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Abstract: This paper studies the sources of economic fluctuations and their implications for exchange rate regime choice in key Latin American countries. In general, external shocks play a limited role in driving output fluctuations in these countries; this absence of common business cycles undermines the case for fixed exchange rates. On the other hand, although there is some evidence that real exchange rates depreciate in response to adverse external shocks, this depreciation, in turn, tends to contract output in the short run. This suggests that exchange rate rigidity may not be as costly for these economies as conventional economic theory predicts.

Keywords: economic fluctuations, Latin America, exchange rate regimes, dollarization.
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1. Introduction

This paper examines the sources of economic fluctuations in six Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela) using a dynamic panel model. Specifically, we are interested in the extent to which short-term fluctuations in output, inflation, and the real exchange rate in these countries are driven by external shocks, such as terms of trade, foreign output, and U.S. real interest rate shocks, versus other economic disturbances (which are identified as real exchange rate, domestic output, and domestic price level shocks).

The primary goal here is to examine the implications of our results for the choice of appropriate exchange rate regimes in developing countries, a topic of much recent debate. To this end, we address the following questions: (1) Does the evidence support the hypothesis that these Latin American countries form an optimal currency area with their main trading partners, a prominent one of which is the United States? In other words, are the business cycles of these countries related to those of their trading partners, including the United States, in such a way that the monetary policy being pursued by these trading partners at any particular time would happen to be the right policy for these countries also? (2) Historically, have recessions in these countries been caused more by adverse external shocks or adverse domestic shocks? (3) Historically, have real exchange rate movements in these countries been important in promoting appropriate adjustments of the economy to external and domestic shocks?

A near-consensus seems to be emerging in the literature that emerging market countries should consider only "polar" regimes of a fully floating or rigidly fixed exchange rate, rather than more mixed systems such as adjustable pegs, which have been particularly prone to ending in crises. (See, for example, Fischer [2001].) However, it remains controversial which of the two polar regimes–rigidly fixed or fully floating–is more appropriate; Frankel (1999), in particular, has emphatically argued that no single exchange rate regime is appropriate for all countries at all times.   The answers to the questions posed above would seem to be at least some of the relevant key considerations in making the right choice for the Latin American countries. Although there has been no dearth of recent debate on these questions in the context of developing countries in both policy and academic circles, there has been relatively little formal empirical analysis that could be used to provide a *quantitative* assessment, which motivates this paper.

The remainder of the paper is organized as follows: section 2 provides a selective review of the previous related literature; section 3 lays out the empirical methodology and discusses the data; section 4 presents and interprets the empirical results for the benchmark model; section 5 discusses some alternative empirical models and examines robustness; and, finally, section 6 provides a summary of the results and the main conclusions.

2. Previous Literature

This study is related to two main lines of inquiry: the literature on the sources of business fluctuations and the literature on exchange rate regimes in developing countries.

The stylized facts of macroeconomic fluctuations in developing countries have been documented by Agenor, McDermott, and Prasad (2000). They find that output fluctuations in developing countries tend to be positively related to those in industrial countries and to world real interest rate changes.[1] While suggestive, these facts do not identify the actual shocks that these economies are subject to.

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[1]By contrast, Larsen and Aziz (1997) find that since the mid-1980s, there has been an apparent decoupling of the business cycles of the ASEAN and industrial countries.

An interesting study that does try to identify the fundamental shocks is Hoffmaister and Roldos (1997). Using panel data, they conclude that *domestic country-specific aggregate supply* shocks are by far the most important source of output fluctuations in the Asian and Latin American countries, which seems to contradict the stylized facts mentioned above. Besides the strong assumptions embedded in their long-run identification restrictions, a problem with their study is that it does not allow for an explicit foreign output shock–this is important because knowledge about shocks countries share in common can be a key input into the decision of the kind of exchange rate regime to adopt. By contrast, the empirical specification of this paper allows for the possibility of such common shocks.

Some other studies have also empirically distinguished between external and domestic shocks for developing countries, e.g. Fackler and Rogers (1995), Reinhart (1995), Edwards and Vegh (1997), and Montiel (1997). However, typically these studies focus either on only one or two countries, or on a very limited number of shocks and variables. This paper uses a rich enough classification of shocks and variables that is needed to be able to adequately answer the questions related to the choice of exchange rate regimes in emerging markets raised earlier.[2,3]

Next we turn to the literature that more directly focuses on exchange rate regimes. The early work on optimal currency areas (OCAs)–Mundell (1961), McKinnon (1963), and Kenen (1969)–identifies the main costs of joining a currency bloc as the loss of flexibility a separate currency provides in responding to adverse shocks (including through counter-cyclical monetary

[2]Another study that does this using the very different approach of estimating a probit model is Kamin, Schindler, and Samuel (2001). We compare their results to ours in section 4.

[3]Some simulation studies, e.g. Mendoza (1995), find a large role for terms of trade changes in accounting for output fluctuations; this paper will help determine if this also holds in estimated models.

policy, exchange rate adjustments, and a lender-of-last-resort capacity) and loss of seigniorage.[4] One of the main factors, mentioned above, affecting these costs is the nature of the shocks hitting an economy–a country sharing common shocks with other countries may have less need for an independent monetary policy and exchange rate adjustments.[5]

Even if the costs of giving up one's own currency completely or moving to a rigidly fixed exchange rate system are not low, countries may still prefer to do so if the benefits of doing this are sufficiently large. The main potential benefit that has been highlighted in the case of developing countries is the policy credibility and confidence gains from a rigidly fixed exchange rate, which lead to a permanently lower inflation rate. Ghosh *et al* (1997) and Ghosh, Gulde, and Wolf (1998) argue that empirically this benefit is quite large.

Several studies imply that giving up exchange rate flexibility may not be very costly for developing countries in the first place because, contrary to conventional economic theory, devaluations in these countries actually contract output and, thus, destabilize the economy. Early papers highlighting this effect include Diaz-Alejandro (1963), Cooper (1971), and Krugman and Taylor (1978). More recently, this literature has expanded to emphasize balance sheet effects that raise the domestic-currency real value of external liabilities–Lizondo and Montiel (1989), Eichengreen and Hausmann (1999), Cespedes, Chang, and Velasco (2000), Christiano, Gust, and Roldos (2000)–and adverse confidence effects that dry up access to international capital markets–Calvo and Reinhart[2001a])–as the reasons for the contractionary effects of devaluations. Previous empirical work has also generally supported the idea that

[4]See, also, Eichengreen (1994) and Masson and Taylor (1993) for surveys of the OCA literature.

[5]The costs are also affected by cross-border factor mobility and factor price flexibility; these features imply less need for exchange rate and monetary policy flexibility in adjusting to asymmetric shocks.

exchange rate depreciations are contractionary in developing countries, e.g. Edwards (1989), Agenor (1991), Copelman and Werner (1995), Kamin and Klau (1998), Kamin and Rogers (2000).

The above arguments have led some, such as Eichengreen and Hausmann (1999), Calvo and Reinhart (2001a, 2001b), and Hausmann, Panizza, and Stein (2001), to question the advisability of floating exchange rate regimes for emerging-market countries. However, as noted in the introduction, the question of which exchange rate regime is right for developing countries remains controversial. Two reasons may, at least partly, account for this: first, there is (as, for example, Edwards and Savastano [1999] argue) a dearth of episodes of truly floating exchange rates in those countries, so that history may not be a good guide for what would happen in pure floats in these counties; second, it remains an open question whether, in the empirical work that finds that devaluations are contractionary, adequate controls have been made for other factors that may directly influence both output and the real exchange rate.

