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Abstract: According to conventional models, flexible exchange rates play an equilibrating role in open economies, depreciating in response to adverse shocks, boosting net exports, and stimulating aggregate demand. However, critics argue that, at least in developing countries, devaluations are more contractionary and more inflationary than conventional theories would predict. Yet, it is not clear whether devaluations *per se* have led to adverse outcomes, or rather the disruptive abandonments of pegged exchange-rate regimes associated with devaluations. To explore this hypothesis, we estimate VAR models to compare the responses to devaluation of developing economies and two types of industrial economies: those that have consistently floated, and those that have sustained fixed exchange-rate regimes as well. We find that both of these types of industrial economies exhibit conventional (i.e., expansionary) responses to devaluation shocks, compared with the contractionary responses exhibited by developing countries. This finding suggests that exchange rate movements may be more destabilizing in developing countries than in industrial countries, regardless of exchange rate regime.

Keywords: Contractionary devaluations, exchange rate regimes.
JEL Classification: F33, F41.

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I. Introduction

In response to the past decade of currency crises, a view has gained prominence that only the extreme ends of the exchange-rate regime spectrum–free floats, on the one hand, and hard fixes such as currency boards or dollarization, on the other–represent sustainable options for developing economies.[1] While most observers acknowledge that no single exchange rate regime will be right for all countries,[2] significant differences of opinion have emerged as to which of the remaining options–more flexible exchange rates or harder fixes–is best suited to most developing countries.

Some argue that because of the flexibility they offer in response to shocks, and that because of the difficulty of choosing the right level of the exchange rate at which to fix, relatively flexible (if not fully floating) exchange rates may be appropriate for most countries. In this view, hard fixes such as currency boards or dollarization should be adopted only by those countries where monetary policy credibility is most lacking, and hence where the benefits of a credible nominal anchor would outweigh the loss of flexibility and monetary autonomy associated with a hard fix.

On the other side of this debate, critics argue that the benefits of exchange rate flexibility are overrated. In the textbook model, adverse external shocks lead to depreciations of the real exchange rate that, by stimulating net exports, boost aggregate demand and offset the effects of

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[1]See Fischer (2001) for an exceptionally comprehensive and well-reasoned discussion of this issue.

[2]Frankel (1999) makes this point particularly emphatically.

the initial shocks. In practice, however, numerous studies appear to indicate that, at least in developing countries, devaluations may have a contractionary effect.[3] This may reflect direct effects of changes in the exchange rate on the economy: for example, by raising the domestic currency value of unhedged foreign currency debt devaluations lower net wealth.[4] It may also reflect indirect effects of devaluation, as when declines in investor confidence triggered by abandonments of a peg lead to a loss of access to international capital markets.[5] In any event, critics argue, the benefits of exchange rate flexibility as a means of offsetting adverse shocks may not be available to many developing countries. Moreover, critics cite evidence that rates of pass-through of exchange rates into prices may be considerably higher in developing countries than in industrial countries.[6]

If devaluations are both more contractionary and more inflationary in developing countries than in industrial countries, this strengthens the case for hard fixes as the appropriate exchange rate regime for many developing countries.[7] Yet, just because devaluations in

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[3]The literature on contractionary devaluation extends back several decades, and has continued to expand in recent years. See, among others, Diaz Alejandro (1963), Cooper (1971), Krugman and Taylor (1978), Edwards (1989), Lizondo and Montiel (1989), Agenor (1991), Kamin and Klau (1998), Ahmed (1999), and Kamin and Rogers (2000).

[4]This channel became particularly evident after the Asian crisis. See Hausmann, Panizza, and Stein (2001), Christiano, Gust, and Roldos (2000), Cespedes, Chang, and Velasco (2000), and Velasco (2001).

[5]See, especially, Calvo and Reinhart (2001a).

[6]See IMF (1996), Kamin (1998).

[7]This is the argument that has been made in several recent influential papers, including Eichengreen and Hausmann (1999), Hausmann, Panizza and Stein (2001), and Calvo and Reinhart (2001a, 2001b). We leave aside here the question of the sustainability of hard fixes such as currency boards and the consequences of their being abandoned in crisis, as in Argentina

developing countries have been highly contractionary and inflationary in the past, it does not follow that they will remain so in the future. Until recently, devaluations in developing countries generally involved an abandonment of a pegged exchange-rate regime as governments ran out of reserves in the context of a financial crisis. These reversals of exchange rate policy often led to sharp declines in investor confidence, heightened concerns about future economic policy, heavy capital outflows, and concordant deteriorations of output and inflation performance.

However, the deleterious consequences of devaluation observed during breakdowns of pegged exchange rate regimes may not be evident during more "normal" depreciations observed in floating exchange rate regimes. Under floating exchange rates, fewer decisions may be made that depend upon future exchange rate stability to be profitable, such as unhedged foreign-currency borrowing. Additionally, depreciations under floating exchange rates would be less likely to be interpreted as indicating sharp breaks in government policy. Hence, depreciations under floats may be less injurious to investor sentiment and monetary policy credibility.

Unfortunately, it is difficult to test this hypothesis directly, since the recent and limited experience of developing countries with floating exchange rates does not provide sufficient data for new estimates of the relationships between exchange rates, output, and inflation.[8] However, among the industrial economies, there are some that have experienced several decades of

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earlier this year.

[8]Broda (2000) endeavors to estimate the impact of terms of trade changes on economic performance in developing countries, depending upon whether they are in fixed or floating exchange rate regimes. However, as indicated in Ghosh *et al* (1997) and Reinhart and Rogoff (2002), among others, distinguishing between fixed and floating rate regimes is extremely difficult. Moreover, many floats in developing countries are merely short-lived and transitional phases in between more managed exchange rate regimes.

uninterrupted floating, while others have sustained fixed exchange rates for long periods. By comparing the response of these different types of economies to devaluation, we can gain a sense of whether the exchange rate regime affects the impact of devaluation on inflation and output. This is the exercise described and undertaken in this paper.

In our analysis, we focus on four groups of countries:

1. Latin American countries that have alternated between fixed and floating exchange rate regimes (but generally have had fixed regimes): Argentina, Brazil, Chile, Colombia, and Mexico.

2. Developing Asian countries that have alternated between fixed and floating exchange rate regimes (but generally have had fixed regimes): Indonesia, Korea, Malaysia, and Taiwan.

3. Industrial countries that have alternated between fixed and floating exchange rate regimes (but generally have had fixed regimes): Finland, Italy, Norway, Spain, and Sweden.

4. Industrial countries that have consistently floated: Australia, Canada, New Zealand, and Switzerland.[9]

For each group of countries, we estimate a panel vector-autoregression (VAR) model that includes the real exchange rate, output, inflation, and measures of several external shocks: the terms of trade, foreign interest rates, and trading-partner growth. These estimates allow us to identify the response of exchange rates to external shocks, and the response, in turn, of output and inflation to changes in exchange rates.

Our VAR estimates for Latin America and Asia should allow us to confirm the argument, made by critics of floating exchange rates, that historically devaluations in developing countries have had particularly adverse impacts on inflation and output. Similarly, our estimates for the

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[9]As discussed below, floating exchange rates were not introduced until the early to mid-1980s in Australia and New Zealand. In the VAR analysis, we use data for those countries drawn from the floating period only.

industrial country "floaters" should help us to confirm the view that, for these countries, flexible exchange rates have played a constructive role in buffering these economies from external shocks.

Finally, our VAR estimates for those industrial economies that have had fixed as well as floating regimes should be particularly interesting. If devaluations historically have led to more contraction and more inflation in these countries than in the industrial country floaters, this would support the case that devaluations in developing countries may also have less adverse consequences, once these countries adopt floating exchange rate regimes. Conversely, if the response to devaluation of industrial countries that have had fixed exchange rates is very similar to that of industrial country floaters, this may indicate that the causes of contractionary devaluation lie in the structural characteristics of developing economies, not in the nature of the exchange rate regime.

The plan of this paper is as follows. Section II briefly reviews the evolution of exchange rate regimes in the countries comprising the different data panels. Section III describes the data used on the project and the methodology used to estimate the panel VARs, followed by a discussion of the results in Section IV. Section V concludes.

II. Exchange Rate Regimes

Figures 1 through 4 indicate the evolution of nominal exchange rates in the countries in our sample, divided into the groups discussed above: Latin America, developing Asia, industrial countries that have had fixed exchange rates for prolonged periods (labeled "non-floaters"), and the industrial countries that have consistently floated (labeled "floaters"). For each country, the shaded bands represent periods when the exchange rate is judged to have been relatively fixed, either narrowly–as in a formal peg–or more broadly–as in a band, crawling peg, or through frequent intervention. In the remaining periods, exchange rates either were floating or were managed more flexibly.

Distinguishing between the two regimes is not, of course, easy or straightforward. In most cases, we merely designated as "floating" those periods in which a country is categorized as "independently floating" in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions, and designated as fixed all other periods. For periods prior to 1982, when the "independent floating" designation was not used, and/or where we thought other considerations might be relevant, we also considered the sample countries' evolution of exchange rate arrangements more directly. Appendix II provides more detail on the evolution of exchange regimes, based on a variety of sources, including the Annual Report on Exchange Arrangements and Exchange Restrictions, Reinhart and Rogoff (2002), and narratives of economic history in specific countries.

Finally, we should note that while delineations between fixed and floating exchange rate regimes clearly are messy and subject to debate, these delineations generally are not used in the subsequent statistical analyses. They serve only to illustrate broad differences in the historical experiences of the various countries in our sample, which are used to group them into different categories, e.g., industrial country floaters and industrial country non-floaters. The exceptions are the cases of Australia and New Zealand, where the delineation of exchange rate regimes is used to set the sample period so that data from those two countries are drawn exclusively from their floating exchange regime periods.

III. Empirical Methodology and Data

Methodology

The empirical methodology, closely based on the approach taken in Ahmed (1999) to analyze three Latin American economies, is to estimate a six-variable vector auto-regression model (VAR) in a panel setting. Of the six variables we consider, three (the terms of trade, foreign output, and the foreign real interest rate) are determined only by external factors and are labeled "external variables," while the remaining three (the real exchange rate, output, and the price level) are influenced by domestic factors in addition to the external variables, and are labeled "domestic variables."[10]

Specifically, we estimate the following structural system of equations:

$$A(0)\Delta X_{it} = A(L)\Delta X_{i,t-1} + u_{it} \tag{1}$$

where ΔX is the vector of variables included in the model (the Δ indicating that most of the variables enter in growth rates), $A(0)$ is the matrix of contemporaneous interactions, $A(L)$ is a matrix of lag polynomials, u is a vector of *i.i.d.* structural errors, and subscripts I and t refer to the country and time period, respectively. Intercepts and fixed effects are included in the empirics, but have been suppressed here for convenience.

