions are interested in the pattern of real and nominal comovements across countries. While the former would like to know whether a limited number of disturbances can account for the majority of world cyclical movements, the latter see in idiosyncratic shocks a threat to certain international monetary arrangements. The exercises I have conducted allow me to present a few facts about conditional comovements of continental macrovariables in response to US disturbances. These facts should be distinguished from those typically reported in the literature (see, e.g., Agenor *et al.*, 1999), which are based on unconditional correlations.

Tables III–V report a few terms of the cross-correlation function of output, inflation and real balances between each Latin American country and the USA in response to US shocks.

Overall, both the direction and the magnitude of the comovements depend on the type of shocks.

Recall that a contractionary US supply shock induces negative responses in US output and US real balances and positive responses in US inflation and short-term rates. Such shocks produce positive comovements in US and Latin American outputs, and the point estimate of

Table III. Cross-correlations of output in response to shocks

	Supply			Monetary			Demand		
	-1	0	1	-1	0	1	-1	0	1
US–MX	-0.518*	0.036	0.153*	-0.069	-0.135*	-0.035	-0.055	-0.116	-0.254*
US–EC	-0.162*	0.383*	0.013	0.152*	0.192*	0.212*	-0.059	-0.020	0.023
US–AR	0.377*	0.564*	-0.057	-0.021	-0.297*	-0.310*	0.004	0.033	0.042
US–PE	0.338*	0.199*	0.052	-0.334*	-0.576*	-0.038	-0.123	-0.048	-0.028
US–UR	0.222*	0.306*	0.403*	0.197*	0.001	-0.106	-0.338*	0.352*	0.070
US–BR	0.521*	0.285*	0.183*	-0.329*	-0.417*	-0.035	0.218*	0.268*	0.156*
US–CH	0.451*	0.243*	0.143	-0.247*	-0.317*	0.194*	0.171*	0.205*	0.208*

Table IV. Cross-correlations of inflation in response to shocks

	Supply			Monetary			Demand		
	-1	0	1	-1	0	1	-1	0	1
US–MX	0.003	-0.063	-0.363*	0.491*	0.655*	0.277*	-0.034	-0.062	-0.152*
US–EC	-0.024	-0.110	-0.352*	0.520*	0.656*	0.270*	-0.140	-0.130	-0.321*
US–AR	0.020	0.102	-0.165*	0.504*	0.615*	0.216*	0.033	0.022	-0.043
US–PE	-0.020	-0.029	-0.307*	0.523*	0.634*	0.221*	-0.036	-0.049	-0.249*
US–UR	-0.032	-0.063	-0.454*	0.376*	0.702*	0.421*	-0.077	-0.066	-0.177*
US–BR	-0.008	-0.028	-0.390*	0.516*	0.644*	0.255*	-0.122	-0.165	-0.332*
US–CH	-0.001	0.022	-0.443*	0.502*	0.652*	0.277*	-0.295*	-0.398*	-0.419*
US–PA	0.027	-0.017	0.104	0.353*	0.432*	0.093	-0.181*	-0.341*	-0.145

Table V. Cross-correlations of real balances in response to shocks

	Supply			Monetary			Demand		
	-1	0	1	-1	0	1	-1	0	1
US–MX	0.476*	0.478	0.608	-0.239	-0.112	-0.077	0.367	0.463*	0.184
US–EC	0.734*	0.246*	-0.068	0.028	0.015	0.040	0.145	0.674*	0.508*
US–AR	0.338*	0.486*	0.511*	-0.118	-0.100	-0.264*	-0.329*	-0.312	-0.397*
US–PE	-0.135	0.301*	0.538*	0.143	0.050	-0.108	-0.512*	-0.736	-0.507*
US–UR	-0.392*	-0.424*	-0.355*	-0.660*	-0.666*	-0.269*	-0.101	-0.108	0.254*
US–BR	-0.446*	-0.229*	0.080	0.146	0.007	-0.003	-0.290*	0.169	-0.026
US–CH	-0.102	0.271*	0.621*	-0.104	-0.158	-0.168	-0.242*	-0.291	-0.611*
US–PA	-0.442*	-0.345*	0.032	0.060	-0.126	-0.120	-0.137	0.087	0.363*