This paper attempts to provide some new evidence with the second problem in mind. The goal is to provide more comprehensive results for several countries in a unified framework that can give a *quantitative* assessment of the effects that real devaluations historically have had on output in Latin America, after controlling for a number of external shocks.[6]

3. Empirical Model, Methodology, and Data

The empirical methodology is to estimate a six-variable vector autoregression (VAR) model using annual data from Argentina, Brazil, Chile, Colombia, Mexico over the period 1983-1999 in

[6]Kamin and Rogers (2000) also control for a variety of factors that might create a spurious, positive raw correlation between exchange rate depreciation and output growth; even with these controls, they still find a positive long-run link between the two variables using Mexican data. This study will help in determining whether their results on Mexico apply more generally to other Latin American economies.

a panel setting. Of the six variables we consider, three (the terms of trade, foreign output, and the U.S. real interest rate) are determined only by external factors and are labeled "external variables," while the remaining three (real exchange rate, output, and price level) are influenced by domestic factors *in addition* to the external variables, and are labeled "domestic variables."

Specifically, we estimate the following dynamic, structural system of equations:

$$A_0 X_{it} = \alpha_i + \beta_1 D_{1it} + \beta_2 D_{2it} + \sum_{j=1}^{p} A_j X_{i,t-j} + u_{it} \tag{1}$$

where X_i refers to country i's vector of stationary variables included in the model, A_0 is the matrix of contemporaneous interactions, A_j's, for j > 0, are matrices representing lagged effects, and u is a vector of *i.i.d.* structural errors. The α_i parameters represent country-specific intercept terms and D_{1i} and D_{2i} are high-inflation dummies, taking on values of 1 for observations where country i's annual inflation rates are greater than 100 percent and 500 percent, respectively. These high-inflation dummies allow the intercept terms to be different for periods of very high inflation and of hyperinflation, instead of throwing out these observations altogether.

It will be useful to partition X_i into "external" and "domestic" variables along the lines discussed earlier and also to partition the structural disturbances correspondingly:

$$X_i = \begin{pmatrix} X_{1i} \\ \hline X_{2i} \end{pmatrix} = \begin{pmatrix} \Delta tot_i \\ \Delta yf_i \\ usr \\ \hline \Delta rer_i \\ \Delta y_i \\ \pi_i \end{pmatrix} ; \qquad u_i = \begin{pmatrix} \varepsilon_i \\ \hline \eta_i \end{pmatrix} = \begin{pmatrix} \varepsilon_{1i} \\ \varepsilon_{2i} \\ \varepsilon_{3i} \\ \hline \eta_{1i} \\ \eta_{2i} \\ \eta_{3i} \end{pmatrix} \tag{2}$$

where the external variables (represented by X_1) are the rate of change of the terms of trade

(Δtot), foreign output growth (Δyf), the U.S. real interest rate (*usr*), and the domestic variables (represented by X_2) are the rate of appreciation of the real exchange rate (Δrer), domestic output growth (Δy), and domestic inflation (π) computed as the rate of change of consumer prices. The vector ε represents the vector of external shocks (the terms of trade, foreign output, and U.S. real interest rate shocks, respectively); and the vector η represents the vector of domestic shocks (a domestic real exchange rate shock, a domestic output shock, and a domestic price level shock, respectively). Since we control for the effects that the external variables have on the domestic economy, the real exchange rate shock, the output shock, and the price level shock largely represent domestic influences–hence, the label "domestic shocks."[7,8] Note that the U.S. real interest rate variable, *usr*, does not have an *i* subscript, as it does not vary across countries.

As is well-known, the assumptions that the economic disturbances in the vector *u* are *i.i.d.* do not fully identify structural models like (1). One common method for introducing additional identification restrictions, which we follow here, is to impose a recursive causal ordering on the contemporaneous interactions (the Choleski factorization). This implies a lower-triangular A_0 matrix that, conforming to the partition of external and domestic variables, can be written as:

$$A_0 = \left(\begin{array}{c|c} A_{11}^0 & A_{12}^0 \\ \hline A_{21}^0 & A_{22}^0 \end{array}\right) = \left(\begin{array}{ccc|ccc} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ \hline a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{array}\right) \tag{3}$$

[7]The possibility remains that part of what we call domestic shocks represent some omitted external factors that are not captured by our terms of trade foreign output, and U.S. real interest rate variables.

[8]It would be desirable to *directly* control for domestic monetary policy changes, perhaps by including real domestic interest rates in the system. However, due to the volatility of expected inflation during hyperinflations, it is very unlikely that the *ex post* real interest will be a good proxy for the relevant *ex ante* domestic real interest rate.

The above A_0 matrix implies the following *contemporaneous* causal ordering of the variables: For the external variables, causality runs from terms of trade to foreign output to the U.S. real interest rate, reflected in the lower triangularity of A_{11}^{0} . We put the terms of trade and foreign output before the U.S. real interest rate in the causal ordering to allow for the possibility that U.S. monetary policy may react to these variables within the year. Putting U.S. real interest rates last in the causal ordering of the three external variables also implies, however, that foreign output, which includes U.S. output, does not react to U.S. monetary policy *contemporaneously.* This identification assumption is often made in studies of U.S monetary policy employing monthly or quarterly data, but may be overly strong for annual data. Therefore, we also consider alternative orderings of the external variables, the results of which are discussed in section 5.

With respect to the domestic variables, it is assumed first that the external variables are causally prior to them, which just reflects the small open economy assumption and is the source of the A_{12}^{0} matrix being the null matrix.[9] Also, within the domestic variables, we assume that the contemporaneous direction of causation goes from the real exchange rate to domestic output to the domestic price level, which translates into a lower triangular A_{22}^{0}. In general, it would seem difficult to determine the direction of causality between the real exchange rate and output. Certainly, changes in exchange rate policy, which could be one source of domestically driven shocks to the real exchange rate, can affect output. But economic theory also predicts that changes in output related to changes in domestic productivity relative to foreign productivity

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[9]Note that the small open economy assumption provides further restrictions as well, in that even *lagged* values of domestic variables should not feed back into the external variables, i.e. $A_{12}^{j}=0$ for all j. These further restrictions are not needed for identification and are, therfore, testable. They are imposed in our empirical work, after statistical tests fail to reject them.

affect the real exchange rate as well. Since this latter effect is more a longer run phenomenon in most open-economy models, it seems reasonable to put the real exchange rate ahead of output in the *contemporaneous* causal ordering.

The identification restrictions given in (3) are used to retrieve the structural dynamic system given by (1) from the reduced-from estimated VAR, which is estimated by ordinary least squares (OLS). Note that in dynamic panels with fixed effects, the OLS estimates of the coefficients on the once-lagged dependent variables are biased. The usual practice to correct for this bias is to use second lags as instruments for the once-lagged dependent variables (see, for example, Hsiao [1986], pp. 73-76 and the literature cited therein). As the discussion in Hsiao [p.75] implies, the OLS bias cannot be ignored unless the number of time-series observations (T), is large; the bias is particularly acute with very small $T = 2$ *or* 3. In our sample, $T=17$ is relatively large as far as typical panels go. Moreover, raw correlations indicate that the second lag of growth rates is unlikely to be a good instrument for the first lag of growth rates with our annual data. Hence, we have decided to report OLS results here, rather than results that are obtained from the use of very weak instruments.