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

[10]It might seem strange to classify a variable such as the real exchange rate as a "domestic" variable. Therefore, it is important to re-iterate that, in our terminology, "external" variables are those that are determined *only* by rest of the world conditions, which the domestic economy takes as given (the small open economy assumption), whereas "domestic" variables are those that are influenced by domestic factors *in addition* to the rest of the world conditions.

and domestic shocks. Thus,

$$\Delta X = \begin{pmatrix} \Delta X_1 \\ \text{----} \\ \Delta X_2 \end{pmatrix} = \begin{pmatrix} \Delta tot \\ \Delta yf \\ rf \\ \text{-----} \\ \Delta rer \\ \Delta y \\ \pi \end{pmatrix} \; ; \qquad u = \begin{pmatrix} \varepsilon \\ - \\ \eta \end{pmatrix} = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \text{--} \\ \eta_1 \\ \eta_2 \\ \eta_3 \end{pmatrix} \tag{2}$$

where the external stationary variables–represented by ΔX_1–are the rate of change of the terms of trade (Δtot), foreign output growth (Δyf), the *level* of the foreign real interest rate (rf), and the domestic stationary variables–represented by ΔX_2–are the rate of appreciation of the real exchange rate (Δrer), domestic output growth (Δy), and domestic inflation (π). The vector ε represents the vector of external shocks (the terms of trade, foreign output, and foreign 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)–i.e. after accounting for the influence of the external shocks on these variables.

It is well-known that the assumptions that the fundamental economic disturbances in the vector u are *i.i.d.* and, therefore, have a diagonal covariance matrix do not fully identify structural models like (1). To meaningfully analyze the effects of various shocks, some further restrictions have to be imposed. We follow the method of imposing a contemporaneous recursive causal ordering on the variables (the Choleski factorization), which implies a lower-triangular $A(0)$ matrix which, conforming to the partition of external and domestic variables made earlier, we denote by:

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

The *A(0)* matrix in (3) implies the following *contemporaneous* causal ordering of the variables: For the external variables, causality runs from terms of trade to foreign output to the foreign real interest rate, reflected in the lower triangularity of $A_{11}(0)$. We put the terms of trade and foreign output before the foreign real interest rate in the causal ordering to allow for the possibility that monetary policy abroad may react to these variables within a quarter; the estimated contemporaneous interactions under this ordering are consistent with the interpretation that unexpected increases in foreign output elicit a tightening of monetary conditions abroad in response. Putting foreign real interest rates last in the causal ordering of the three external variables also implies, however, that foreign output, does not react to foreign monetary policy changes *contemporaneously* (i.e. within the quarter). The identification assumption that output does not react to monetary policy changes contemporaneously is often made in studies of U.S monetary policy employing monthly or quarterly data.

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. The small open economy assumption entails further restrictions as well, in that even *lagged* values of domestic variables should not feed back into the external variables, which we have imposed, so that the whole system is block recursive (i.e.

$A_{12}(L) = 0$. These restrictions on the lagged values are not needed for identification and are, therefore, testable. In practice, very similar results are obtained whether or not they are imposed.

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 $A_{22}(0)$. While we feel relatively comfortable putting the only nominal variable in our model, the price level, last in the causal ordering, it is more controversial what the direction of contemporaneous causality is 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. However, shocks to domestic activity such as technological innovation or changes in fiscal policy can affect both output and the real exchange rate. Since, in practice, the exchange rate is more likely to respond to these shocks faster than output, we put the real exchange rate ahead of output in the *contemporaneous* causal ordering; feedback from output changes to real exchange rate changes with a one-quarter or greater lag is, of course, allowed.

Since the external variables are causally prior to the domestic variables, the computed shocks to the real exchange rate, domestic output, and the price level variables have already accounted for the effects that the external shocks (the terms of trade, foreign output, and the U.S. real interest rate shocks) have on these variables. Given this, it is likely that our measured shocks to the real exchange rate, output, and the price level represent largely the influence of domestic factors, and, hence, we call them domestic shocks. The possibility remains, though, that they include the influence of some other external factors that are not captured by the external variables we explicitly model.

Data

Separate dynamic panels are estimated with quarterly data over (maximum) date ranges of 1981Q2-1999Q2 for the Latin American countries, 1972Q2-2001Q2 for the developing Asian economies, 1976Q2-1998Q4 for the industrial country "non-floater" group, and 1976Q2-1998Q4 for the industrial country floaters.[11] For each country (see Appendix I for details): domestic output is real GDP, the domestic price level is the consumer price index (CPI), foreign output is an export-weighted[12] (using weights from 1998 data) aggregate of the real GDP of the eight largest export markets; the real exchange rate is the Federal Reserve Board's 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 or the ratio of unit export values to unit import values, taken from various sources. The foreign real interest rate is either the monthly average of the one-month German interbank rate less 4-quarter German inflation (for Finland, Italy, Norway, Spain, Sweden, and Switzerland) or the monthly average of the 30-day U.S. treasury bill rate less 4-quarter U.S. inflation (for Latin America, Asia, Canada, New Zealand, and Australia).

[11]As detailed in the data appendix, for some countries data for the entire estimation range were not available; for these countries, shortened data series were used, leading to unbalanced datasets for the panel regressions. Additionally, in order to ensure that their contribution to observed behavior reflects exclusively their floating exchange rate regimes, observations for Australia and New Zealand start two years after the beginning of their floating periods, or 1986Q1 and 1987Q2, respectively. (This is particularly necessary given that the VAR regressions involve four quarterly lags, so that the fourth lag occurs only one year after the onset of the floating exchange rate regimes.)

[12]For Chile, Colombia, Norway, and Spain, trade (exports plus imports) weights are used instead.

IV. Results

Figures 5 through 8 present the key results of our analysis: the responses of GDP and prices to various types of shocks. Recall that the VAR model was estimated using data that was first-differenced, except for the foreign interest rate variable. For ease of interpretation, for all the differenced variables, the impulse-response functions have been cumulated over time so that we can observe the impact of shocks on the levels of the variables. Thus, the impulse responses are the percent deviation from baseline of the levels of the variables, plotted over the number of quarters that have elapsed since the shock occurred. In all cases, the magnitude of the shock is equal to one standard deviation. Given that the shocked variables exhibit different volatilities in the different country sets examined, this leads to different magnitudes of shock across these country sets. The dashed lines in the figures display 1.65 percent standard deviation bands around the impulse responses, roughly corresponding to 90 percent confidence intervals.[13]

Each row of the figures presents the impulse responses estimated for a different country panel. Hence, the "Latam," "Asia," "Floater," and "Non-floater" rows refer to Latin American countries, developing Asia, industrial country floaters, and industrial country non-floaters, respectively.

Terms-of-trade shocks

Figure 5 indicates the response of output and prices in each of the country sets to a one-period, one-standard-deviation positive shock to the rate of change of the terms of trade. In all

[13]Standard errors for the impulse responses and variance decompositions (shown later) were computed using Monte Carlo simulations with 5000 iterations.

four sets of countries, this leads to a persistent increase in the level of the terms of trade, in the neighborhood of 2½ to 6½ percentage points above its baseline value.

For the Latin American countries, this shock leads to no significant change in the level of the real exchange rate, consistent with the view that their exchange rate regimes have diminished the flexibility of its exchange rates with respect to shocks. The same result holds, on balance, for the developing Asian economies. On the other hand, it is interesting that among the industrial economies, not only do the currencies of the floaters appreciate in response to the terms of trade improvement, consistent with economic theory, but so, too, do the currencies of the industrial countries with mixed exchange rate regime histories.

The output responses to a favorable terms of trade shock are positive for all groups in the first year–statistically significant in the case of the non-floater industrial countries, borderline significant in the case of the floaters and the Latin American countries, but not significant in the case of the Asian economies. Only the "non-floater" countries exhibit a significant positive GDP response in the longer run.

Finally, the price level responses to a terms of trade shock vary widely across the groups: there is practically no long-run response of the price level in the Latin American countries; Asian prices appear to rise; prices fall in the non-floater industrial countries, but rise in the industrial country floaters. The difference in the response of the price level across the industrial countries that float and the industrial countries with mixed regimes is puzzling: given that the real exchange rate appreciates significantly and by a similar extent in each case; the different price responses imply that the nominal exchange rate appreciates considerably more in the industrial countries with mixed regimes than in the pure industrial country floaters.

Foreign output shocks

Figure 6 indicates the response of the different sets of economies to one-time shocks to the growth rate of GDP in these economies' trading partners. Here, real exchange rates exhibit no significant responses among either the Latin American countries or, surprisingly, the industrial country floaters (although the floaters' long-run response is nearly significant); conversely, the non-floater industrial countries and the Asian economies both exhibit significant real exchange rate appreciation. All sets of countries experience significant increases in domestic output, as we might expect, although these occur only in the first year for the industrial country non-floater group. While the price level rises above the baseline in the pure floaters, it does not show much of a response in the other countries.

Foreign interest rate shocks

Figure 7 indicates the response of the different economies to positive shocks to the foreign real interest rate. In Latin America, higher U.S. interest rates depreciate the real exchange rate, although not statistically significantly, depress domestic output and raise prices. This is consistent with the generally held view that a tightening of U.S. monetary policy diminishes capital flows to developing countries, and Latin America in particular, leading to declines in currencies, economic slowdowns, and higher inflation. The responses of the Asian and non-floater industrial economies to a foreign interest rate shock are broadly similar to the Latin American case, except without Latin America's sustained inflationary response. Curiously, while the real exchange rate depreciates for the other country groups, consistent with standard theory, it is essentially unchanged for the industrial country floaters, where depreciation might have been expected to be most apparent; this is especially puzzling since the floaters represent the only group exhibiting a positive and significant (at least, in the short run) GDP response to the foreign interest rate shock.

Real exchange rate shocks

Figure 8 indicates the response of the different groups of economies to a positive (i.e., appreciation) shock to the real exchange rate. According to conventional models, this shock should elicit a decline in output and some fall in prices, as the decline in the price of imports adds to the effect of the economic slowdown. As indicated in the row for Latin America, however, an appreciation of the real exchange rate leads to a significant rise in domestic GDP, consistent with the results of earlier empirical work, but contradicting the conventional models. At the same time, and more in keeping with the models, prices decline significantly, and by a substantial extent as well. The responses of the Asian developing countries to an exchange rate shock are quite similar, although the price response is somewhat more muted.

The output responses of the industrial countries to real exchange rate appreciations are more in line with conventional theory. In both the floaters and the non-floaters, output declines to a nearly significant extent in the short run, although longer-run responses are not significantly different from zero. Prices in the industrial country floaters fall, following the real exchange rate appreciation, consistent with the impact of the appreciation on costs of imports. Prices remain unchanged among the non-floaters, however, for reasons that are not clear to us.

