

IMF Working Paper

Pick Your Poison: The Exchange Rate Regime and Capital Account Volatility in Emerging Markets

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IMF Institute

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Capital Account Volatility in Emerging Markets¹**

Prepared by Shigeru Iwata and Evan Tanner

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Abstract

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We characterize a country's exchange rate regime by how its central bank distributes a capital account shock across three variables: exchange depreciation, interest rates, and international reserve flows. Structural vector autoregression estimates for Brazil, Mexico, and Turkey, suggest that countries face two tradeoffs when shocked adversely (argument symmetric): (i) a combination of higher interest rates and more exchange depreciation helps limit reserve losses; and (ii) higher interest rates help limit exchange depreciation. Capital account shocks are further shown to have impacts on output growth and inflation. The nature and magnitude of these impacts may depend on the exchange rate regime.

JEL Classification Numbers: F32, F32, F33

Keywords: exchange rate regime, capital account, structural vector autoregression.

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Contents		Page
I.	Introduction.....	4
II.	A Structural Vector Autoregression (SVAR) Approach	9
	A. The Basic Model.....	10
	B. Identification.....	11
	C. How Does the Central Bank Distribute an External Capital Market Shock (e_N)?	14
III.	Empirical Results: Brazil, Mexico, and Turkey.....	17
	A. Central Bank Reactions and Tradeoffs	18
	B. The Transmission of Capital Account Shocks e_N to the Domestic Economy	32
IV.	What If the Exchange Rate Had Been More (or Less) Flexible? A Counterfactual Analysis.....	38
V.	Summary and Conclusion.....	43
 Figures		
1.	Mexico: 1988:5–1994:10 Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)	19
2.	Mexico: 1995:1–2000:12 Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)	20
3.	Brazil: 1994:8–1998:12 Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X).....	21
4.	Turkey: 1987:1–1993:12 Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)	22
5.	Turkey, 1995:5 - 1999:10 Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X).....	23
6.	Mexico: Impulse Responses to e_N , Monetary variables	28
7.	Brazil: Impulse Responses to e_N , Monetary variables.....	30
8.	Turkey: Impulse Responses to e_N , Monetary variables.....	31
9.	Mexico: Impulse Responses to e_N , Non-monetary variables.....	34
10.	Turkey: Impulse Responses to e_N , Non-monetary variables.....	35
11.	Simulated responses of output growth (Y) to shock e_N (act vs. counterfactual β)	41
12.	Simulated responses of inflation (P) to shock e_N (act. vs. counterfactual β)	42
 Table		
1.	Contemporaneous Central Bank Responses to e_N	25

Appendix	
I. Data construction	45
References.....	46

I. INTRODUCTION

The choice of exchange rate regime is a perennial issue for policy makers. But, in the wake of the recent volatility in global capital markets, this issue has taken on special relevance for emerging markets.² Recent exchange rate crises have led some to conclude that, in an environment of capital market volatility, more exchange rate flexibility is desirable.³

Unfortunately, accepting more exchange rate flexibility can also represent a choice among undesirable alternatives: facing an adverse shock, central banks must “pick their poison.”⁴

Letting the currency depreciate, they have to accept unwanted effects on both possible acceleration of inflation through the pass-through and further domestic financial fragilities caused by increased foreign currency liabilities. Raising the interest rate to defend the

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² Over the years, many authors analyzed the welfare implications of alternative exchange rate regimes; the papers are too numerous to mention. Recent papers relate exchange rate regimes to key issues in this paper—volatile external capital markets, domestic output and inflation, and fragile financial sectors—include Lahiri and Végh (2001) and Parrado and Velasco (2002).

³ Stanley Fischer (2001) suggests that since traditional (soft) pegs are unsustainable in such an environment, exchange rate regimes have instead drifted towards the polar extremes of either hard pegs or free floats. On this issue, see also Edwards and Savastano (1999) and Edwards (2000).

⁴ This phrase comes from Karin Lissakers (representative from the United States to the International Monetary Fund) in Bluestein (2001, p. 156): “ ‘There was huge ambivalence’ on the part of the staff (regarding policy options for Asian countries facing capital outflows)... if we jack up interest rates, we will kill off our companies. But, you are dealing with a foreign exchange crisis. So pick your poison. You are going to have a terrible problem either way.”

exchange rate, on the other hand, may adversely impact economic activity, financial sector balance sheets, or both.