Notes: Tables III–V report $\text{corr}(x_t, y_{t-1})$, $i = -1, 0, 1$ where x_t is the US variable and y_t the corresponding variable for Mexico (MX), Ecuador (EC), Argentina (AR), Peru (PE), Uruguay (UR), Brazil (BR), Chile (CH) and Panama (PA). An asterisk indicates that the 68% band does not include zero.

the contemporaneous correlations ranges from 0.03 (Mexico) to 0.56 (Argentina). The size of the responses seems to be independent of the trade ties with the USA and the size of the countries. The correlation of inflation rates is mixed, ranging from -0.11 to 0.10 contemporaneously, but all correlations turn negative, albeit insignificant, at the first lag. The effect on real balances is very mixed: there are countries where the correlation with the US real balances is positive and large (e.g. Argentina or Mexico) and others where it is negative and large (Uruguay, Panama and Brazil).

The responses of Latin American output and inflation to a US demand shock are, in general, small and insignificant. Recall that an expansionary shock of this type makes output, inflation and short rates increase and real balances decline in the USA. Contemporaneous Latin American output responses are sizable only in Brazil, Chile and Uruguay. Inflation correlations are negative at all three horizons, stronger at the one lag and significant for Chile, Brazil and Ecuador. Once again, trade and size do not seem to matter. The behaviour of real balances is also mixed: some correlations are highly positive (Ecuador and Mexico) and others highly negative (Peru). For the remaining countries no clear pattern emerges.

A contractionary US monetary shock makes US short-term interest rates increase, producing declines in US output, inflation and real balances. Output comovements have mixed sign: they are significant and negative in Peru, Brazil, Argentina and Chile and insignificant for all other countries. Latin American inflation comoves positively with US inflation. In this case the maximum correlation is contemporaneous and reaches on average 0.6. Finally, comovements in real balances depend on the country: negative correlations exceed in number positive ones and are typically larger.

To summarize, there is some evidence of a continental business cycle driven by US shocks (see also Loayza *et al.*, 1999). Monetary and supply disturbances generate sizable output comovements, while the real comovements generated by real demand shocks are small. Inflation comovements are present and they tend to be stronger when demand shocks drive the US economy. Finally, conditional correlations are, roughly speaking, independent of the country size, the trade ties and the monetary regime in place.

3.6. Fear of Floating and Dollarization

While Ecuador and El Salvador have followed Panama and dollarized in the last few years, the policy debate on the costs and benefits of dollarization is still open. The exercises I have conducted allow me to discuss two relevant issues in the debate: whether the exchange rate regime and/or the degree of dollarization of the economy makes a difference in the transmission of US shocks and whether the output effects of US shocks in dollarized vs. non-dollarized countries are different.

Figure 4 indicated that differences between floating and non-floating economies have more to do with the magnitude of the responses than with the pattern of propagation. Furthermore, output responses are roughly similar in the groups of countries. What is the country-specific information telling us about this issue? Unfortunately not much: country-specific output responses to US monetary disturbances are heterogeneous and posterior estimates imprecise. One reason for the large posterior uncertainty could be the multiple exchange rate regimes experienced in the sample. Similarly, heterogeneities may be due to the presence of multiple regimes and to differences in their durations. Despite this negative conclusion, there are two features of country-specific output responses which are worth mentioning. First, they appear to be more synchronized in terms of

timing and shape among floaters than non-floaters. Second, the peak response in non-floating countries is somewhat delayed relative to the others.

As mentioned, the pattern of nominal effective exchange rates, interest rates and price responses appears to contradict the conventional wisdom regarding the differences between flexible vs. fixed exchange rate regimes. One possible explanation for the homogeneity we find is that countries in the floater group are actually suffering 'fear of floating' (see Calvo, 1999; Calvo and Reinhart, 2000). That is, the nominal exchange rate is only notionally free to move because central banks use reserves to contain nominal exchange rate volatility. This explanation is appealing because it can reconcile two facts: the insignificant movements of exchange rates among floaters and the similarities in the transmission of US monetary shocks in the two groups of countries.