Variance Decompositions

Tables 1-3 show the variance decompositions of domestic output growth, the rate of change of the real exchange rate, and domestic inflation respectively. The results in table 1 illustrate that the percentage of output growth that can be explained by the external shocks as a group is relatively small (below 20 percent at best for up to a two-year time horizon) for each of the four groups of countries. For the Asian countries, foreign output shocks make a much greater contribution to domestic output variability than the terms of trade or foreign interest rates. For the remaining groups, the contributions of the three different shocks are more similar.

As can be seen from table 2, the contribution of external shocks in explaining real exchange rate fluctuations is least in the Latin American countries (2-8 percent), a bit more in the Asian countries (3-9 percent) and the industrial country floaters (3-12 percent), and the most in the industrial country non-floaters (4-18 percent). This is consistent with the impulse responses discussed earlier, which showed that there was little response of real exchange rates to external shocks in Latin America while, ironically, the industrial country non-floaters generally exhibited the most sensitivity of real exchange rates to these type of shocks. Finally, table 3 shows that inflation movements also are primarily explained by domestic shocks in each of the four groups of countries.

V. Conclusion

Our VAR results tend to confirm the findings of many previous studies showing that in developing countries, real exchange rate devaluations tend to be contractionary. This finding, by itself, would lend support to the view that the responses of floating exchange rates to adverse external shocks might be destabilizing in these countries. In turn, this suggests that the cost of their giving up exchange rate flexibility may not be as large as traditional theory implies.

However, our view was that it remained an open question whether exchange rate depreciations *per se* were contractionary in developing countries, or whether it was really the abandonment of pegged exchange rate regimes that was causing the damage. To answer that question, we looked at the response to devaluation of two types of industrial economies–those that had floated consistently, and those that have had long periods of fixed exchange rates. If devaluation had been contractionary in the latter group but expansionary in the former, this might have held out some hope that developing countries, once they float their exchange rates, might also enjoy expansionary effects of exchange rate devaluations.

But instead, we found that, on the whole, both types of industrial economies showed relatively similar and conventional responses to a variety of shocks, especially to exchange rate shocks. These findings suggest that the perverse, contractionary effects of devaluations are not a function of changes in exchange regimes alone. There appear to be features of the structure of developing economies that lead exchange rate devaluations to have non-conventional contractionary effects, as has been much discussed in the recent literature. However, our findings, by themselves, do not necessarily indicate that under floating exchange rates, devaluations would continue to be contractionary for developing countries. It may be the interaction of both (1) changes in exchange rate regimes, and (2) the structure of developing economies, that leads to the contractionary effects of devaluation. If that is true, it could still be that under floating rates, exchange rate depreciations could be expansionary, and floating exchange rates could play a stabilizing role. As developing economies accumulate more experience with floating, this will be an important area for further investigation.

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Appendix I: Data

This appendix gives further details on the construction of the six variables used in the VAR: rate of change of terms of trade, foreign output growth, foreign real interest rate, rate of change of real exchange rate, domestic output growth, and domestic inflation.

Data Description

Rate of change of Terms of Trade

This is the quarterly percent change of a terms of trade index that was obtained by taking the ratio of export prices to import prices. When not directly available, export and import price indices were created from nominal and real trade data. For Chile and Indonesia, terms of trade derived in this way were available only from 1990 and 1986 onwards, respectively. In the case of these two countries we back-casted terms of trade using a regression of terms of trade changes on key commodity prices for which data are available from before 1990 and 1986.

Foreign Output Growth

For each country this was computed as the growth rate of an index number of export-weighted real GDP of its major trading partners. (In the case of Chile, Colombia, Norway, and Spain, trade weights–imports+exports–rather than export weights were used.)

Foreign Real Interest Rate

For all non-European countries, the foreign real interest rate is computed as the monthly average of the one-month U.S. Treasury Bill secondary market rate less the previous four-quarter percent change in U.S. consumer prices. For the European countries, it is monthly average of the one-month German interbank rate less the previous four-quarter percent change in German consumer prices.

Rate of change of the Real Exchange Rate

This is the quarterly percent change of a multi-lateral trade-weighted CPI-based real exchange rate index. Weights used for each country are those constructed by the Federal Reserve Board based on ½ imports, ½ exports combined with third-party competition.

Domestic Output Growth

This is the quarterly percent change of real GDP.

Inflation

This is the quarterly percent change of consumer prices.

Data Sources

The data were obtained from multiple sources, including the HAVER, CEIC, and IFS databases, individual country sources, and–for the construction of the weights–IFS Direction of Trade Statistics. Output growth and inflation data are seasonally adjusted. For these variables, when the original sources did not provide seasonally-adjusted data, seasonal adjustment was carried out using the X-12 procedure. Further details on data sources and seasonal adjustment are available on request.

Sample Periods

Since all of the data were available only for very limited time spans for some countries, we decided to work with unbalanced panels in order to have more observations. Below the sample period actually used for each of the countries is reported, with dates in bold highlighting the longest available time span of data within each group.

Country/Group	Start:	End:
Latin America:		
Brazil	1981Q2	1999Q2
Argentina	1987Q2	1999Q2
Mexico	1981Q2	1999Q2
Chile	1987Q2	1999Q2
Colombia	1981Q2	1999Q2
Asia:		
Indonesia	1972Q2	2001Q2
Korea	1972Q2	2001Q2
Malaysia	1992Q2	2001Q2
Taiwan	1977Q2	2001Q2
Float:		
Australia	1986Q1	1998Q4
Canada	1976Q2	1998Q4
New Zealand	1987Q2	1998Q1
Switzerland	1976Q2	1998Q4
Non-floater:		
Finland	1976Q2	1998Q4
Italy	1976Q2	1998Q4
Sweden	1976Q2	1998Q4
Spain	1978Q2	1998Q4
Norway	1978Q2	1998Q4

Appendix II: Exchange Rate Regimes in Sample Countries

Shaded rows indicate periods when exchange rate regimes are judged to be relatively fixed. Non-shaded rows indicate periods when exchange rates are judged to be floating.

I. Latin America

Argentina

12/78 - 4/81	"Tablita" – pre-determined crawling peg.
4/81 - 6/85	Alternating periods of (1) floating and (2) frequent *ad hoc* devaluations, with exchange controls.
6/85 - 4/86	Austral Plan – nominal exchange rate frozen against the dollar.
4/86 - 8/88	Frequent *ad hoc* devaluations.
8/88 - 2/89	Plan Primavera – predetermined crawling peg commercial exchange rate, crawling band for financial exchange rate.
2/89 - 7/89	Floating financial exchange rate, frequent *ad hoc* devaluations of commercial exchange rate.
7/89 - 12/89	Plan Bunge y Born – nominal commercial exchange rate frozen against the dollar.
12/89 - 4/91	Floating exchange rate with occasional intervention.
4/91 - 1/02	Convertibility Plan – currency board arrangement.
1/02 - present	Floating exchange rate with occasional intervention.

Brazil

1960s - 12/79	Frequent mini-devaluations to offset difference between domestic and foreign inflation.
12/79 - 12/80	Pre-determined crawling peg.
1/81 - 2/86	Frequent mini-devaluations to offset difference between domestic and foreign inflation.
2/86 - 11/86	Fixed exchange rate against the dollar.
11/86 - 3/95	Combination of frequent mini-devaluations and floating, including at start of Real Plan in 7/94.
3/95 - 1/99	Crawling band system under Real Plan.
1/99 - present	Floating exchange rate with occasional intervention.

Chile

2/78 - 6/79	Tablita System - Pre-announced rate of devaluation of Chilean peso.
6/79 - 6/82	Peso pegged to the U.S. dollar.
6/82 - 9/82	Series of nominal devaluations as well as short period where exchange rate floats. Separate exchange rate established for some financial transactions.
9/82 - 6/89	Crawling band with a 4% width adjusted based on inflation differentials. Several substantial devaluations also occur over this time.
6/89 - 6/98	Crawling band width increased to 10% in 1989, 20% in 1992, and 25% in 1997. Several revaluations of peso also occur.
6/98 - 9/99	Band width narrowed to 5.5% in June of 1998 but gradually widened and center rate adjusted to allow for greater depreciation of the peso.
9/99 - present	Floating exchange rate with occasional intervention. Rates unified.

Colombia

3/67 - 6/91	Multiple exchange rates with the official rate following a pre-announced crawling peg.
6/91 - 2/94	Multiple exchange rates with most transactions occurring at a rate managed informally as a crawling peg.
2/94 - 9/99	Crawling band exchange rate regime with 14% width. Width widened to 20% in June of 1999.
9/99 - present	Floating exchange rate regime with frequent interventions to smooth excessive volatility.

Mexico

3/77 - 2/82	Fixed exchange rate against the dollar.
2/82 - 12/82	Mixture of floats and *ad hoc* devaluations with parallel exchange rates.
12/82 - 7/85	Predetermined crawling peg devaluations with parallel exchange rates.
7/85 - 12/87	Frequent ad hoc devaluations with parallel exchange rates.
12/87 - 12/94	Fixed exchange rate against the dollar, evolving into pre-determined crawling band system.
12/94 - present	Floating exchange rate with occasional intervention.

II. Asia

Indonesia

4/70 - 11/78	Indonesian rupiah pegged to the US dollar.
11/78 - 12/83	Informal pegged exchange rate arrangement where rupiah managed against a trade-weighted basket of currencies.
12/83 - 7/97	Informal crawling peg where rupiah managed by central bank to adjust in large part to inflation differentials between Indonesia and its major trading partners.
8/97 - present	Floating exchange rate with central bank intervening frequently to smooth excessive short-run fluctuations.

Korea

5/64 - 2/80	Korean won pegged against US dollar.
2/80 - 3/90	Multiple-Basket Pegged Exchange Rate System: Korean won pegged against trade-weighted basket of currencies.
3/90 - 12/97	Market Average Exchange Rate System: Korean won managed against U.S. dollar. Won is allowed to fluctuate within specified band that is revised daily.
12/97 - present	Floating exchange rate regime with central bank intervening frequently to smooth short-run fluctuations.

Malaysia

9/75 - 6/93	Malaysian ringgit pegged within a specified band against trade-weighted basket of currencies.
6/93 - 7/97	Malaysian ringgit managed against a basket of trade-weighted currencies with central bank intervening frequently to avoid excessive fluctuations in value of ringgit.
7/97 - 9/98	Floating exchange rate regime.
9/98 - present	Ringgit pegged to the US dollar.

Taiwan

10/63 - 1/79	New Taiwan dollar pegged to the U.S. dollar.
1/79 - 4/89	Taiwan dollar managed against the U.S. dollar so that Taiwan dollar is allowed to float within specified range that is revised daily.
4/89 - present	Floating exchange rate with central bank regularly intervening to smooth out excessive short-run fluctuations.