Data

The Latin American countries selected for study (Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela) are ones for which annual data on their own variables and their *major trading partners'* relevant variables are easily available. For each country, domestic output is real GDP, the domestic price level is the consumer price index (CPI), foreign output is an export-weighted (using weights from 1999 data) aggregate of the real GDP of the eight largest export markets, the real exchange rate is a broad (covering 35 countries) CPI-based real exchange rate index (with an increase indicating a real appreciation of the domestic currency), and the terms of trade are the ratio of export to import prices (either taken from import and export unit values or from national income accounts data on nominal and real exports and imports). The U.S real interest rate is a monthly average of the 30-day treasury bill rate less the *ex post* consumer price inflation rate. This variable obviously does not vary across the three cross-sections in the panel.

4. Results

Once the structural model is retrieved, impulse responses and variance decompositions are computed. The impulse responses are the dynamic responses of the variables to one standard-deviation shocks to the structural disturbances, and are plotted in figures 1-6. For variables that are in growth-rate form in the VAR, the impulse responses have been accumulated to show the evolution of the levels of the variables over time; the figures also show 1.67 standard-error bands (roughly corresponding to 90 percent confidence intervals).[10] The variance decompositions are the percentages of the error variances at various forecast horizons that are attributable to each of the individual shocks, and are presented in tables 1-3. Our discussion of the results is organized as answers to the specific questions that were posed in the introduction.

Question 1: Are the business cycles of key Latin American countries related to those of its trading partners, including the United States, in such a way that the monetary policy being pursued by these trading partners at any particular time would happen to be the right policy for these countries also?

The two most relevant impulse responses for answering this question are the responses to a foreign output shock (shown in figure 1as a function of the horizon in years, with 0 indicating

[10]The standard errors for the impulse responses and variance decompositions were obtained from Monte Carlo simulations with 5000 replications.

the contemporaneous impact) and the responses to a U.S. real interest rate shock (figure 2). Foreign output includes U.S. real GDP, which, in most cases, has quite a large weight. As figure 1 depicts, a one standard-deviation positive shock to foreign output (which represents an increase of a little over one percent) does not have much of an effect on domestic output–we easily cannot reject the null hypothesis that the response is zero. Moreover, the variance decompositions in table 1 show that the foreign output shock explain, at best, a statistically insignificant 3 percent of the forecast error variance of domestic output growth at up to a six-year forecast horizon.

Since the foreign output variable for the Latin countries includes U.S. output as a major component, it is instructive to examine the response of the U.S. real interest rate to a shock to this variable. As shown in figure 1, a slightly greater than one percent shock to foreign real GDP increases the U.S. real interest rate within the year by about 30 basis points; this is consistent with unexpected increases in U.S. output leading to a tightening of U.S. monetary policy.

Figure 2 shows the responses to a standard-deviation positive shock to the U.S. real interest rate, which implies an increase of just under 1 percentage point. The responses are consistent with the view that tighter monetary conditions in the United States diminish capital flows to the Latin American countries, thereby leading to a contraction of their outputs and a depreciation of their currencies. Specifically, domestic output falls by about ½ percent on impact and by over 1½ percent in the long run, with these responses being statistically significant.[11] The real exchange rate also depreciates over time (by about 8 percent in the long run). However, the currency depreciation does not lead to an increase in prices; we cannot reject the hypothesis that

[11]However, it is puzzling that foreign output (in which U.S. output has a quite large weight for most of the Latin American countries) rises in response to a rise in U.S. real interest rates.

the price-response is zero. The variance decompositions suggest that U.S. real interest rates explain a statistically significant 11 percent of domestic output growth fluctuations at a two- to six-year horizon (table 1) and 4 to 10 percent of real exchange rate fluctuations (table 2).

To sum up, the business cycles of these Latin countries as a whole do not appear to be driven by output shocks in the countries they export to, including the United States. However, U.S. real interest rate movements do appear to have significant effects on outputs in these countries. These results suggest that it is unlikely that the six Latin countries studied here form an optimal currency area (OCA) with the United States, at least as a group.[12] In fact, increasing the rigidity of exchange rate arrangements (such as through currency boards or dollarization) could lead to a situation where U.S. monetary policy changes act as a destabilizing force on these countries. For example, with asymmetric shocks, it is quite possible that the U.S. is experiencing an expansion with inflationary pressures, while a particular Latin American country is in a downturn. In that case, according to our results, the resulting tightening of U.S. monetary policy would contract output further in that Latin American country. A case can be made that this contributed partly to the recent demise of Argentina's currency board-style arrangement.[13]

On the other hand, since domestic monetary policy is not separately controlled for, there is no direct evidence on whether, in fact, in the past, in periods in which flexibility of monetary

[12]This is consistent with the results in Bayoumi and Eichengreen (1994), who find that the Northern American countries or the Mercosur countries do not appear to meet the major criterion of an OCA of having commons shocks. They do identify three regional groupings which face similar underlying disturbances–a Northern European bloc, a Northeast Asian bloc, and a Southeast Asia bloc.

[13]Notice that Argentina's recent peg is not characterized here as a full-fledged currency board. This is because there was some flexibility granted to the central bank to back a limited amount of the monetary base by the Argentine government's domestic dollar denominated assets, rather than foreign exchange reserves. In practice, this provision was only used in emergency situations (in 1995 and in the months prior to the collapse of the peg in early 2002.)

policy has been available, Latin American monetary policy has reacted appropriately to shocks. The history of these economies suggests, however, that this is unlikely to have been the case.

Question 2: Historically, have recessions in key Latin American countries been caused more by adverse external shocks or adverse domestic shocks?

The responses of domestic output to two of the external shocks, foreign output and U.S. real interest rate shocks have already been discussed. The responses to the remaining external shock, a terms of trade shock, are displayed in figure 3. A one standard-deviation positive shock to the terms of trade, an improvement of about 12 percent, increases domestic output with the effect peaking after one year at about a 1 percent rise; the level of output remains elevated in the long-run, but only the one-year lagged effect is statistically significant. Even though these effects on output are of economically significant magnitudes, the variance decompositions in table 1 show that the terms of trade shocks explain less than 8 (and a statistically insignificant), percent of domestic output growth fluctuations at a one- to six-year horizon.

Table 1 also shows that external shocks as a group explain at most about a fifth of the movements in domestic output growth relative to baseline growth at up to a six-year forecast horizon, which, although not a trivial proportion, is not very large.[14]

Turning to the impulse responses of the domestic shocks, as shown in figure 4, a one standard-deviation *positive* shock to the real exchange rate (which translates into about a 14 percent real *appreciation*) leads an increase of about 1½ percent in domestic output within the

[14]Ahmed and Loungani (1998) find similar results for the ASEAN countries. However, in the newly industrialized Asian economies of Hong Kong, Korea, Singapore, and Taiwan, external shocks explain a higher percent of domestic output movements (about 35 percent).

year and output remains above baseline the following year.[15] This implies that devaluations tend to be contractionary, at least in the short run, *even after controlling for the effects of the three external shocks.* Note that the real exchange rate shock by itself explains about a fifth of domestic output growth movements (table 1), as much as the three external factors put together.