One way to verify the relevance of this explanation is to examine the behaviour of central bank reserves: if fear of floating is present, the response of reserves should be contemporaneously negative and roughly similar in magnitude across all countries, regardless of the exchange rate regime in place. Figure 5 provides mixed evidence on this conjecture: while in Mexico reserves fall following US monetary shocks, in Brazil, Chile and Peru reserves increase (in the latter case with a delay). Furthermore, the responses of reserves to the other two shocks are insignificant everywhere except for Brazil and, in the case of demand shocks, for Ecuador. There are two possible interpretations of this evidence. First, domestic interest rate jumps in response to US shocks are sufficient to limit nominal exchange rate variability without affecting reserves (as suggested, e.g., by Lahiri and Vegh, 2000). Second, reserves are mostly unaffected because credit lines from international institutions or borrowings from future markets are temporarily used to respond to external shocks. While in principle possible, we have no data to support or disprove this conjecture.

In sum, I find little evidence supporting the idea that the exchange rate regime matters for both the magnitude of output responses and the mechanics of transmission of US shocks but, except for Mexico, fear of floating does not seem to be the explanation. There are two other, less mundane reasons which can explain this pattern. The first is that differences across regimes are really small and the limited amount of data does not allow me to distinguish them. The second is that the sample mixes different exchange rate regimes in many countries, effectively blurring the differences. While both explanations have some merit they fall short of accounting for the evidence. For example, Panama was dollarized while Chile was floating over the entire period and the responses of variables in the two countries do display sizable differences.

3.7. Exchange Rates and US Shocks: Three Case Studies

The posterior estimates I have obtained allow me to undertake a counterfactual exercise which may shed further light on the channels of transmission of US shocks to Latin America. The exercise traces out the time path of the nominal effective exchange rate of Mexico, Brazil and Argentina if only US shocks were present. Here, I am interested in the path produced in 1994, 1998 and 2001, the years when these countries experienced a currency crisis. In other words, I wish to analyse whether US shocks have contributed to stabilize or destabilize the nominal exchange rate in these episodes. Figure 6 presents the counterfactual nominal effective exchange path, in deviation from its predicted value based on x_t and lags of y_{it} , implied by each of the three shocks. Darker areas indicate the years under consideration.

The contribution of US shocks to the 1994 Mexican crisis was small: both demand shocks were inducing a slight appreciation of the peso while the supply disturbance was inducing a slight