An exchange rate regime should ultimately reflect a central bank's preference as to how such a shock should be transmitted to the domestic economy. However, providing evidence on this issue can be problematic. As is well known, a country's stated exchange rate policy can differ substantially from its actual one, as observed by Levy-Yeyati and Sturzenegger (2002), Bubula and Otker-Robe (2002), and Reinhart and Rogoff (2002) among others.⁵ Moreover, exactly *how* to measure the exchange rate regime—that is, the degree of flexibility—remains an open question, which will be discussed in greater detail below.

This paper examines choice of exchange rate regimes and their effect on the economies in emerging markets. First, we empirically characterize a country's exchange rate regime *as a dynamic response* to capital account shocks—how countries “pick their poison.” Second, we analyze the impact of capital market shocks on the domestic economy—the outcome of the “poison.” Specifically, we assess the effect of such shocks on three key domestic variables: real economic growth, inflation, and the primary fiscal balance, *conditional* on an exchange rate regime chosen by the central bank. In this way, we can evaluate how—if at all—the

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⁵ The standard reference on nominal or declared exchange rate regimes is the International Monetary Fund's *Annual Report on Exchange Rate Arrangements*. As a point of comparison, these authors develop several measures of effective exchange rate policy.

choice of exchange rate regime affects the outcome of external shocks to the domestic economy.⁶

More specifically, our model casts this policy decision in two dimensions. In one dimension, the central bank decides whether to adjust monetary aggregates (reserves, with corresponding domestic credit flows) or prices (exchange rates, interest rates), or some combination thereof. In the other dimension, the central bank decides which of the prices to adjust: interest rates, exchange rates, or some combination thereof.⁷

We estimate two empirical *tradeoffs* faced by a central bank when confronted with a capital account shock. First, the central bank is presumed to trade off reserve losses against price (interest rate or exchange rate) movements. Suppose, facing an adverse shock, the central bank permits some combination of interest rate hikes and exchange rate depreciation. Then, it

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⁶ To further place the first goal in context, other authors have also recently developed quantitative measures of the exchange rate regime. For example, Levy-Yeyati and Sturzenegger (2002) propose to gauge exchange rate policy by examining exchange rate volatility, both unconditionally and relative to the *sum* of the variances of exchange rates and reserves (a bivariate measure of exchange market pressure). Unfortunately, such indices ignore the essential nature of an exchange rate regime as a response to a shock. As a remedy, we propose to model an exchange rate regime in the context of capital market shocks. When confronted with such a shock, the central bank must let three variables adjust in some combination, namely exchange depreciation, interest rates, and international reserve flows.

⁷ When central banks aim to shield domestic economies from such shocks, they typically do so by limiting both exchange rate and interest rate flexibility. By so doing, the shock is partly absorbed by international reserve flows, which may in turn be offset to some degree by domestic credit creation through sterilized intervention. As mentioned above, such a policy may be unsustainable, but interest rate and exchange rate flexibility may also be undesirable.

would lose fewer reserves than otherwise. Second, the central bank also trades off interest rate hikes against exchange depreciation. With an adverse shock, if the central bank permits the interest rate to rise, the exchange rate would depreciate less than otherwise.

This paper examines three emerging market (EM) economies, namely Brazil, Mexico, and Turkey, which have recently faced several kinds of external shocks, including shocks to the external capital account.⁸ Results in this paper help illustrate a variety of exchange rate/monetary regimes. At one extreme, in pre-crisis Mexico, external shocks were nearly completely reflected in reserve flows. By contrast, in Turkey's later period, one that also preceded an exchange rate crisis, the central bank responded to external shocks with interest rate movements.

To analyze how one shock is distributed across several variables, single equation methods are generally inadequate. A more appropriate method, and the one chosen here, is the structural vector autoregression (SVAR) framework. In recent years, many authors have used the SVAR to study monetary policies.⁹ While we borrow some insights from several of these

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⁸ Such shocks may reflect industrialized country business cycles and monetary policy, perceived investor risk, exchange rate risk, and market contagion.