Two caveats with respect to the above results need to be emphasized. First, the sample period covers a mix of exchange rate regimes. A discrete large depreciation of the currency in a fixed exchange rate regime may be inherently a different type of change than smaller, more frequent depreciations in floating rate periods. In failed fixed exchange rate regimes, devaluation shocks are often accompanied by domestic austerity measures, capital outflows, and crisis situations. Moreover, in the collapse of a fixed exchange rate regime, while the measured shocks may identify the "final straw that broke the camel's back," it is still difficult to ascertain which of the past shocks led to an accumulation of pressures on the currency which actually made the "final straw" final. This problem is difficult to address. One possible solution is to divide our sample period into periods of fixed and floating exchange rates for each country, but the delineations of the actual timing of exchange rate regime switches for these countries will be messy and subject to debate.[16] However, one thing that can be done at least is to examine if the main results are driven by "extreme" years in which sharp currency devaluations are accompanied by severe recessions. We do so in section 5.

[15]Only the responses of the real exchange rate, domestic output, and prices are shown for the domestic shocks, since, by construction, the dynamic effects of domestic shocks on the external variable are zero.

[16]Edwards and Savastano (1999) point to such difficulties. In a comprehensive very recent study, Reinhart and Rogoff (2002) also forcefully argue that official historical classifications of different countries exchange rate regimes often do not correspond to the actual regimes that were being followed. That said, it might be relatively uncontroversial to classify Mexico as floating from 1995 onwards and Brazil as floating from Feb 1999 onwards, but these characterizations do not give us enough observations to estimate the effects of the various shocks in floating rate regimes with any degree of precision.

The second caveat is that a limited set of external variables has been used here. If there are external factors not captured by these variables, or their interactions with the other variables in our system, the effects of such "omitted" external factors could still appear in our measured domestic shocks. However, we do control for the main candidates for external shocks that are typically discussed in the exchange rate regime literature.

The responses to a domestic output shock are displayed in figure 5. A one-standard deviation positive shock to domestic output (about a 3 percent increase) raises output permanently by an amount close to the size of the initial shock. However, the domestic output shock does not have statistically significant dynamic effects on the real exchange rate.[17] The response of the price level to a positive output shock is negative in the short run. This is suggestive of an "aggregate supply shock" interpretation of the output shock; note that the negative price response is not statistically significant in the short run, but it is borderline significant over the longer run. Considering the variance decompositions, the "own" shocks explain a large fraction of domestic output growth fluctuations (table 1), but output shocks explain hardly any fraction of real exchange rate fluctuations (table 2) .

To sum up, although the external shocks we model are significant determinants of domestic output growth, their relative contribution is only modest (about 20 percent) compared with the contribution of shocks we presume to be stemming largely from domestic influences, including domestic fiscal and monetary policies. However, it is possible that some relevant external factors at work–such as shocks to capital flows resulting from exogenous changes that are *not* caused by the external variables we have modeled–are not included here. As such, our

[17]Note that as an identification assumption the contemporaneous effect of an output shock on the real exchange rate is constrained to be zero, but the dynamic effects are unrestricted.

conclusions on the importance of domestic shocks may be overstated to some extent. [18]

Question 3: Historically, have real exchange rate movements in key Latin American countries been important in promoting appropriate adjustments of the economy to external and domestic shocks?

It should be emphasized that the analysis here is limited to the equilibrating role that the real exchange rate has played in the *actual historical experience* of these countries, which, as already mentioned, consists of a mixture of different exchange rate regimes, including soft pegs which often had to be abandoned in crisis situations. As such, the history of these countries may not be an ideal testing ground for analyzing the effects of a *hypothetical regime switch to a conventional floating exchange rate system*.[19] Yet, this historical experience is still quite relevant, as this is the experience that Latin policy makers often refer to when discussing these issues; many of their doubts concerning the merits of exchange rate flexibility stem from their countries' historical experiences in which neither exchange rate adjustment nor the ability to follow an independent monetary policy seemed to have had much of a stabilizing influence on the economy.

Subject to these caveats, consider the response of the real exchange rate to external shocks, depicted in the real exchange rate panels of figures 1-3. In response to a positive foreign output shock (figure 1), the real exchange rate, surprisingly, depreciates but note that the short run

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[18]Kamin, Schindler, and Samuel (2001) find similar results, using a very different approach. Employing an early warnings systems methodology, they compute the probability of a crisis for a number of developing countries from a probit model. On average, they find only a limited contribution of external variables to the probability of a crisis. However, their results do suggest that adverse swings in external factors may have been important in pushing economies that were already vulnerable (due to domestic factors) over the edge.

[19]This point has been emphasized by Edwards and Savastano (1999), for example.

effects are not significant, although the medium run response (2-3 years out) is. A rise in the U.S. real interest rate (figure 2), an adverse shock for our Latin countries, induces a large and statistically significant real depreciation of the currency, consistent with the notion that a rise in the world real interest rate causes capital outflows from developing countries. Also, as might be expected, a favorable terms of trade shock (figure 3), leads to a real exchange rate appreciation over time, which is almost statistically significant at a one year lag.[20] Note, as shown in table 2, that the terms of trade and U.S. real interest rate shocks together explain roughly 10-20 percent of real exchange rate fluctuations at a two- to six-year forecast horizon.

Overall, the results presented above provide some support for the idea that the real exchange rates in Latin American economies depreciate in response to adverse and appreciate in response to favorable external shocks, at least for foreign interest rate and terms of trade shocks. However, in order for exchange rate changes to promote appropriate adjustment of the economy to various shocks, not only does the real exchange rate need to depreciate in response to adverse external shocks, but the resulting real exchange rate depreciation itself needs to improve external balances, thereby having an *expansionary* effect on output over time. As already seen, exchange rate depreciation shocks actually have a negative, rather than positive, effect on domestic output in these Latin countries, even after controlling for the main external shocks.

5. Robustness

Model with Exports

An important distinction that some researchers have made (see, for example, Canova and Dellas (1993) and Canova (1998)) is between common shocks and shocks that originate in one

[20]Montiel (1997) finds stronger effects of terms of trade movements on real exchange rates in the ASEAN economies.

country but get transmitted to other countries through trade links. If the propagation mechanisms associated with these two types of shocks are different, we may be misspecifying the effects of external shocks in our empirical model. Moreover, which of these two types of shocks hitting the economy is more important may be germane to the issue of choice of exchange rate regime.

One way to address this problem within the general framework used in this paper is to introduce a shock to the demand for exports for these countries separately, and see if the results change much when this is done. We do this by introducing exports into our VAR system and having the following contemporaneous causal ordering of the variables: terms of trade, exports, foreign output, foreign real interest rate, real exchange rate, domestic output, and domestic prices. The idea is that besides terms of trade, there might be other shocks to exports as well, and these should be kept fixed separately and allowed to influence foreign output to see if foreign output shocks, purged of the component that results in a contemporaneous change in exports, still have an effect on the domestic economy.

The results are not formally presented here but the key point to emphasize is that they are very similar to those of the benchmark model, and none of our conclusions changes. Moreover, the results on the effects of the newly introduced export shocks, as well as the results for the effects of other shocks on exports, are quite plausible for the most part. Specifically, a shock that improves the terms of trade increases exports over time, an exchange rate appreciation shock depresses exports one period later when it is allowed to influence exports, and a foreign output shock also feeds back to raise exports in the future. As far as the export shock itself is concerned, it has positive dynamic effects on domestic output, as expected, but, surprisingly, it also leads to a depreciation of the domestic currency, raising some concerns that there might be some contemporaneous reverse causation involved here which our identification scheme is missing.