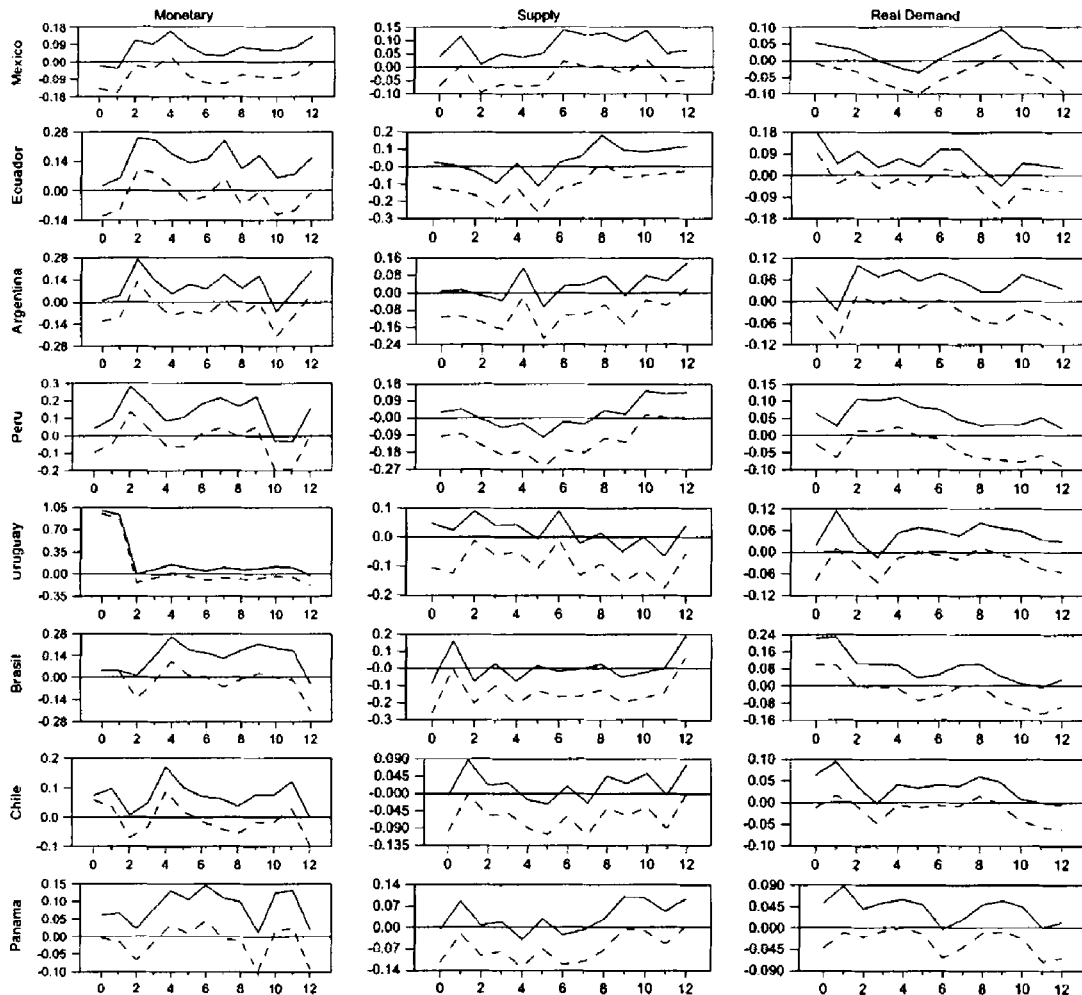


Figure 5. Reserve responses to US shocks

depreciation, but the combined effect of the three shocks on the exchange rate was negligible. In Brazil, US demand shocks were counterfactually producing a large depreciation of the real while supply shocks were producing an appreciation. Each effect is large and significant and the combined contribution of the three shocks to the exchange rate was negative (-0.35). Therefore, in 1998, US shocks were piling on top of international speculative pressures, following the contagion effect of the Asian and Russian crises, in forcing a depreciation of the real. For Argentina, US supply shocks appear to produce negligible nominal effective exchange rate movements in 2001 but the two demand shocks were inducing an effective appreciation of the peso. Once again, the magnitude is large: by the end of 2001 the combined effect of US shocks would have produced a 36% appreciation of the peso.

In sum, US shocks play an important role in the dynamics of nominal exchange rates of all the three major countries in Latin America. Although each episode has idiosyncratic characteristics,