⁹ Papers that use vector autoregressions to analyze monetary policies in open economies include Cushman and Zha (1997), Kim and Roubini (2000), and Kim (2001, 2002). Note that a model like the one presented in this paper might also be used to analyze the effects of monetary policy shocks. However, we have chosen to leave such an analysis for another paper.

papers, our emphasis is closer to that of Calvo, Leiderman, and Reinhart (1993) who examine the impacts of reserve shocks on domestic variables.¹⁰

By extension, we also ask whether the effect of capital account shocks on key domestic variables—output growth, inflation, and the fiscal deficit—depends on the exchange rate regime. For example, if the authority defends the exchange rate with interest rate movements rather than reserve flows, we would expect that capital account shocks to have a larger impact on output—through their effects on interest rates. Likewise, as the exchange rate regime becomes more flexible, we would expect that capital account shocks should have a larger impact on inflation—through their effects on exchange depreciation.¹¹ Such issues are addressed by examining *actual* impulse response functions (IRFs) of capital market shocks on these domestic variables across different time periods and exchange rate regimes. As a supplementary analysis, *simulated* IRFs based on counterfactual exchange rate regimes assumptions, are also presented.

The rest of this paper is organized as follows. In Section II, the SVAR model and its identifying restrictions are developed. Section III presents the empirical results, including

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¹⁰ Specifically, Calvo, Leiderman, and Reinhart (1993) use a vector autoregression to examine the effect of reserve shocks (as a proxy for capital market shocks) on the real exchange rate in several Latin American countries. In this paper, we also use reserve shocks to approximate shocks to the external capital account.

¹¹ We also examine the responses of fiscal policy to capital account shocks.

effects of capital market shocks on the domestic economy. Section IV presents the simulation analysis mentioned above. Section V provides a summary and conclusions.

II. A STRUCTURAL VECTOR AUTOREGRESSION (SVAR) APPROACH

Central banks in emerging market (EM) economies face several factors that distinguish them from industrialized countries. First, emerging market economies are typically subject to substantial external shocks. Such shocks may reflect business cycles and monetary policy in industrialized countries, perceived investor risk, exchange rate risk, and market contagion.¹² Second, emerging market assets are poor substitutes with, and generally riskier than, those from industrialized countries. Third, emerging market central banks intervene in foreign exchange markets to much larger a degree than in most industrialized countries.

This section lays out a structural vector autoregression (SVAR) model of central bank's behavior in an emerging market economy. In Section II.A, the basic SVAR model is developed. Section II.B presents the identifying assumptions. Section II.C provides a detailed discussion of how the central bank distributes a capital account shock across international reserve, interest rate, and exchange rate adjustment.

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¹² Several authors, including Calvo, Leiderman and Reinhart (1993), and Fernandez-Arias (1996), suggest that capital flows to and from less industrialized countries are primarily due to exogenous (or “push”) factors.

A. The Basic Model

Consider a vector of observed variables \mathbf{X} .¹³ We partition this vector into two subvectors: \mathbf{X}^n and \mathbf{X}^m . The vector \mathbf{X}^n contains broader macroeconomic (“nonmonetary”) variables: output growth (Y), inflation (P), and the fiscal deficit (scaled by the monetary base) (F).¹⁴ The vector \mathbf{X}^m represents a set of “monetary” and financial variables, including changes in net foreign reserves (N) and domestic credit (D),¹⁵ the interest rate (R) and nominal exchange depreciation (E). The model also includes the terms of trade (T) and the dollar (London interbank) interest rate (R^*) as the exogenous variables on the right hand side.¹⁶ The reduced form system is:

$$\mathbf{X}_t = \mathbf{c}_0 + \mathbf{C}_1 \mathbf{X}_{t-1} + \dots + \mathbf{C}_p \mathbf{X}_{t-p} + \mathbf{C}_0^* \mathbf{Z}_t + \dots + \mathbf{C}_q^* \mathbf{Z}_{t-q} + \mathbf{u}_t \quad (1)$$

where $\mathbf{X}_t = [\mathbf{X}_t^n, \mathbf{X}_t^m]'$, $\mathbf{X}_t^n = [Y_t, P_t, F_t]'$, $\mathbf{X}_t^m = [N_t, D_t, R_t, E_t]'$, $\mathbf{Z}_t = [T_t, R_t^*]'$, \mathbf{c}_0 is a vector of constants, \mathbf{C}_i is a matrix of the coefficients on the lagged endogenous variables \mathbf{X}_{t-i} ($i = 1, 2, \dots, p$), \mathbf{C}_j^* is a matrix of the coefficients on the current as well as lagged exogenous

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¹³ The construction of all variables is detailed in an appendix.