There is some change in the variance decomposition results. If the entire export shock is treated as arising due to external factors (i.e. is an exogenous shift to the demand for exports arising from rest of the world condition)–which is a very strong assumption–the contribution of external shocks in explaining output growth rises from about 20 percent at best to about 35 percent at best, and in explaining real exchange rate changes rises from about 20 percent to about 40 percent. Note that even under this strong assumption, the majority of domestic output growth and real exchange rate movements are still explained by domestic shocks.

The bottom line is that distinguishing between foreign shocks that might be getting transmitted through trade (here modeled as exports shocks) and other external shocks does not change our key results on the dynamic responses at all, although it does suggest that the basic model presented earlier might be understating somewhat the contribution of external shocks to explaining output fluctuations and real exchange rate changes in the variance decompositions.

Controlling for Sharp (Crisis-Related) Movements in Exchange Rates

To what extent are the benchmark results influenced by very sharp depreciations in exchange rates associated with collapses of pegged exchange rate regimes? Rather than attempt to isolate for each country periods when exchange rates are and are not allowed to respond to shocks–a very difficult task to accomplish–it seems more fruitful to consider whether the results (especially relating to contractionary effects of devaluations) are driven mainly by what happens to these countries in crisis years. Accordingly, we introduced a crisis dummy into our basic model, which takes on a value of 1 for those years in which real exchange rate depreciation exceeded 10 percent *and* real GDP contracted more than 2 percent.[21] This crisis dummy was included in all of our VAR equations and the results were compared to our benchmark model.

Consider first the results on the estimates of the coefficients on the crisis dummy variable. Interestingly, the crisis years do not tend to be characterized by especially adverse terms of trade or adverse foreign output shocks, but are characterized by significantly higher foreign real interest rates. Not surprisingly, given how it is defined, the crisis dummy is highly significant in the output growth and real exchange rate changes equations (t-statistics that are approximately 5 and 7, respectively), indicating a big fall in output growth and a big exchange rate depreciation during crisis years. The crisis dummy is not significant in the inflation equation, but note that separate dummies for high inflation years in our basic model have already been included.

Considering the impulse responses to external and domestic shocks in the model with the crisis dummy, most of the results are almost exactly the same but there are some interesting differences. Specifically, the magnitude of the real exchange rate depreciation following a positive shock to the foreign real interest rate falls moderately. More importantly, the magnitude of the positive short run output response to an exchange rate appreciation shock more than halves, but it is still substantial and statistically significant. The implication is that, while the magnitude of the output response to exchange rate changes is certainly being influenced by the crisis years, the sign and statistical significance are not–we can still reasonably confidently conclude that exchange rate depreciations are contractionary.

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[21]In an exception to this rule, 1983 is designated a crisis year for Venezuela, even though that year's large real exchange rate depreciation was not followed by an output collapse until the next year. This is a judgment call, based on the observation that 1983 is generally regarded as a crisis time for Venezuela.

Thus qualitatively our results and conclusions do not change after taking into account that the crisis years might be different, but the magnitudes of some key responses are smaller.

Alternative Orderings

As discussed earlier, one cannot provide a sound theoretical justification for the recursive ordering of the variables within the block containing the external variables. Although, heuristic arguments defending the ordering used in the benchmark model were given, it was also pointed out that these arguments may not apply strongly to annual data. Accordingly, it is important to show that our results are robust to other plausible orderings of the external variables.

In this regard, it is instructive to study the correlation properties of the shocks in the reduced-form VAR to see which ordering changes might have the potential to affect our results and conclusions significantly; if two reduced-form shocks have very little to no correlation with each other, we already know the results would be affected very little by changing their ordering. The correlation matrix of the reduced-form shocks is presented in table 4. First, note that the correlation of each of the three external shocks with each of the three domestic shocks is relatively low, in the range of 0 to 0.15 in absolute value. This provides some confidence that the block recursivity assumptions under which the external-variables block is causally prior to the domestic block, which follow from our small open economy set-up, are plausible. Second, within the external block, the correlation between the foreign output shock (the second external shock) and the U.S. interest rate shock (the third external shock) is 0.3, while the other two pairs of shocks have roughly a zero correlation. These correlation coefficients suggest that an alternative model in which the causal ordering of the foreign output and U.S. real interest variables is reversed is the relevant ones to consider in examining robustness.

The results from the estimation of this alternative model are very similar to our benchmark results, with two exceptions. First, the puzzling result that foreign output rises in response to a rise in the U.S. real interest rate (noted in footnote 10) is still there, but it becomes statistically insignificant. However, a different puzzle arises, in that the response of the U.S. real interest rate to a positive foreign output shock becomes statistically insignificant; that is, we do not get evidence for countercyclical U.S. monetary policy any more, which seems to be implausible.

6. Conclusion

Recently, there has been renewed interest with respect to emerging-market countries in the age-old question of the appropriate form of exchange rate arrangements. In particular, the dollarization proposal has been vigorously debated. What can we conclude, based on the empirical results of this study, about the desirability from a Latin American perspective of moving to very rigid forms of exchange rate systems, including dollarization? If we take these panel results as representative of the responses of Latin American economies to various shocks, the results are mixed, suggesting no strong, clear case against or in favor of rigidly fixed exchange rates. On the one hand, the lack of causality running from the U.S. business cycle to the Latin American business cycles, together with the cyclical fluctuations that would result in Latin America from U.S. real interest rate changes, suggest that rigidity in exchange rate arrangements is not a good idea. On the other hand, the results that real exchange rates have historically not been very strongly responsive to external shocks, and that devaluations have been contractionary in the short run, seem to indicate that getting rid of exchange rate flexibility may not be as costly as conventional economic theory suggests.

There are, however, some caveats to using a data set that includes failed fixed exchange rate regimes to make the second conclusion above. Although this paper represents a start and attempts to control for external shocks and very large one-time movements in exchange rates, more work needs to be done to sort out whether a “pure” form of exchange rate flexibility might prove to be more useful for emerging market economies.

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Table 1: Variance decomposition of output growth

k (years)	Percentage of the k-step ahead forecast error variance of domestic output growth explained by							
	external shocks			domestic shocks			all external shocks	all domestic shocks
	terms of trade shock	foreign output shock	U.S. real interest rate shock	real exch. rate shock	domestic output shock	domestic price shock		
1	1.6 (2.1)	1.0 (1.4)	3.3 (3.2)	16.4 (6.4)	77.7 (7.0)	0*	5.9	94.1
2	5.9 (4.2)	1.9 (1.8)	10.6 (5.5)	17.4 (5.8)	63.7 (7.4)	0.5 (0.6)	18.4	81.6
3	6.4 (4.1)	2.3 (1.9)	10.7 (5.3)	20.0 (6.2)	59.5 (7.3)	1.1 (0.9)	19.4	80.6
6	7.4 (4.4)	2.8 (2.1)	11.2 (5.4)	19.9 (6.2)	57.5 (7.5)	1.3 (1.0)	21.4	78.7

NOTES: Standard errors in parentheses. The contribution of all external and domestic shocks may not sum exactly to 100 percent due to rounding. An " 0* " indicates contribution constrained to be zero as a consequence of the identification assumptions.