III. Industrial Country "Floaters"

Australia

9/74 - 11/76	Australian dollar pegged based on a trade-weighted basket of currencies.
11/76 - 12/83	Australian dollar set in reference to trade-weighted basket of currencies but peg reviewed frequently and changed based on assessment of economic factors.
12/83 - present	Floating exchange rate regime.

Canada

6/70 - present	Floating exchange rate regime.

New Zealand

7/73 - 3/85	New Zealand dollar pegged to trade-weighted basket of currencies but adjusted frequently based on assessment of economic factors.
3/85 - present	Floating exchange rate regime.

Switzerland

2/73 - present	Floating exchange rate regime.

IV. Industrial Country "Non-floater"

Finland

11/77 - 4/91	Markaa trades within a 4.5% currency band based on a trade-weighted basket of currencies. Maarka devalued sharply in early 1980s. Deregulation of foreign exchange markets occurs throughout the 1980s. Band widened in 1988 and Markaa devalued in 1989.
4/91 - 9/92	Markaa pegged to the ECU with 3% bands.
9/92 - 10/96	Floating exchange rate regime.
10/96 - 1/99	Finland joins European ERM.
1/99 - present	European Monetary Union - Markaa fixed against euro.

Italy

2/73 - 3/79	Floating exchange rate with regime characterized by heavy interventions and government controls.
3/79 - 3/83	Lira part of European ERM with 6% fluctuations bands. Frequent devaluations of lira occur over this period.
3/83 - 1/90	Lira devalued once in 1985 under ERM. Last vestiges of capital controls removed in late 1980s.
1/90 - 9/92	Lira devalued in early 1990 and fluctuation bands reduced to 2.25% under ERM.
9/92 - 11/96	Floating exchange rate regime.
11/96 - 1/99	Lira part of ERM again with 2.25% fluctuation bands.
1/99 - present	European Monetary Union - Lira fixed against euro.

Norway

12/78- 9/84	Krone pegged based on a trade-weighted basket of currencies. Weighting scheme modified in 1982 and 1984.
9/84 - 5/86	Ad hoc crawling peg - attempt to steer Krone to a weaker value versus its trade-weighted index.
5/86 - 10/90	Fixed exchange rate regime allowing Krone to trade within 4.5 percent fluctuation bands against trade-weighted currency index. Change in regime precipitated speculative attack on Krone, making large devaluation necessary.
10/90-9/92	Norway joins ERM with fluctuation bands.
9/92-6/01	Managed floating exchange rate regime with exchange rate stability an important objective of monetary policy.
6/01 - present	Flexible exchange rate regime characterized by inflation targeting.

Spain

1973 - 6/89	Managed floating exchange rate regime with frequent interventions.
6/89 - 1/99	Spain joins European ERM with wide fluctuation bands. Peseta devalued frequently in 1992 and 1993. Fluctuation bands widened significantly in August of 1993 and peseta devalued 7% in 1995.
1/99 - present	European Monetary Union - Peseta fixed against euro.

Sweden

3/73 - 8/77	Krona associated with the “snake”. Krona devalued in 1976 and 1977.
8/77 - 5/90	Krona trades within a currency band based on a trade-weighted basket of currencies. Krona devalued sharply in 1981 and 1982 relatively stable thereafter. Deregulation of foreign exchange markets in late 1980s.
5/90 - 9/92	Krona traded within a currency band based on ECU.
9/92 - present	Floating exchange rate regime.

Table 1: Variance Decompositions of Domestic Output Growth

k (quarters)	Percentage of the k-step ahead forecast error variance explained by							
	external shocks			domestic shocks			all external shocks*	all domestic shocks*
	terms of trade	foreign output	for. real interest rate	real exch. rate	domestic output	domestic price		
Latin America								
1	0.9 (0.9)	0.3 (0.5)	0.7 (0.8)	8.1 (2.8)	90.1 (3.0)	-	1.9	98.2
4	3.2 (1.8)	3.0 (1.6)	3.2 (1.7)	11.0 (3.1)	77.7 (3.8)	1.8 (1.0)	9.4	90.5
8	4.8 (2.1)	3.5 (1.8)	3.8 (1.9)	11.0 (3.0)	74.4 (4.0)	2.4 (1.0)	12.1	87.8
Asia								
1	0.6 (0.7)	3.4 (1.8)	0.3 (0.4)	1.6 (1.2)	94.2 (2.2)	-	4.3	95.8
4	1.5 (1.0)	12.7 (3.8)	1.6 (1.1)	11.1 (3.1)	70.6 (4.4)	2.4 (1.4)	15.8	84.1
8	2.1 (1.2)	12.9 (3.8)	2.5 (1.5)	12.2 (3.1)	67.6 (4.4)	2.7 (1.4)	17.5	82.5
Industrial country floaters								
1	0.8 (1.0)	3.7 (2.2)	1.1 (1.1)	0.4 (0.6)	94.0 (2.6)	-	5.6	94.4
4	3.2 (1.7)	8.7 (2.7)	3.7 (1.7)	1.5 (1.0)	80.6 (3.6)	2.2 (1.2)	15.6	84.4
8	4.3 (2.0)	9.0 (2.7)	4.6 (1.8)	2.1 (1.2)	76.0 (4.0)	4.1 (1.7)	17.9	82.2
Industrial country non-floaters								
1	0.5 (0.6)	2.9 (1.5)	0.4 (0.5)	1.2 (1.0)	95.0 (1.9)	-	3.8	96.2
4	1.8 (1.0)	3.6 (1.7)	2.7 (1.4)	3.5 (1.4)	87.9 (2.7)	0.6 (0.5)	8.1	92.0
8	2.1 (1.1)	4.5 (1.7)	4.2 (1.6)	3.9 (1.5)	84.3 (2.9)	1.0 (0.6)	10.8	89.2

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

Table 2: Variance Decompositions of Rate of Change of Real Exchange Rate

k (quarters)	Percentage of the k-step ahead forecast error variance explained by							
	external shocks			domestic shocks			all external shocks*	all domestic shocks*
	terms of trade	foreign output	for. real interest rate	real exch. rate	domestic output	domestic price		
Latin America								
1	0.7 (0.8)	1.0 (1.0)	0.4 (1.4)	98.0 (1.4)	-	-	2.1	98.0
4	2.0 (1.2)	1.8 (1.1)	1.6 (1.1)	86.4 (2.8)	1.9 (1.3)	6.3 (1.7)	5.4	94.6
8	2.5 (1.4)	2.8 (1.4)	2.2 (1.3)	82.4 (3.4)	3.0 (1.5)	7.0 (1.9)	7.5	92.4
Asia								
1	1.0 (1.0)	1.2 (1.0)	0.3 (0.5)	97.5 (1.5)	-	-	2.5	97.5
4	3.3 (1.7)	1.8 (1.1)	1.0 (0.7)	85.2 (3.3)	0.9 (0.7)	7.9 (2.6)	6.1	94.0
8	4.6 (2.1)	2.5 (1.3)	1.6 (1.0)	81.2 (3.7)	1.4 (0.9)	8.7 (2.6)	8.7	91.3
Industrial country floaters								
1	1.2 (1.2)	0.8 (1.0)	0.6 (0.8)	1.2 (1.2)	2.3 (1.7)	93.8 (2.6)	2.6	97.3
4	2.7 (1.4)	2.0 (1.6)	3.5 (2.4)	12.0 (4.8)	2.6 (1.4)	77.2 (5.3)	8.2	91.8
8	5.1 (3.1)	3.5 (2.1)	3.8 (2.1)	13.8 (5.8)	5.6 (2.6)	68.2 (6.6)	12.4	87.6
Industrial country non-floaters								
1	2.7 (1.5)	1.0 (0.8)	0.2 (0.3)	96.1 (1.7)	-	-	3.9	96.1
4	3.7 (1.7)	9.5 (3.1)	2.5 (1.3)	78.8 (3.6)	4.6 (1.9)	1.0 (0.7)	15.7	84.4
8	4.8 (2.1)	9.9 (3.3)	3.7 (1.7)	75.0 (4.0)	5.1 (2.0)	1.4 (0.8)	18.4	81.5

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

Table 3: Variance Decompositions of Domestic Inflation

k (quarters)	Percentage of the k-step ahead forecast error variance explained by							
	external shocks			domestic shocks			all external shocks*	all domestic shocks*
	terms of trade	foreign output	for. real interest rate	real exch. rate	domestic output	domestic price		
Latin America								
1	0.4 (0.5)	0.9 (1.0)	0.3 (0.5)	0.7 (0.8)	3.6 (2.0)	94.1 (2.4)	1.6	98.4
4	3.4 (1.8)	3.9 (1.7)	1.8 (1.1)	13.9 (3.2)	4.8 (2.0)	72.2 (3.8)	9.1	90.9
8	4.4 (1.9)	4.7 (1.9)	5.0 (2.3)	14.4 (3.0)	6.4(2.2)	65.0 (4.1)	14.1	85.8
Asia								
1	4.1 (2.0)	1.3 (1.1)	0.3 (0.5)	2.2 (1.4)	1.7 (1.2)	90.4 (2.8)	5.8	94.3
4	4.0 (2.1)	3.3 (2.2)	5.0 (2.7)	21.3 (4.9)	2.1 (1.4)	64.3 (5.3)	12.3	87.7
8	4.3 (2.0)	5.0 (2.7)	9.9 (4.2)	20.2 (4.8)	2.4(1.5)	58.3 (5.5)	19.2	80.9
Industrial country floaters								
1	0.4 (0.6)	0.6 (0.7)	0.7 (0.8)	0.6 (0.8)	0.8 (0.8)	96.9 (1.7)	1.7	98.3
4	1.9 (1.2)	1.0 (0.9)	1.7 (1.4)	15.2 (4.6)	4.8 (2.3)	75.4 (5.0)	4.6	95.4
8	3.9 (2.6)	4.4 (2.8)	1.9 (1.5)	13.3 (4.9)	10.1 (3.7)	66.4 (6.1)	10.2	89.8
Industrial country non-floaters								
1	0.7 (0.8)	0.3 (0.4)	1.4 (1.0)	0.7 (0.8)	0.7 (0.7)	96.2 (1.7)	2.4	97.6
4	1.8 (1.5)	0.9 (0.7)	3.5 (2.2)	1.4 (0.8)	5.0 (2.4)	87.3 (3.5)	6.2	93.7
8	2.7 (2.4)	1.2 (1.2)	3.3 (2.1)	1.6 (1.1)	8.9(4.1)	82.2 (5.0)	7.2	92.7