¹⁴ Scaling the deficit in this way reflects the fact that base money is often the residual financing source for an emerging market government. Note also that the primary (noninterest) deficit is used.

¹⁵ Net foreign reserves and domestic credit are both scaled by base money so that their sum is equal to the growth rate of monetary base.

¹⁶ Terms of trade are available for Brazil and Mexico. For Turkey, the dollar price of petroleum is used, following Kim and Roubini (2000) and others. Also, to test for industrial country business cycle effects, the regressions were also run with a monthly index of production from industrialized countries. The results (not reported here) were almost identical to those presented in this paper.

variables \mathbf{Z}_{t-j} ($j = 0, 1, \dots, q$), and \mathbf{u}_t is a vector of the one-step-ahead forecast errors. The reduced form errors \mathbf{u}_t are related to the structural shocks \mathbf{e}_t according to:

$$\mathbf{u}_t = \mathbf{B}\mathbf{e}_t, \quad (2)$$

where $\mathbf{E}(\mathbf{e}_t) = 0$ and $\text{Cov}(\mathbf{e}_t) = \mathbf{D}$, which is diagonal. The structural model is given by

$$\mathbf{A}\mathbf{X}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{X}_{t-1} + \dots + \mathbf{A}_p\mathbf{X}_{t-p} + \mathbf{A}_0^*\mathbf{Z}_t + \dots + \mathbf{A}_q^*\mathbf{Z}_{t-q} + \mathbf{e}_t,$$

where $\mathbf{A} = \mathbf{B}^{-1}$. There are seven structural shocks: the aggregate supply shock (e_{AS}), the aggregate demand shock (e_{AD}), the fiscal shock (e_F), the external (capital account) shock (e_N), the money supply shock (e_{MS}), the money demand shock (e_{MD}), and the exchange rate shock (e_E). We conformably partition \mathbf{u}_t and \mathbf{e}_t into the non-monetary and monetary components: $\mathbf{u}_t = [\mathbf{u}^n, \mathbf{u}^m]'$ and $\mathbf{e}_t = [\mathbf{e}_t^n, \mathbf{e}_t^m]'$, where $\mathbf{u}_t^n = [u_{Yt}, u_{Pt}, u_{Ft}]'$, $\mathbf{u}_t^m = [u_{Nt}, u_{Dt}, u_{Rt}, u_{Et}]'$, $\mathbf{e}_t^n = [e_{ASt}, e_{ADt}, e_{Ft}]'$, and $\mathbf{e}_t^m = [e_{Nt}, e_{MSt}, e_{MDt}, e_{Et}]'$. Similarly, \mathbf{B} may be partitioned as:

$$\mathbf{B} = \begin{bmatrix} \mathbf{B}^{nn} & \mathbf{B}^{nm} \\ \mathbf{B}^{mn} & \mathbf{B}^{mm} \end{bmatrix} \quad (3)$$

B. Identification

The identification scheme rests on seven key assumptions.¹⁷ First, output growth, inflation, and the fiscal deficit are assumed to respond to the monetary and financial shocks (e_N , e_{MS} , e_{MD} , e_E) with delay. Thus, $\mathbf{B}^{nm} = \mathbf{0}$.¹⁸ Second, output growth responds to both the aggregate demand shock and the fiscal shock with a lag but not contemporaneously. Likewise, inflation responds the fiscal shock with a lag but not contemporaneously. Jointly, these assumptions imply that matrix \mathbf{B}^{nm} is lower triangular. The lagged responses implied by the first two assumptions plausibly reflect delays in the production process and price rigidities for a monthly dataset.

Third, the external capital account shock e_N has non-zero effects on all variables in monetary and financial block. Such a shock is intended to reflect factors like those mentioned previously: perceived investment (default) risk, exchange rate risk, and market contagion.¹⁹

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¹⁷ The restrictions presented in this section ensure that the model is just identified.