Table 2: Variance decomposition of the rate of change of the real exchange rate

k (years)	Percentage of the k-step ahead forecast error variance of the rate of change of the real exchange rate explained by							
	external shocks			domestic shocks			all external shocks	all domestic shocks
	terms of trade shock	foreign output shock	U.S. real interest rate shock	real exch. rate shock	domestic output shock	domestic price shock		
1	1.0 (1.5)	1.5 (1.9)	1.0 (1.4)	96.4 (2.8)	0*	0*	3.5	96.4
2	6.5 (4.3)	3.0 (2.5)	3.9 (3.2)	83.6 (5.9)	0.8 (1.1)	2.2 (1.6)	13.4	86.6
3	7.3 (4.4)	3.7 (2.6)	6.6 (3.9)	78.6 (6.1)	1.4 (1.4)	2.4 (1.5)	17.6	82.4
6	7.6 (4.3)	4.0 (2.5)	9.8 (4.9)	74.6 (6.8)	1.6 (1.5)	2.5 (1.6)	21.4	78.7

NOTES: Standard errors in parentheses. The contribution of all external and domestic shocks may not sum exactly to 100 percent due to rounding. An " 0* " indicates contribution constrained to be zero as a consequence of the identification assumptions.

Table 3: Variance decomposition of inflation

k (years)	Percentage of the k-step ahead forecast error variance of domestic inflation explained by							
	external shocks			domestic shocks			all external shocks	all domestic shocks
	terms of trade shock	foreign output shock	U.S. real interest rate shock	real exch. rate shock	domestic output shock	domestic price shock		
1	1.4 (1.9)	1.0 (1.5)	1.6 (2.1)	1.2 (1.6)	1.3 (1.7)	93.4 (3.8)	4.0	95.9
2	2.4 (2.4)	1.8 (1.8)	2.7 (2.5)	1.9 (1.9)	2.2 (2.2)	88.9 (4.6)	6.9	93.0
3	3.1 (2.5)	3.5 (2.4)	3.9 (2.6)	2.5 (2.0)	4.4 (3.1)	82.6 (5.2)	10.5	89.5
6	3.5 (2.5)	4.3 ()2.7)	7.3 (4.3)	2.8 (2.0)	4.6 (3.2)	77.5 (6.1)	15.1	84.9

NOTES: Standard errors in parentheses. The contribution of all external and domestic shocks may not sum exactly to 100 percent due to rounding.

Table 4: Correlation matrix of the reduced form VAR residuals

Shock \ Shock	Terms of trade	Foreign output	U.S. real interest rate	Real exch. rate	Domestic output	Domestic price
Terms of trade	1.0	0.08	-0.10	-0.16	0.08	-0.06
Foreign output		1.0	0.30	-0.08	0.02	0.01
U.S. real interest rate			1.0	0.00	-0.15	-0.07
Real exch. rate				1.0	0.40	0.06
Domestic output					1.0	-0.02
Domestic price						1.0