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

Figure 1

Nominal Exchange Rates (Quarterly)
Foreign currency/$
Latin America

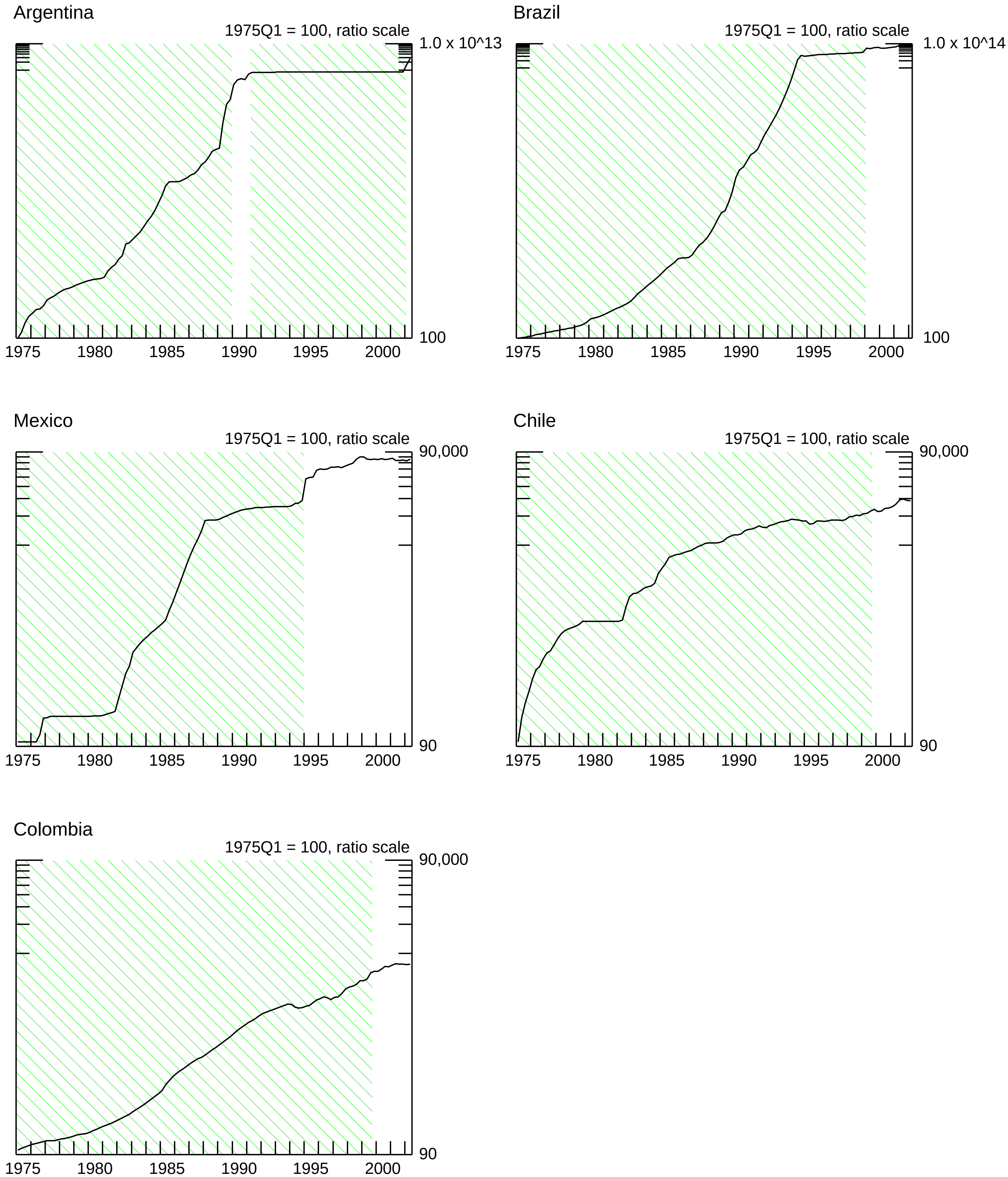


Figure 2

Nominal Exchange Rates (Quarterly)
Foreign currency/$
Asians

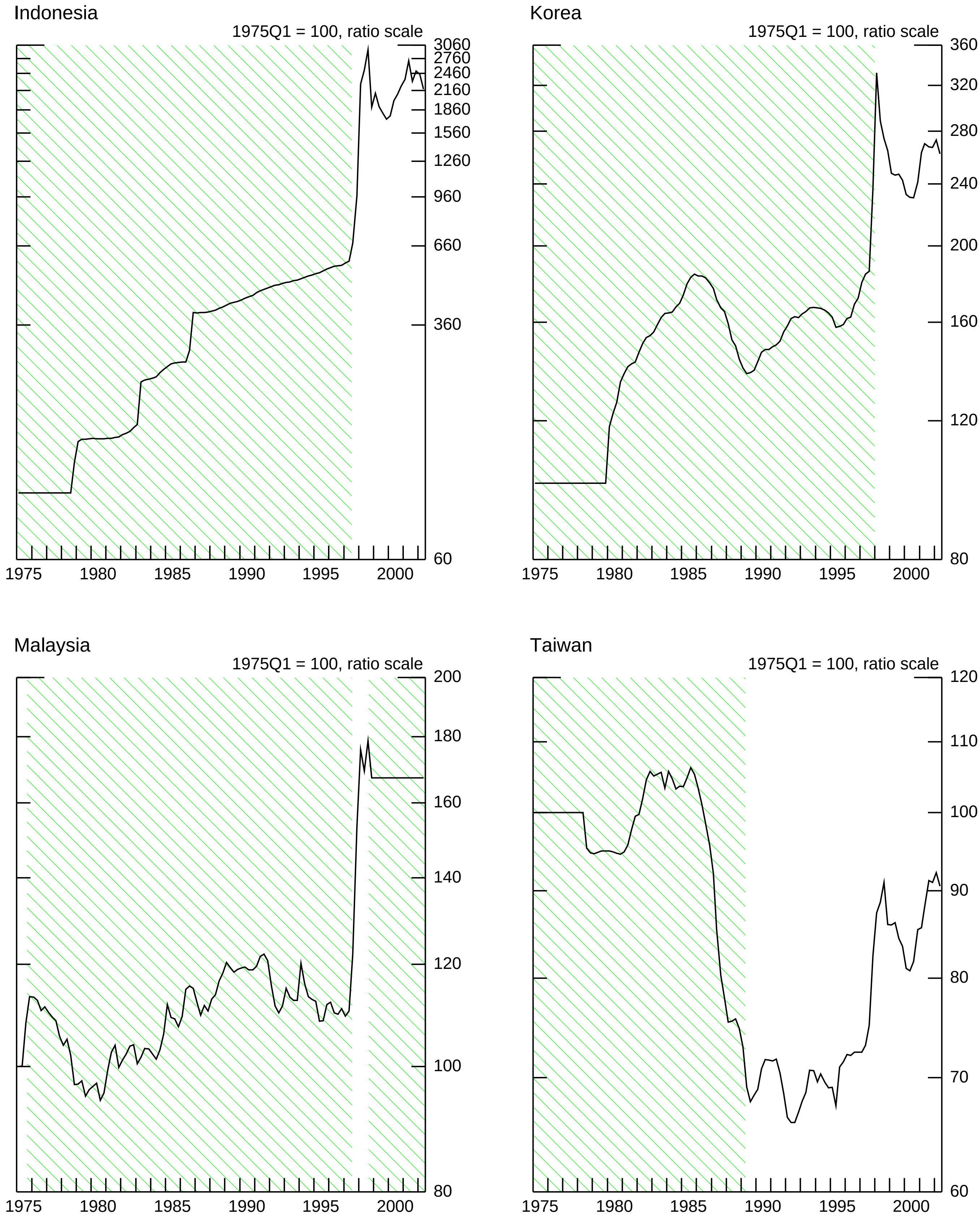
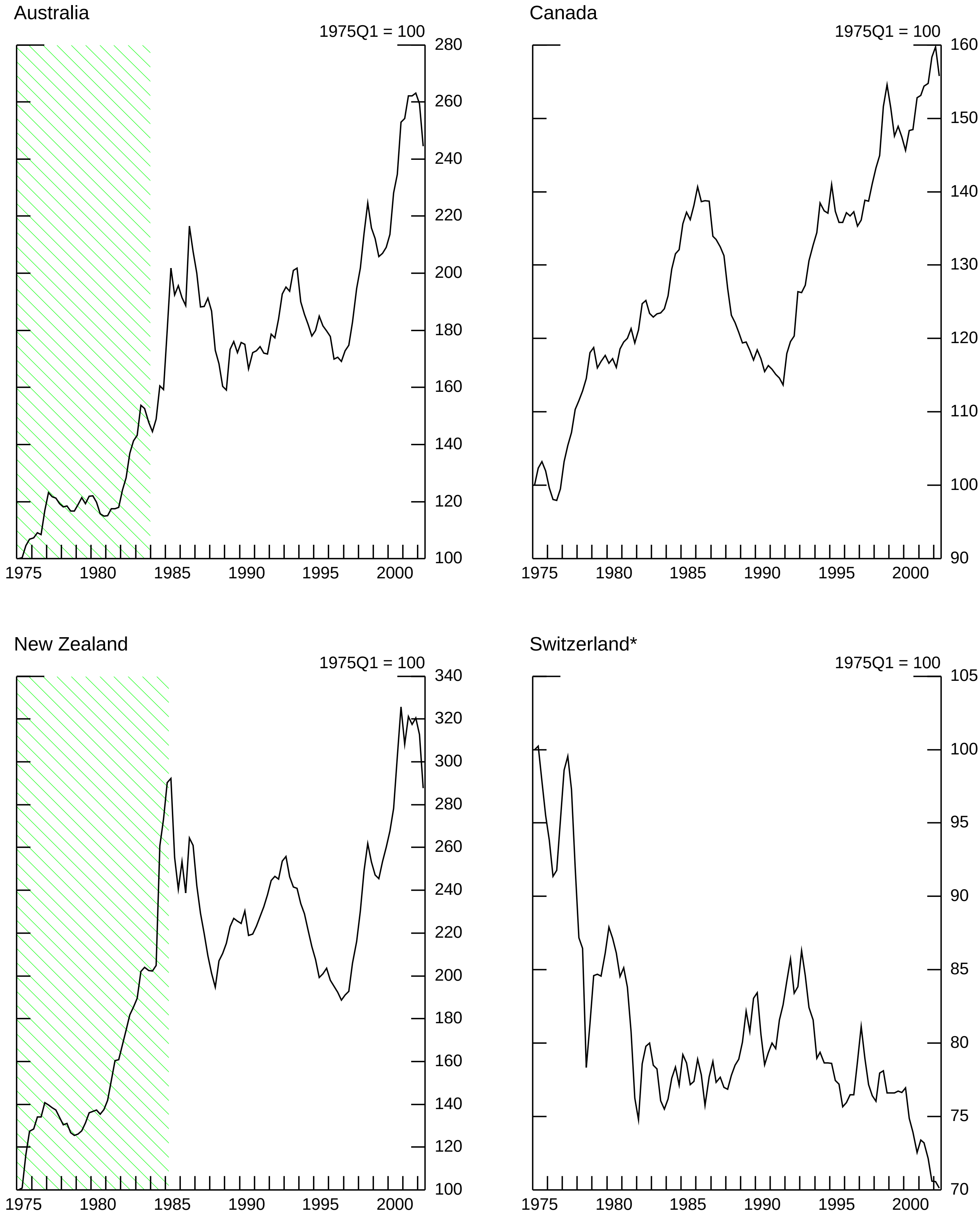


Figure 3

Nominal Exchange Rates (Quarterly)
Foreign currency/$
Floaters



*Shown as francs/DM.