¹⁸ And, as mentioned above, other recent research justifies similar restrictions in this way. Output reaction is generally presumed to be slow, and fiscal shocks take more than a month to have an impact on output as well as inflation.

¹⁹ Note that the shock term e_N resembles in some ways several commonly-used indices of exchange market pressure (EMP) that are based on seminal work by Girton and Roper (1977) (see also Eichengreen, Rose, and Wyplosz (1996), Sachs, Tornell, and Velasco (1996), and Tanner (2000)). Both e_N and EMP are weighted averages of reserve movements, interest differentials, and exchange rate depreciation. Another widely used measure of external pressures faced by a country is the emerging market bond index (EMBI). Our measure has several advantages over the EMBI, however. First, EMBI is a spread between two *dollar-*

(continued...)

The central bank must respond to such a shock; it does so according to the cross-equation restrictions shown below.

Fourth, the money demand term e_{MD} reflect *idiosyncratic* shocks in domestic money holding behavior. These shocks are orthogonal to e_N and thus do not enter in contemporaneous reaction functions for either international reserves or domestic credit.

Fifth, in a similar vein, the exchange shock e_E reflects *idiosyncratic* exchange rate policy, likewise orthogonal to e_N . Accordingly, this shock does not enter in contemporaneous reaction functions for international reserves, domestic credit, or the interest rate.

Sixth, fiscal shocks are assumed to have no direct contemporaneous effects on international reserves. However, such shocks will have *indirect* contemporaneous impacts through the domestic credit channel: innovations to the public deficit contemporaneously affect international reserves if only they are financed with domestic money creation.

Seventh, responses of international reserves, domestic credit, interest rate changes, and exchange depreciation to the external capital account shock e_N reflect the following cross equation restrictions:

denominated interest rates. Therefore, unlike our measure, the EMBI reflects country risk but not exchange risk *per se*. Second, unlike the EMBI, our measure directly reflects the balance of payments constraint faced by the central bank.

$$\begin{bmatrix} b_{NN} \\ b_{DN} \\ b_{RN} \\ b_{EN} \end{bmatrix} = \begin{bmatrix} \lambda \\ \lambda\alpha \\ -(1-\lambda)\beta \\ -(1-\lambda)(1-\beta) \end{bmatrix} \quad (4)$$

The intuition behind these restrictions is fully explained in the next section.

The above assumptions together with their appropriate normalizations imply that the matrix \mathbf{B} is:

$$\mathbf{B} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{PAS} & 1 & 0 & 0 & 0 & 0 & 0 \\ b_{FAS} & b_{FAD} & 1 & 0 & 0 & 0 & 0 \\ b_{NAS} & b_{NAD} & 0 & b_{NN} & b_{NMS} & 0 & 0 \\ b_{DAS} & b_{DAD} & b_{DF} & b_{DN} & 1 & 0 & 0 \\ b_{RAS} & b_{RAD} & b_{RF} & b_{RN} & b_{RMS} & 1 & 0 \\ b_{EAS} & b_{EAD} & b_{EF} & b_{EN} & b_{EMS} & b_{EMD} & 1 \end{bmatrix}, \quad (5)$$

Thus coefficients in \mathbf{B} matrix are estimated subject to both the cross-equation restrictions in (4) and the zero-restrictions in (5).

C. How Does the Central Bank Distribute an External Capital Market Shock (e_N)?

Our modeling strategy rests on two key ideas. First, as mentioned above, the shock e_N summarizes all external capital market shocks to which the central bank must react. Second, the central bank faces a constraint: the *entirety* of such a shock must be distributed across

three variables: international reserves, interest rates, and exchange rates.²⁰ Thus, the central bank's constrained choice is summarized by two parameters introduced above, λ and β . Restating the cross-equation restrictions in equation (4), we have: $b_{NN} = \lambda$, $b_{RN} = -(1-\lambda)\beta$, $b_{EN} = -(1-\lambda)(1-\beta)$. As discussed below, these parameters can be estimated directly with standard non-linear techniques.²¹