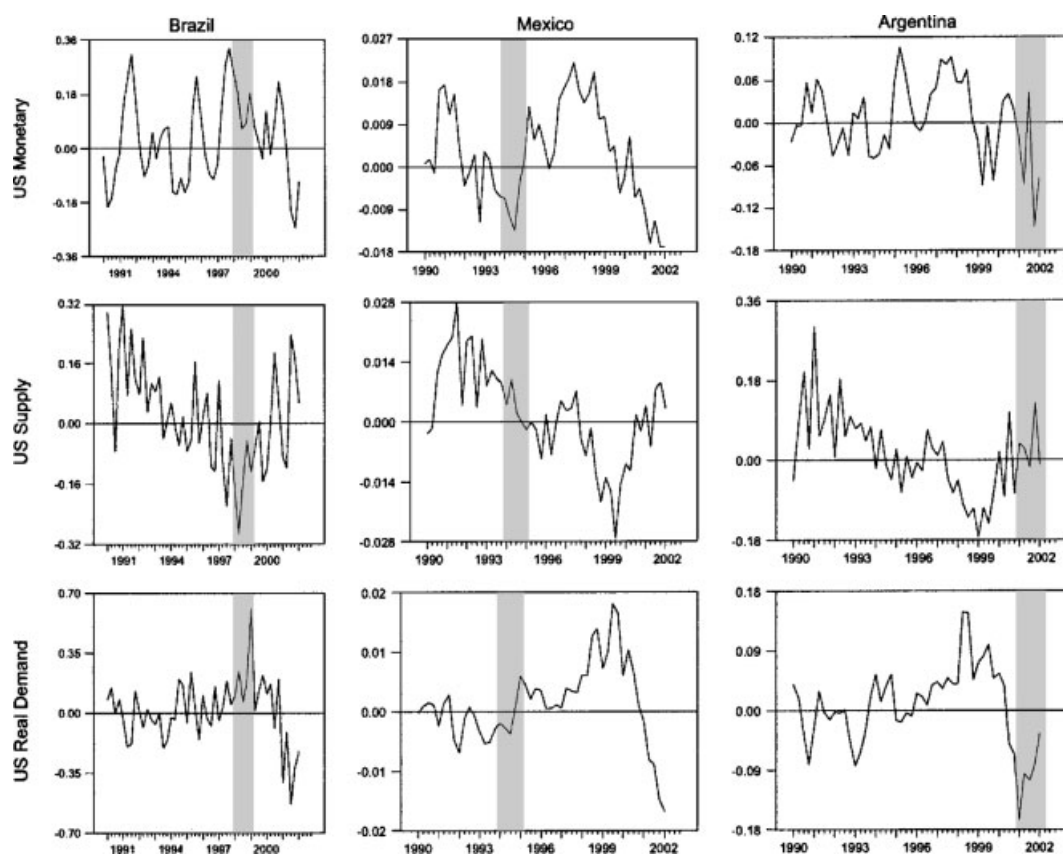


Figure 6. Counterfactual nominal effective exchange rate

developments in the US economy seem to have played a destabilizing role in the case of Argentina and Brazilian crises: in the first case appreciating the nominal (and the real) effective exchange rate and in the second depreciating it.

4. CONCLUSIONS AND SOME POLICY IMPLICATIONS

This paper studied the extent and the features of the transmission of US shocks to Mexico, Panama, Ecuador, Argentina, Uruguay, Peru, Brazil and Chile. I identify US structural shocks using the two-step procedure of Canova and De Nicoló (2002), which first extracts orthogonal innovations from reduced form residuals and then studies whether their informational content is consistent with the restrictions imposed by a large class of theoretical dynamic models. Then I feed these statistical shocks into VAR models for each Latin American economy, study the pattern of propagation, measure their contribution to the variability of domestic variables, and describe conditional comovements in the continent using posterior estimators which efficiently combine cross-sectional information.

Four major conclusions can be drawn from the analysis. First, while US real demand and supply shocks generate insignificant fluctuations in the typical Latin American economy, US monetary disturbances induce large and significant responses in several Latin American macroeconomic variables. The interest rate channel is a crucial amplifier of US monetary disturbances, while the trade channel appears to play a negligible role. Transmission, when it occurs, is almost instantaneous with Latin American variables peaking within a couple of quarters of the shocks. Second, the patterns of transmission differ somewhat from those documented in developed countries. Third, US disturbances account for an important portion of the variability of Latin American macrovariables; induce significant continental output and inflation comovements and, at least in two episodes, have important destabilizing effects on nominal exchange rates. Fourth, while there are differences in the responses of countries with floating and non-floating exchange rates, these differences have more to do with the magnitude of the effects than with the pattern of transmission.