Figure 4

Nominal Exchange Rates (Quarterly)
Foreign currency/DM
Industrial Non-Floater

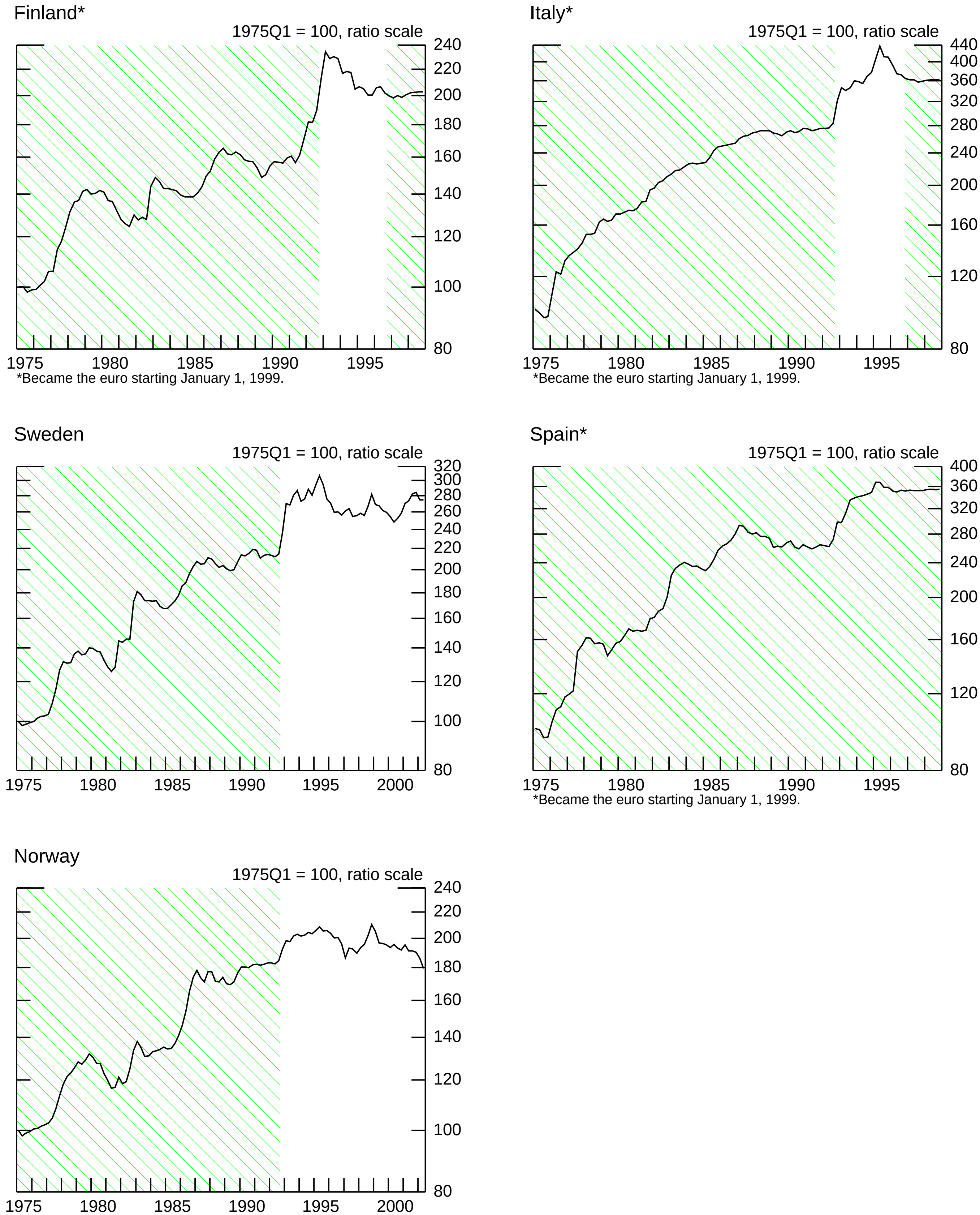


Figure 5: Responses to a Shock to Terms of Trade

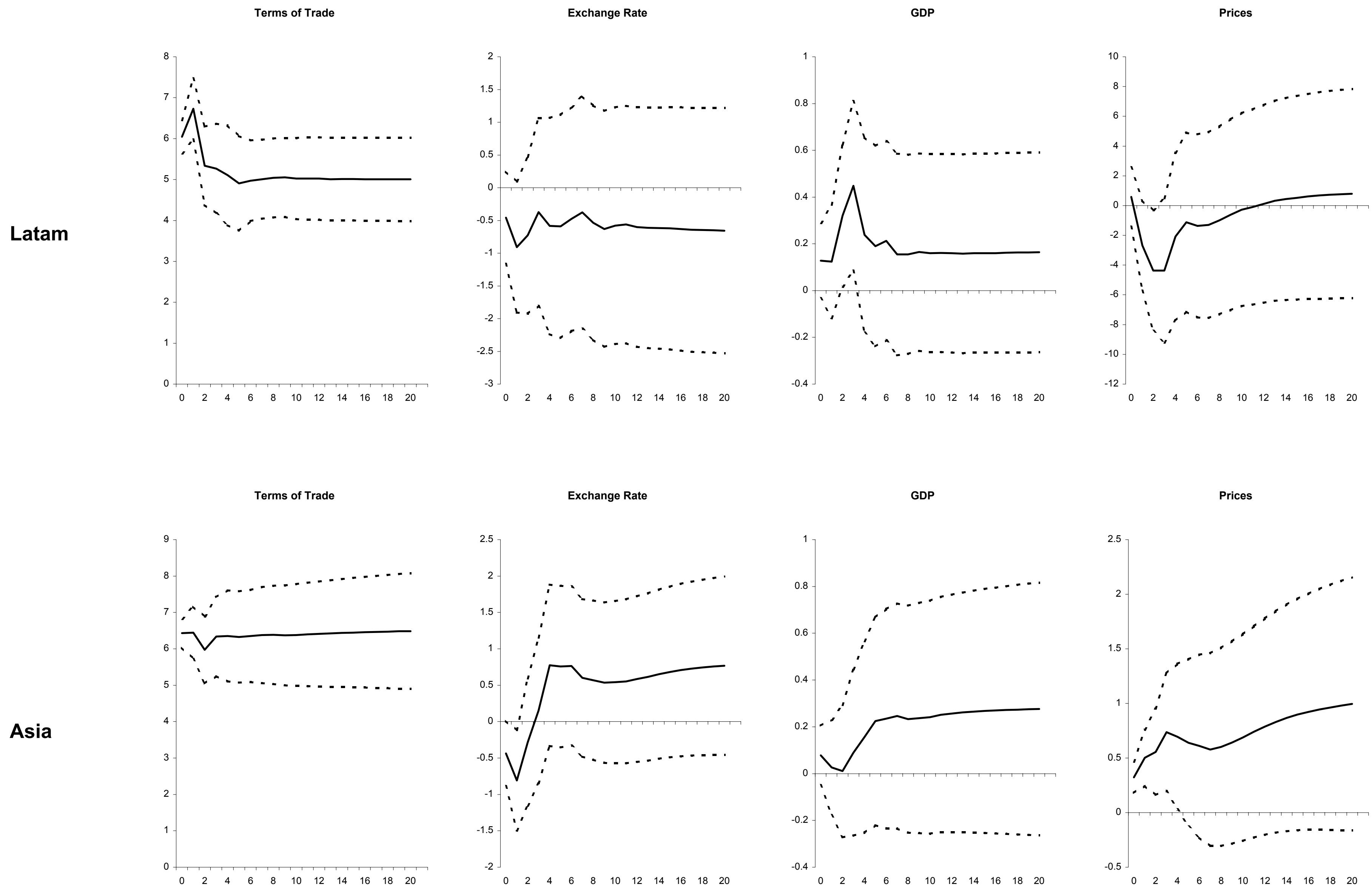


Figure 5: Responses to a Shock to Terms of Trade (con't)