The first parameter, λ , reflects the central bank's decision to adjust monetary aggregates (reserves and domestic credit) versus prices (interest rates and/or exchange rates). If $\lambda = 1$, the adjustment takes place entirely through quantities (fixed interest rates and exchange rates). By contrast, if $\lambda = 0$, the adjustment takes place entirely through prices. For intermediate cases $0 < \lambda < 1$, the adjustment occurs in some combination.²²

The second parameter, β , measures how adjustment of prices is distributed between interest rates and exchange depreciation. If $\beta = 1$, the exchange rate is fixed and the entire adjustment

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²⁰ One way to interpret e_N is that it includes time-varying, unobservable elements like expected exchange depreciation and risk. Here, the shock has been normalized on reserves. While this normalization is arbitrary, it does conform to previous literature, including Calvo, Lederman and Reinhart (1993). Also, in the strictest sense, e_N may imply some sort of quantity rationing, since capital market shocks are not fully contained in the interest rate.

²¹ The same result may be obtained by restricting b_{NN} equal to unity (as is more commonly done). In this case, the parameters uncovered from linear estimates would be: $\lambda = 1 + b_{RN}/\beta$, $\beta = b_{RN}/(b_{EN} + b_{RN})$.

²² Of course, we might think of an "over-adjustment" case ($\lambda > 1$). In such a case, the central bank reduces interest rates in response to an external shock and thus stimulates a larger reserve outflow than otherwise would have taken place.

falls on the interest rate; if $\beta = 0$, the authority is targeting the interest rate and instead the exchange rate bears the entire adjustment (assuming λ does not equal unity). For intermediate cases, $0 < \beta < 1$, the adjustment occurs in some combination.

Note that the central bank faces two *tradeoffs*: First, when an external shock (e_N) hits, the central bank's tradeoff between monetary aggregate and price adjustment is $-(1-\lambda)/\lambda$. To see the intuition behind this term, consider a regime with flexible interest rates and exchange rates ($0 < \lambda < 1$, $0 < \beta < 1$). Facing an adverse shock (argument symmetric), the central bank cuts its reserve losses by 1 percent (of the monetary base) by raising interest rates by $(1-\lambda)/\lambda * \beta$ percent and permitting exchange rates to depreciate by $(1-\lambda)/\lambda * (1-\beta)$ percent.

Second, the central bank's tradeoff between higher interest rates and more exchange depreciation, given e_N and λ , is $-(1-\beta)/\beta$. Hence, for an adverse shock (argument symmetric) and given that λ , has been chosen, for every 1 percent that the central bank raises interest rates, it reduces exchange rate depreciation by $(1-\beta)/\beta$ percent.²³

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²³ A closely related issue is how the exchange rate responds to monetary policy (interest rate or money demand) shocks—*deviations* from a policy rule. Our focus is different: we emphasize the tradeoff implied by a policy rule. However, in recent research, the former approach is more common. Estimations of the effect of interest rate shocks on exchange rates include: for industrialized countries, Cushman and Zha (1997), Kim and Roubini (2000), Kim (2001, 2002 forthcoming) and others; for emerging markets, Lahiri and Végh (2001), and others. Note, however, that our model also permits such tests. Our results, not included here, are similar to those of Lahiri and Végh: evidence regarding the impact of interest rate shocks on exchange rate depreciation is not robust. By contrast, the evidence regarding the tradeoffs discussed here is more robust.

Lastly, sterilized intervention is easily introduced into the model. The coefficient b_{DN} is composed of two parameters, $\lambda\alpha$. This parameter may be thought of as a sterilization or offset coefficient.²⁴ If $\lambda = 1$ and $\alpha = 1$, domestic credit flows fully offset or sterilize reserve flows.

III. EMPIRICAL RESULTS: BRAZIL, MEXICO, AND TURKEY

This section presents empirical results of the model for three emerging market countries, namely Brazil, Mexico, and Turkey.²⁵ These results help address several issues. Section III.A examines the reactions by each country's central banks to shocks to e_N , both in terms of the impact multipliers (the elements of B^{mm}) and in terms of dynamic responses (through impulse response functions). Section III.B examines the impact of capital account shocks on three domestic variables: output growth, inflation, and the primary fiscal deficit.