The results of the investigation have important policy implications: putting the house in order is far from being sufficient to avoid cyclical fluctuations in Latin American economies. Given that the majority of domestic fluctuations are of foreign origin, Latin American policymakers are required to carefully monitor international conditions and to disentangle the informational content of US disturbances in order to properly react to external imbalances. Moreover, since US monetary policy has important destabilizing exchange rate effects, the Fed ought to adopt a broader point of view when choosing the level of US interest rates, possibly internalizing some of the external consequences.

Finally, since the exchange rate regime and/or the degree of dollarization of the economy do not appear to matter either for the transmission of US shocks or for the size of domestic real fluctuations, the question of whether Latin American countries should dollarize or not, a question currently at the forefront of policy debates, seems somewhat ill-posed. Whether our results are due to fear of floating, mix of different regimes, shortage of data or insignificant differences across regimes is hard to tell.

The literature has highlighted another aspect of dollarization which is relevant here: the sustainability of the arrangement. It is often stressed that the feasibility of currency areas crucially depends on the presence of comovements in macroeconomic variables across countries. In particular, a fixed exchange rate regime is more easily sustainable if shocks are internationally contemporaneously correlated or if there is a quick transmission of shocks from one country to another. Dollarization imposes a further constraint on this picture as local currency varies only to the extent that 'dollars' enter the country.

The evidence I have collected suggests that important continental comovements in response to monetary shocks do exist, but also that the other two shocks generate mixed output and inflation comovements. Hence, the sustainability of certain international arrangements may well depend on the type of shocks experienced by the US economy. Since interest rates move significantly only in response to monetary shocks, discovering the relative frequency of real demand, monetary and supply shocks affecting the US economy may provide valuable information on whether the dollarization of these economies will be sustainable or not.

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APPENDIX A: EXCHANGE RATE REGIMES

Argentina: Floating rate up to 1990:4; currency board up to 2001:4; floating afterwards.

Brazil: Floating rate up to 1994:4; crawling bands up to 1997:4; crawling bands with two market rates up to 1999:1; floating afterwards.

Chile: Crawling peg, central parity fixed to US dollar or to basket of currencies up to 1999:3; floating afterwards.

Ecuador: Crawling bands with two or three market rates up to 1999:1; floating up to 1999:4; dollarized afterwards. Low degree of dollarization up to 1995.

Mexico: Managed floating.

Panama: Dollarized.

Peru: Floating, partially dollarized.

Uruguay: Managed float up to 1994:4; fixed band up to 1996:4; crawling band afterwards, partially dollarized.

REFERENCES

- Agenor P, McDermott J, Prasad E. 1999. Macroeconomic fluctuations in developing countries. IMF Working Paper, 99–35.
- Amhed S, Loungani P. 1999. Business cycles in emerging market economies. Manuscript, IMF and Board of Governors of the Fed.
- Amhed S, Ickes B, Wang P, Yoo B. 1993. International business cycles. *American Economic Review* **83**: 335–359.
- Arora V, Cerisola M. 2000. How does US monetary policy influence economics conditions in emerging markets. IMF Working Paper, 00–148.
- Backus D, Kehoe P, Kydland F. 1994. The dynamics of the trade balance and of the terms of trade: the J-curve. *American Economic Review* **84**: 84–103.
- Calvo G. 1999. On dollarization. Manuscript, University of Maryland.
- Calvo G, Reinhart C. 2000. Fear of floating. NBER Working Paper, 7993.
- Calvo G, Leiderman L, Reinhart C. 1993. Capital inflow and real exchange rate appreciation in Latin America: the role of external factors. *IMF Staff Papers* **40**: 108–151.
- Canova F, Ciccarelli M. 2004. Forecasting and turning point predictions in Bayesian panel VAR model. *Journal of Econometrics* **120**: 327–359.
- Canova F, De Nicoló G. 2000. Stock returns, term structure, inflation, and real activity: an international perspective. *Macroeconomic Dynamics* **4**: 343–372.
- Canova F, De Nicoló G. 2002. Monetary disturbances matter for business cycles fluctuations in the G-7. *Journal of Monetary Economics* **49**: 1131–1159.
- Canova F, De Nicoló G. 2003. On the source of cyclical fluctuations in the G-7. *Journal of International Economics* **59**: 77–100.
- Canova F, Marrinan J. 1998. Sources and propagation of international output cycles. *Journal of International Economics* **37**: 22–54.
- Canova F, Pina J. 2001. Monetary policy misspecification in VAR models. In *New Trends in Macroeconomics*, Diebolt C, Krystou C (eds). Springer-Verlag: New York.