Figure 1: Responses to a shock to Foreign Output

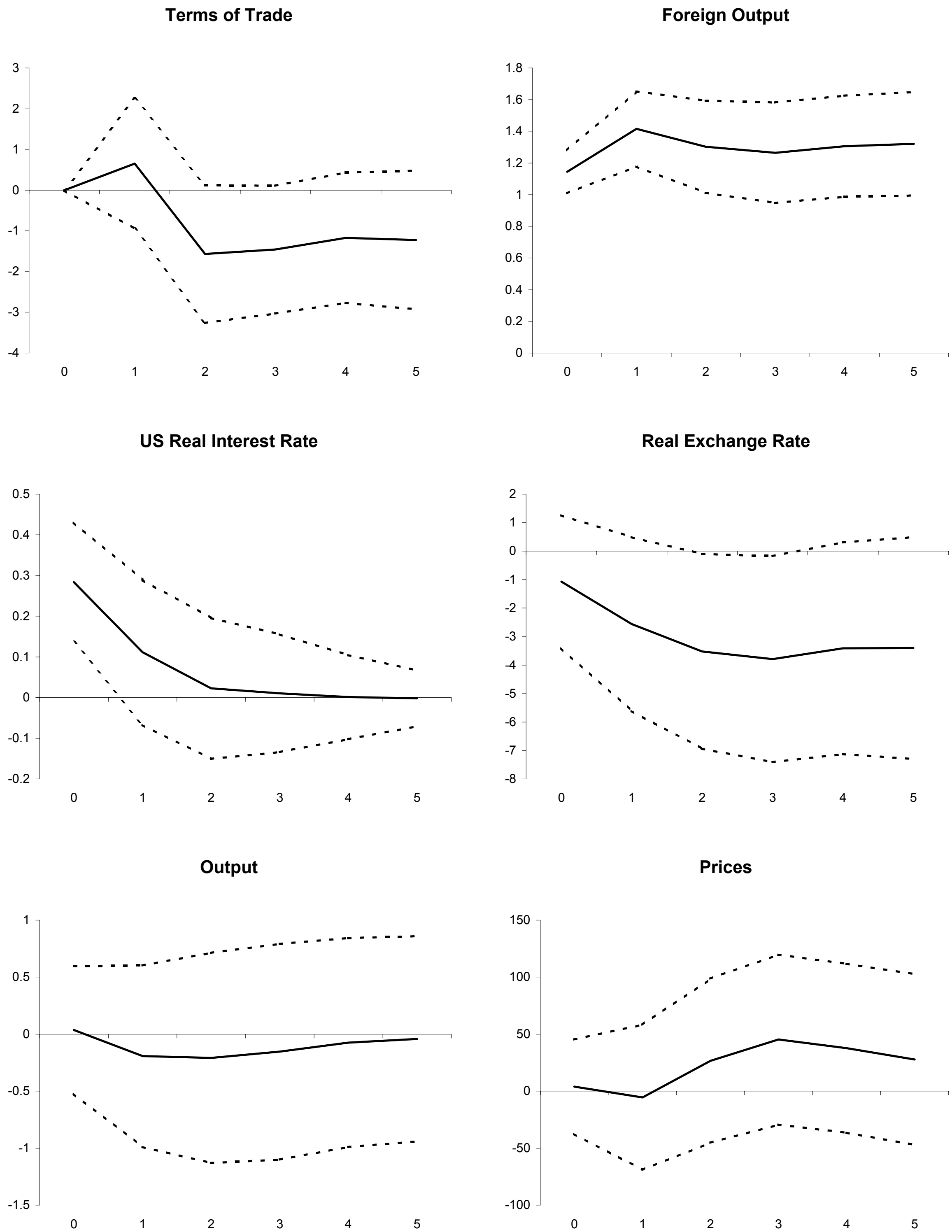

Figure 2: Responses to a shock to US Real Interest Rate

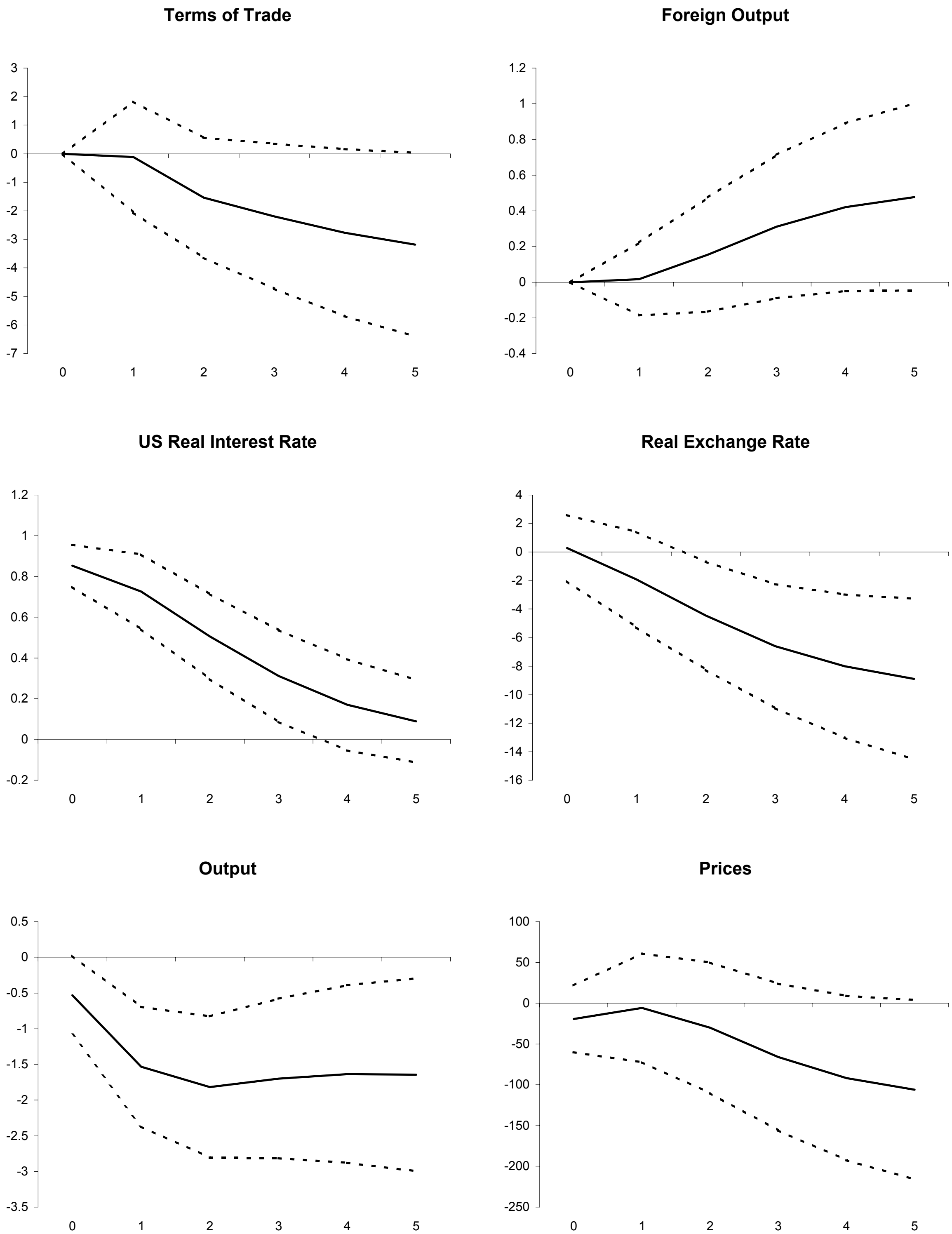

Figure 3: Responses to a shock to Terms of Trade