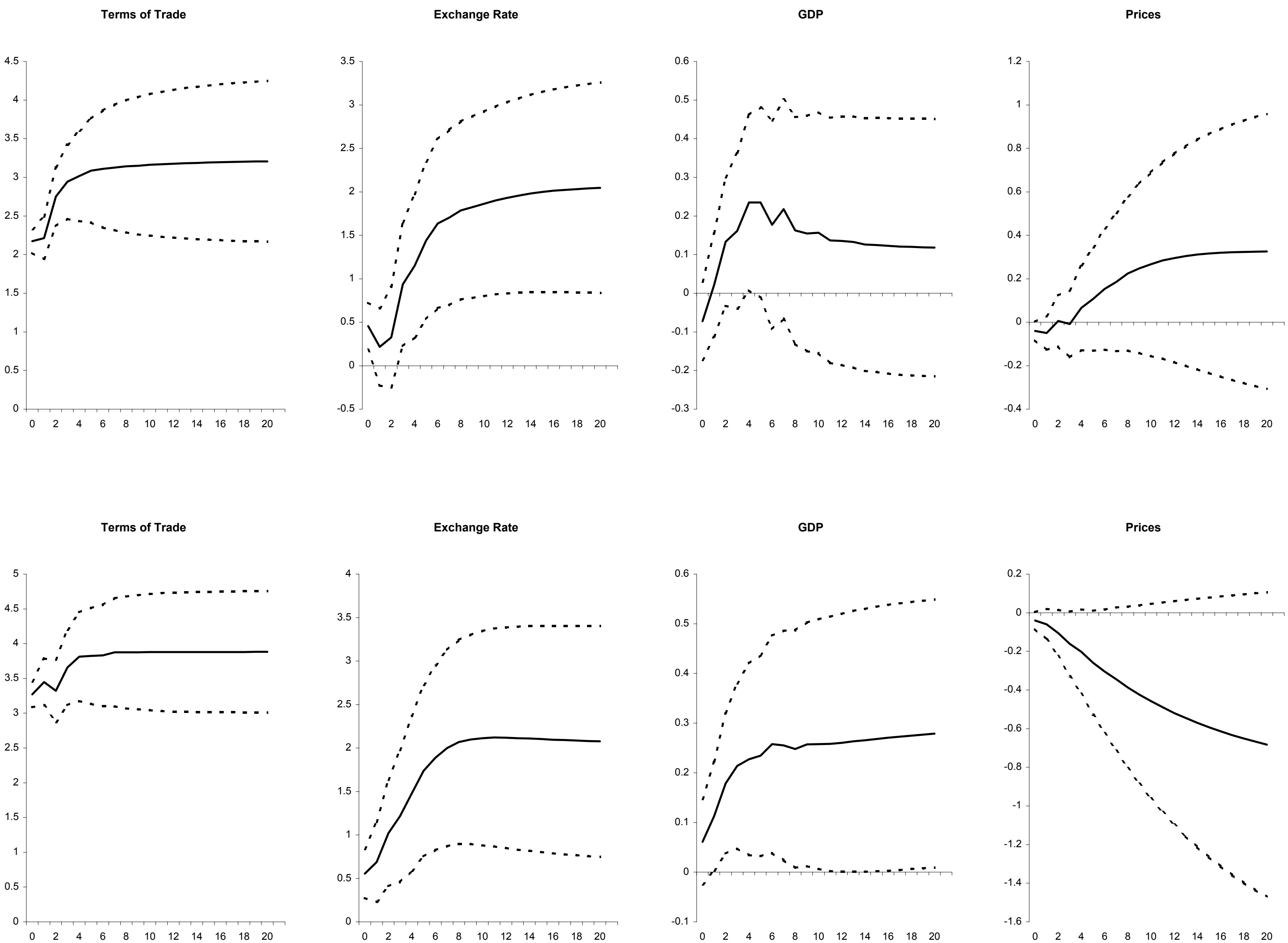


Figure 6: Responses to a Shock to Foreign Output

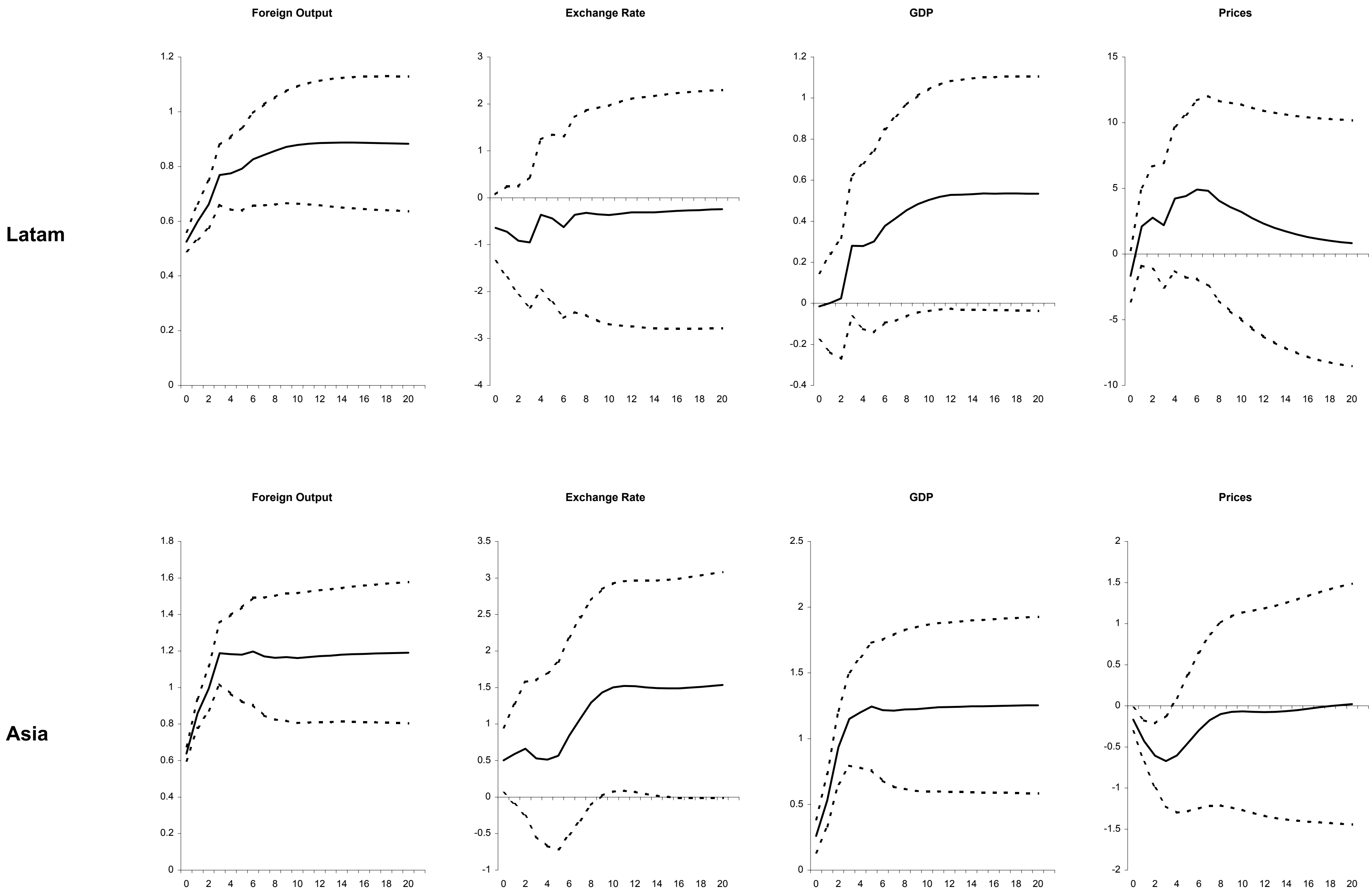


Figure 6: Responses to a Shock to Foreign Output (con't)