- Ciccarelli M, Rebucci A. 2000. Asymmetries in the transmission mechanism of European monetary policy. Manuscript, University of Alicante and IMF.
- Cogley T, Sargent T. 2003. Drifts and volatilities in US monetary policies. Manuscript, University of Arizona.
- Cooley T, Quadrini V. 2001. The costs of losing monetary independence: the case of Mexico. *Journal of Money Banking and Credit* **33**: 370–398.
- Cushman J, Zha T. 1997. Identifying monetary policy in a small open economy under flexible exchange regime. *Journal of Monetary Economics* **39**: 433–448.
- Edwards S. 2001. Dollarization and economic performance: an empirical investigation. NBER Working Paper, 8274.
- Eichenbaum M, Evans C. 1995. Some evidence on the effects of monetary policy on exchange rates. *Quarterly Journal of Economics* **110**: 975–1009.
- Fackler J, Rogers J. 1995. Output, inflation and stabilization: a counterfactual analysis. *Journal of International Money and Finance* **14**: 619–640.
- Farmer R. 1997. Money in a real business cycle model. *Journal of Money, Banking and Credit* **29**: 568–611.
- Goldfajn I, Olivares G. 2000. Is adopting full dollarization the solution? Looking at the evidence. Manuscript, PUC-Rio.
- Hoffmaister A, Roldos J. 1997. Are business cycles different in Asia and Latin America. IMF Working Paper, 97–9.
- Kim S. 2001. International transmission of US monetary policy shocks: evidence from VARs. *Journal of Monetary Economics* **48**: 339–372.
- Kim S, Roubini N. 2000. Exchange rate anomalies in industrialized countries: a solution with a structural VAR approach. *Journal of Monetary Economics* **45**: 561–586.
- Lahiri A, Vegh C. 2000. Living with the fear of floating: an optimal policy perspective. In *Preventing Currency Crises in Emerging Markets*, Edwards S, Frankel J (eds.) Chicago University Press: Chicago.
- Loayza N, Lopez H, Ubide A. 1999. Sectorial macroeconomic interdependencies: evidence for Latin America, East Asia and Europe. IMF Working Paper, 99/11.
- Mackowiak B. 2003. External shocks, US monetary policy and macroeconomic fluctuations in emerging markets. Manuscript, Humbolt University.
- Mendoza E. 1991. Business cycles in a small open economy. *American Economic Review* **81**: 797–818.
- Mendoza E. 2001. The benefits of dollarization when stabilization policy lacks credibility and financial markets are imperfect. *Journal of Money Banking and Credit* **33**: 440–474.
- Prasad E. 1999. International trade and business cycle. *Economic Journal* **109**: 580–606.
- Rojas-Suarez L. 1999. Dollarization in Latin America. paper prepared for *Hearing on Official Dollarization in Latin America*, US Senate, Banking Committee, Washington, DC (www.senate.gov/banking/9907hrg/071599/rojas.htm).
- Schmitt-Grohe S, Uribe M. 2001. Stabilization policy and the costs of dollarization. *Journal of Money Banking and Credit* **33**: 482–509.
- Sims C. 1980. Comparison of interwar and postwar business cycles: monetarism reconsidered. *American Economic Review, Paper and Proceedings* **70**: 250–257.
- Sims C, Zha C. 1998. Bayesian methods for dynamic multivariate models. *International Economic Review* **39**: 949–968.
- Sims C, Zha T. 2001. Macroeconomic switching. Manuscript, Princeton University.
- Ulhig H. 1999. What are the effects of monetary policy: results from an agnostic identification approach. Tilburg University, CentER Working Paper, 9928.