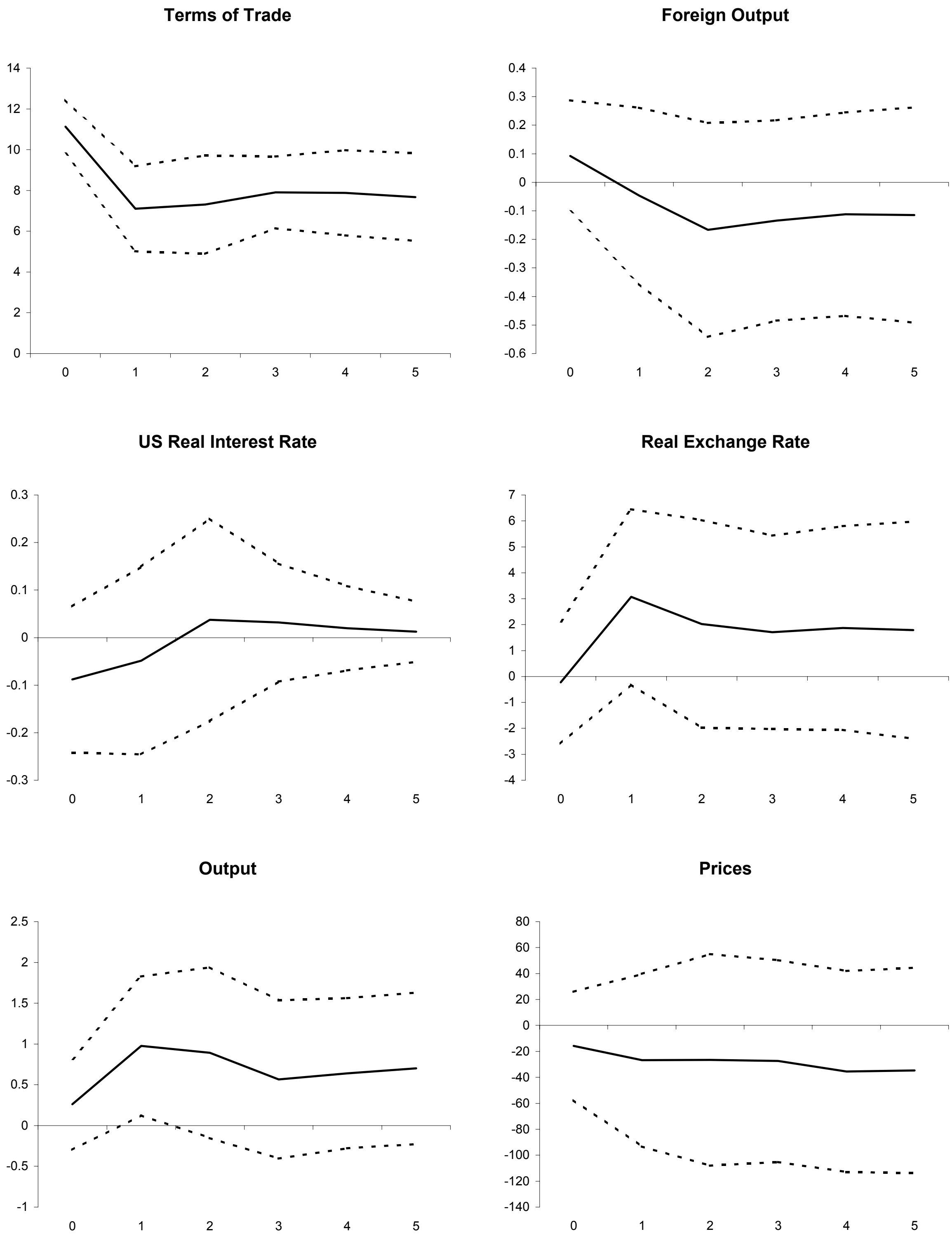

Figure 4: Responses to a Shock to Real Exchange Rate

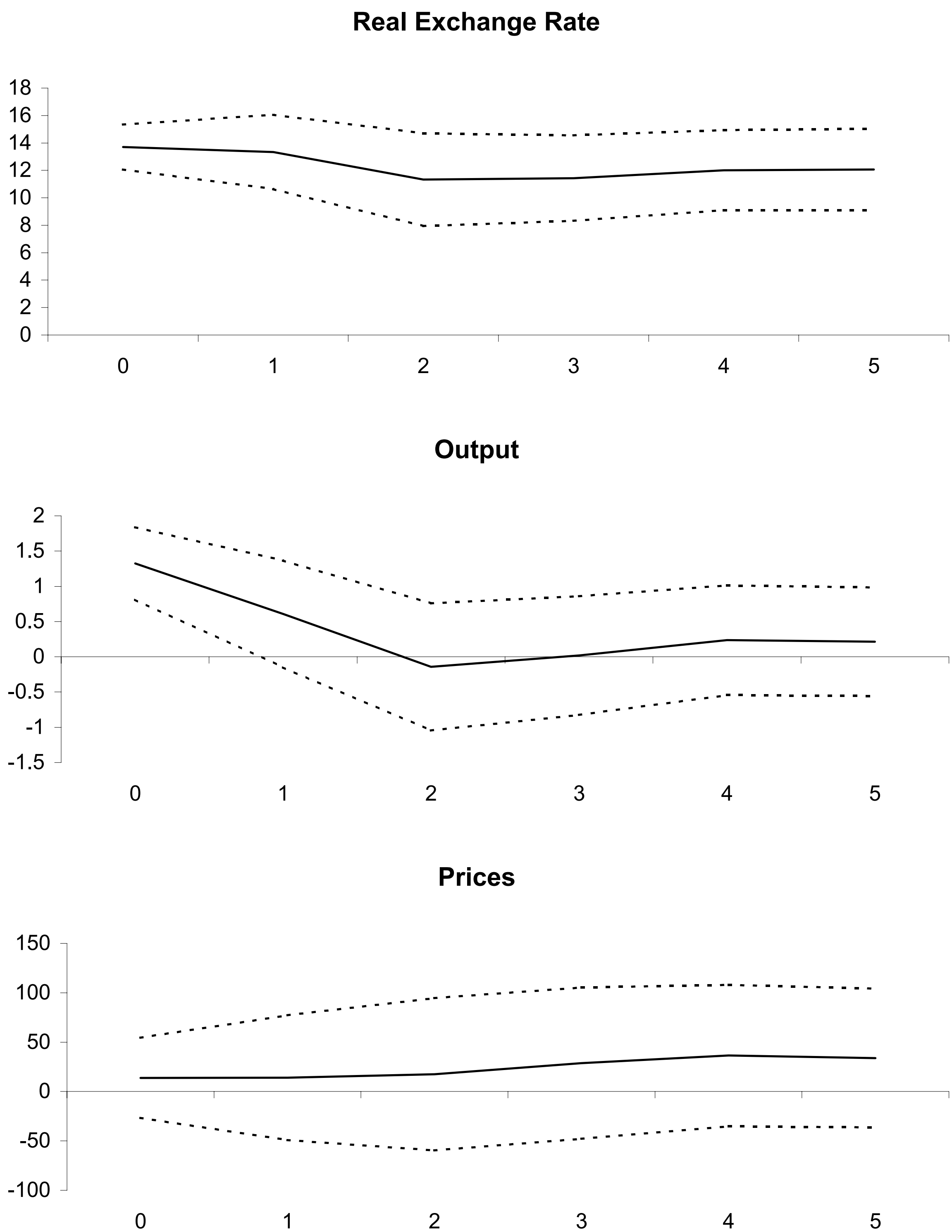

Figure 5: Responses to a Shock to Output

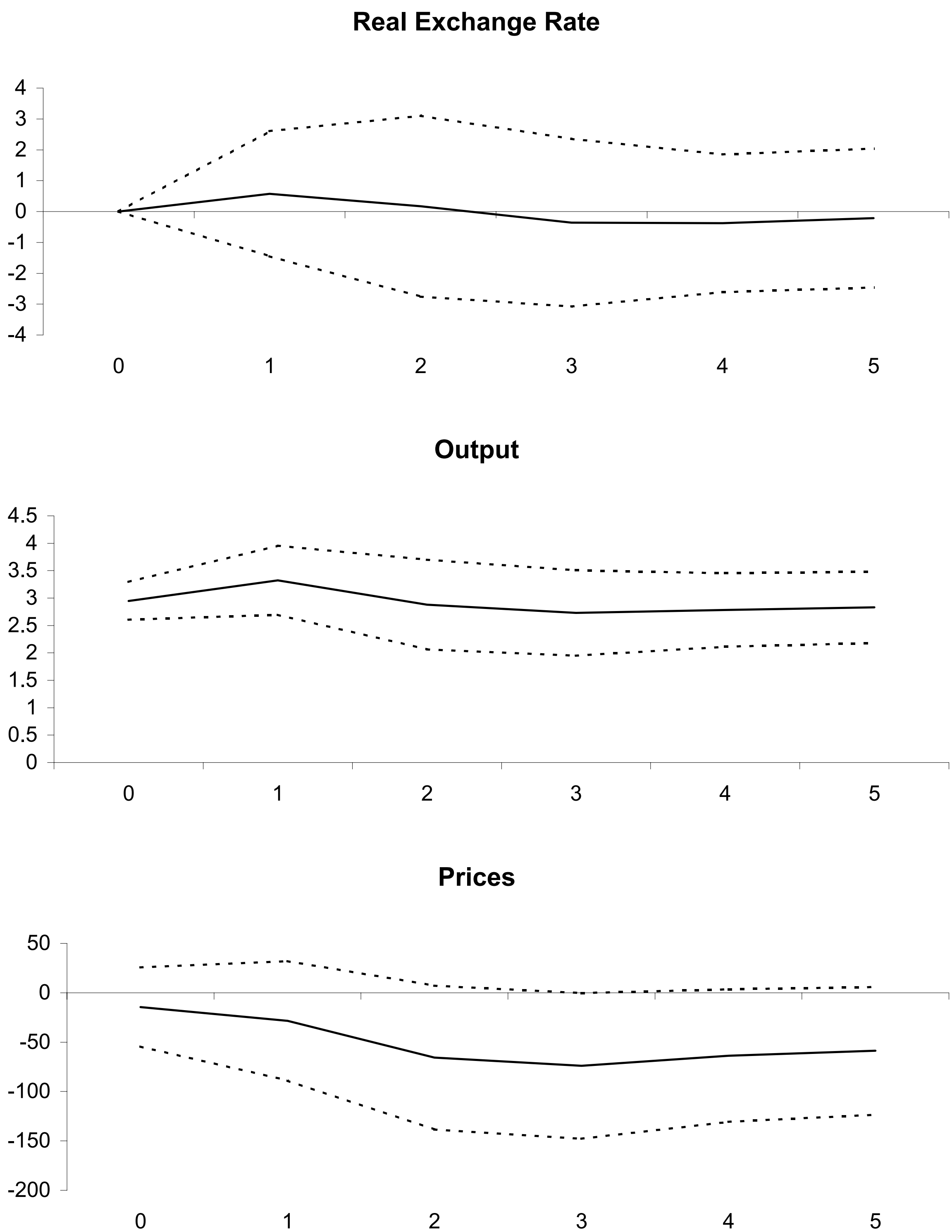

Figure 6: Responses to a Shock to Prices