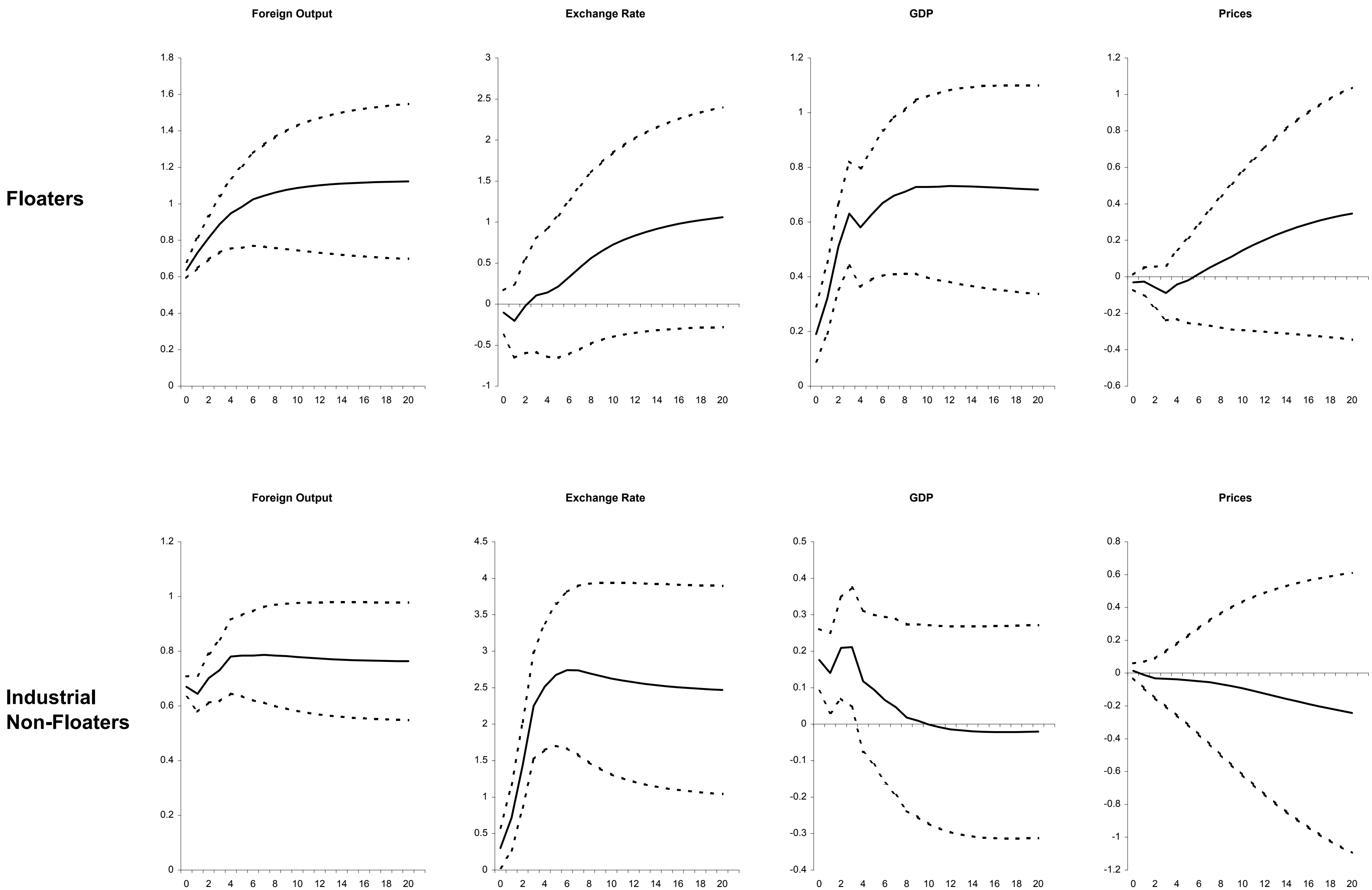


Figure 7: Responses to a Shock to Foreign Interest Rate

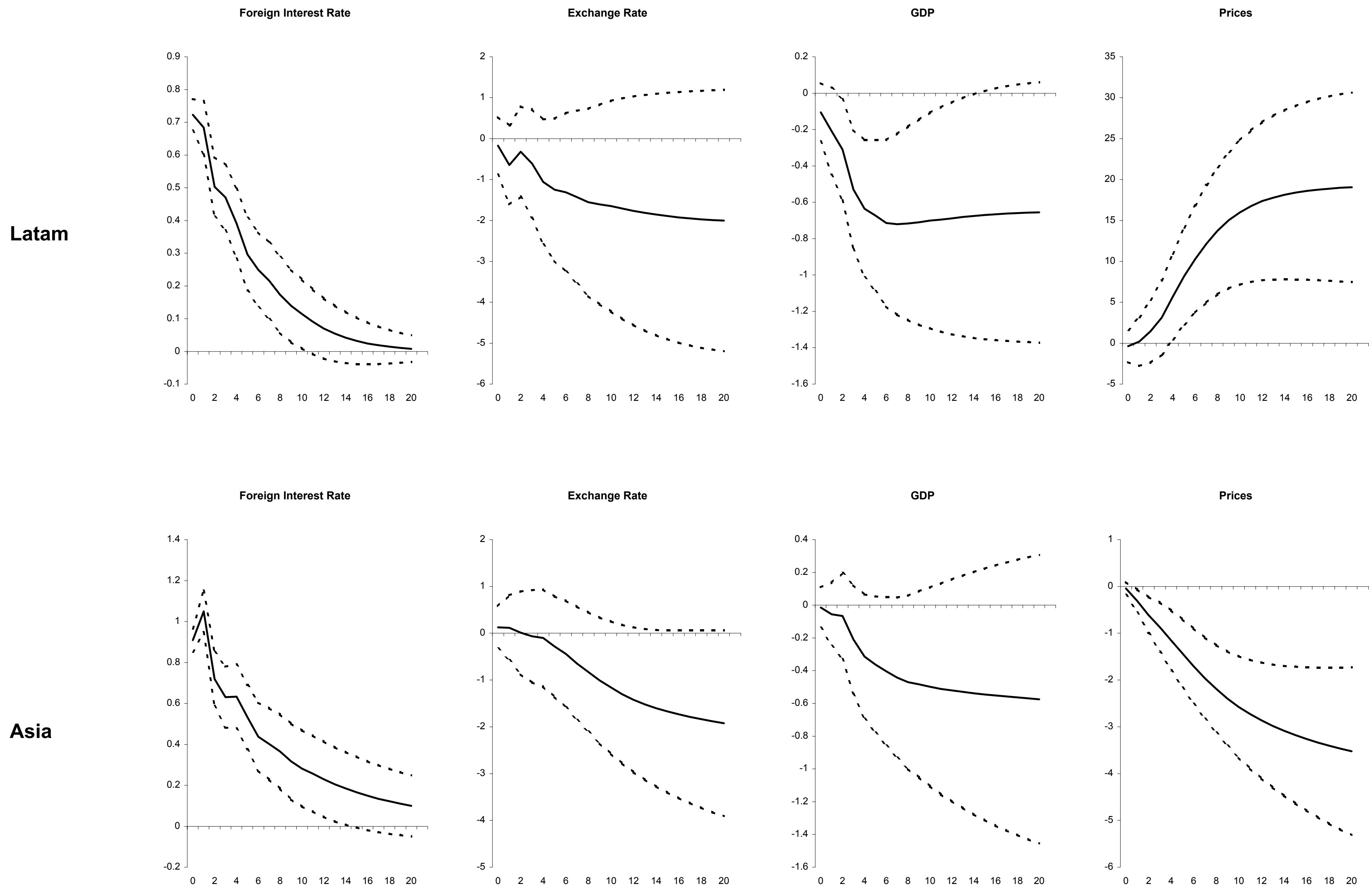


Figure 7: Responses to a Shock to Foreign Interest Rate (con't)

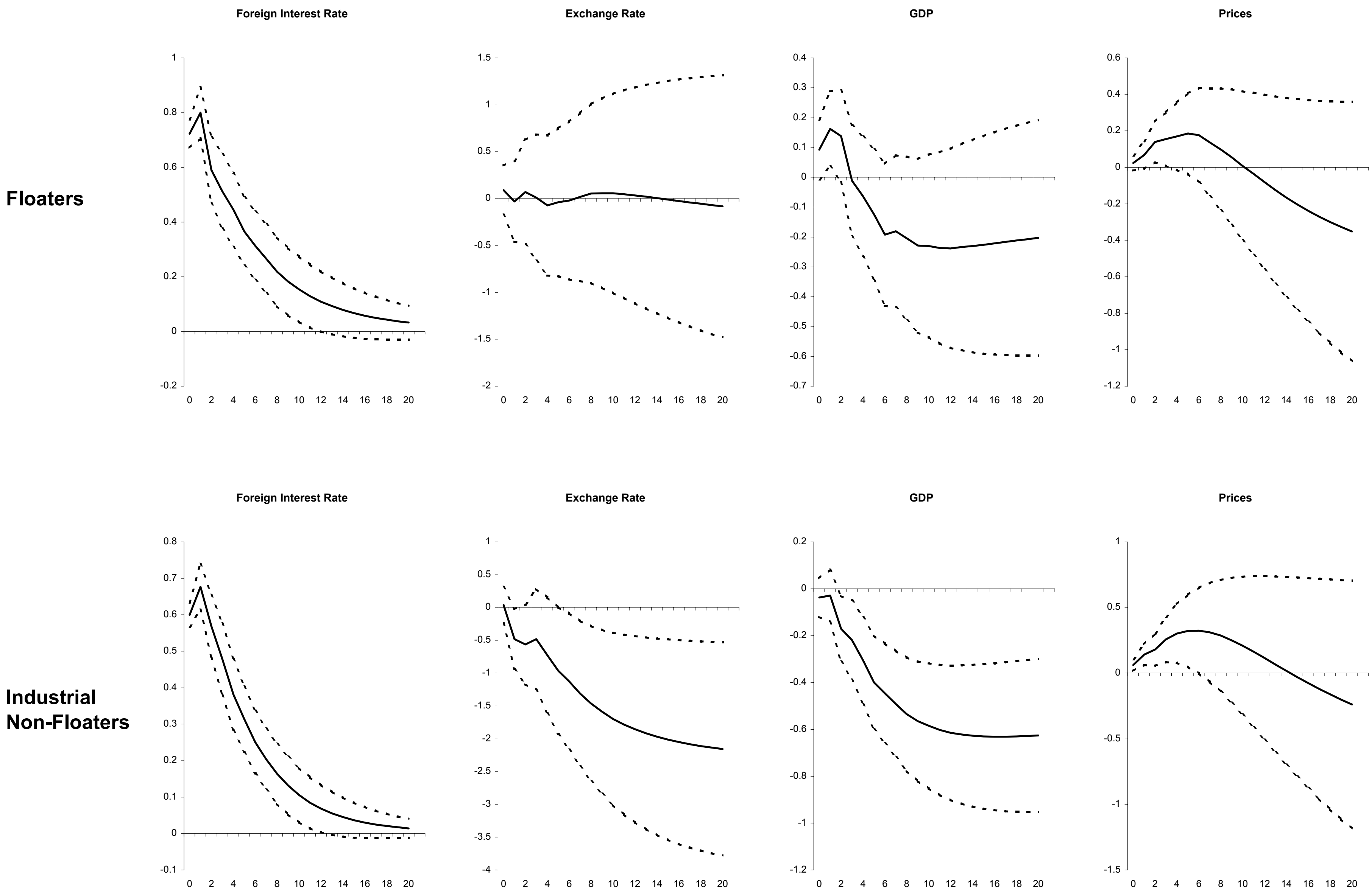


Figure 8: Responses to a Shock to Exchange Rate

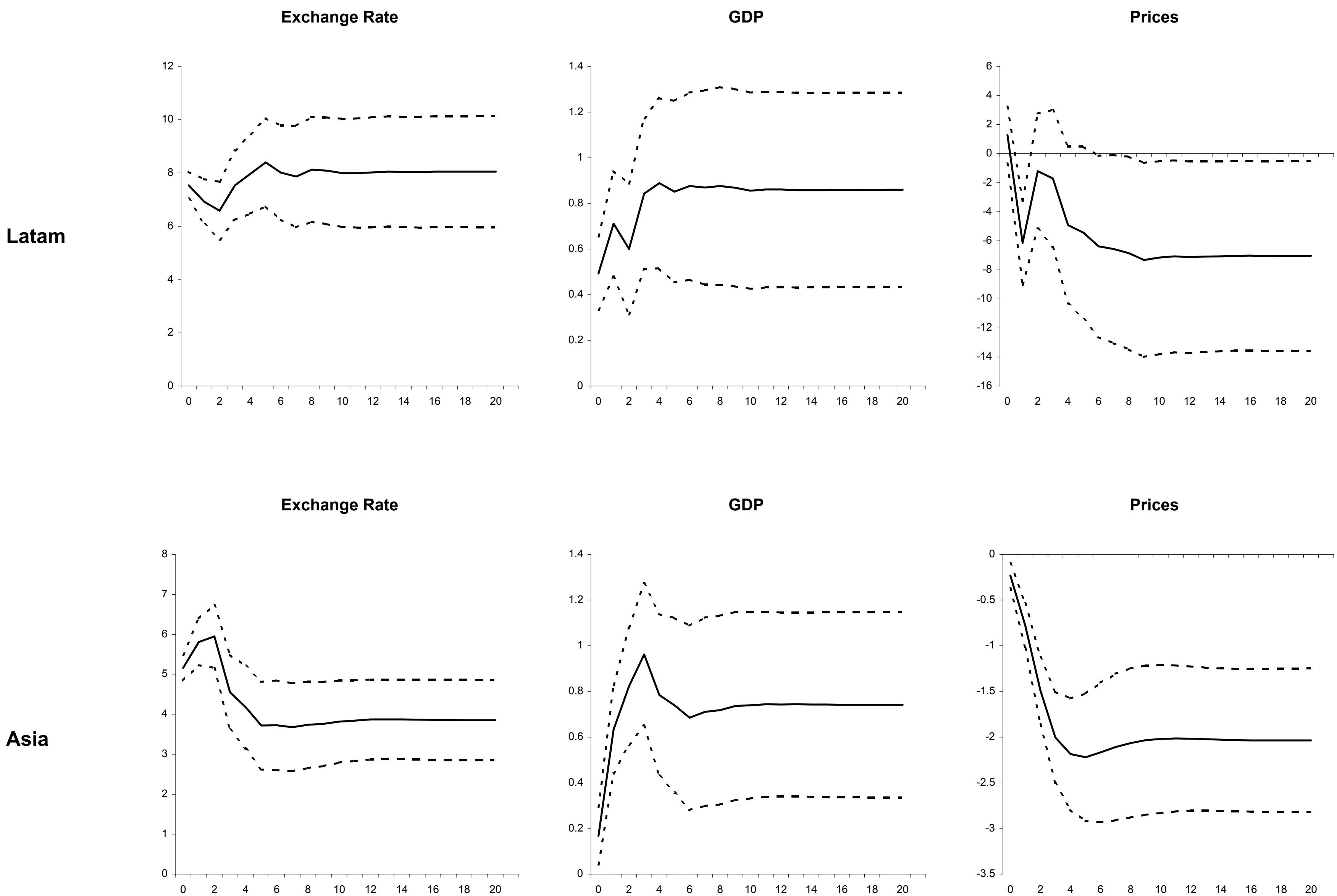


Figure 8: Responses to a Shock to Exchange Rate (con't)