For each country, results are presented for selected subperiods that reflect distinct and well-known policy regimes.²⁶ For Mexico, we divide the sample period into two subperiods:

(i) the low-inflation, managed exchange rate period before the Tequila crisis (1988:1–

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²⁴ Older literature, notably Kouri and Porter (1974) also attempted to estimate such a parameter. For a more recent discussion of this issue, see Kletzer and Spiegel (1998).

²⁵ All estimates are performed with the Regression Analysis for Time Series (RATS) package; SVAR estimates use the CVMODEL procedure.

²⁶ Mexico, widely studied by other authors (Calvo and Mendoza (1985), Edwards and Savastano (1998), and Khamis and Leone (2001)) is the reference case and hence discussed first.

1994:10), and (ii) the post-crisis period, including the float (1995:1–2000:12). Similarly, for Turkey, the two periods are separated by an exchange rate crisis, namely (i) 1987:1–1993:12 period and (ii) 1994:5–2001:1 period. For Brazil, we have only one period: the Post-Real managed float/exchange rate band era (1994:8–1998:12).²⁷ All variables are stationary. Results of both unit root tests and the reduced form of the VAR system (1) are available upon request.

A. Central Bank Reactions and Tradeoffs

Figures 1 through 5 present the estimated series for the capital account shock e_N along with the observed values for reserve changes (as a percent of the monetary base) (N), changes in the interest differential (R), and exchange depreciation (E). The scale for e_N and N are *inverted*: an upward movement on the chart indicates an adverse shock and reserve *losses*.

Upward movements of e_N are apparent during the recent episodes of market turbulence, including the Asian and Russian crises: see Mexico's later period (Figure 2), Brazil's managed float (Figure 3), and Turkey's later period (Figure 5). Also, comovements between e_N and N, while not perfect, are nonetheless visually evident.²⁸

The figures suggest differences in exchange rate policy over periods. For example, the difference between the earlier and later periods in Mexico (Figures 1 and 2) is visually

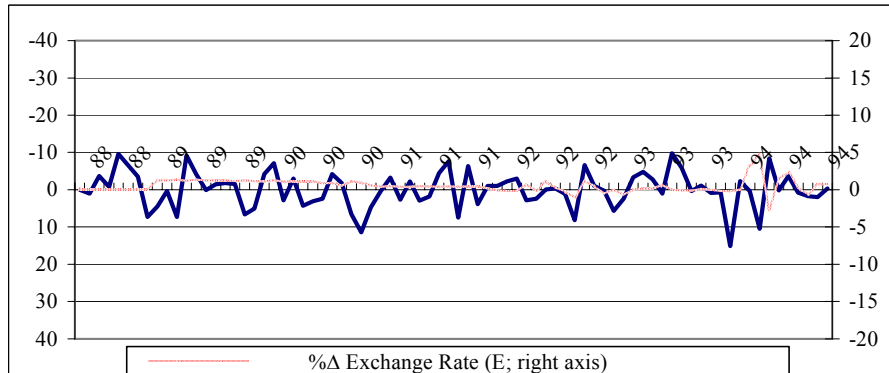
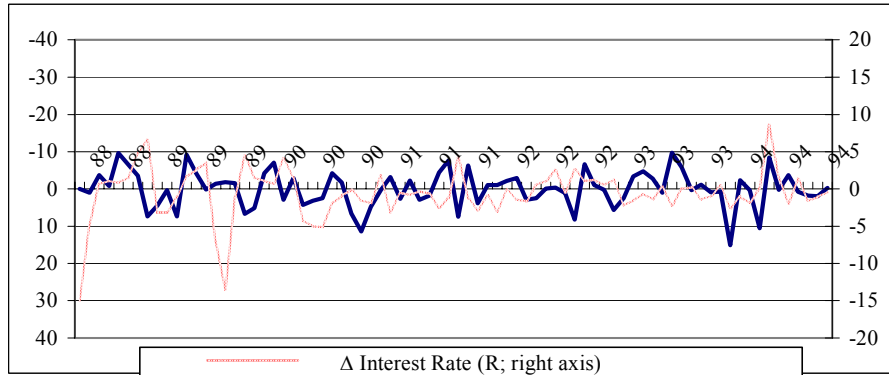
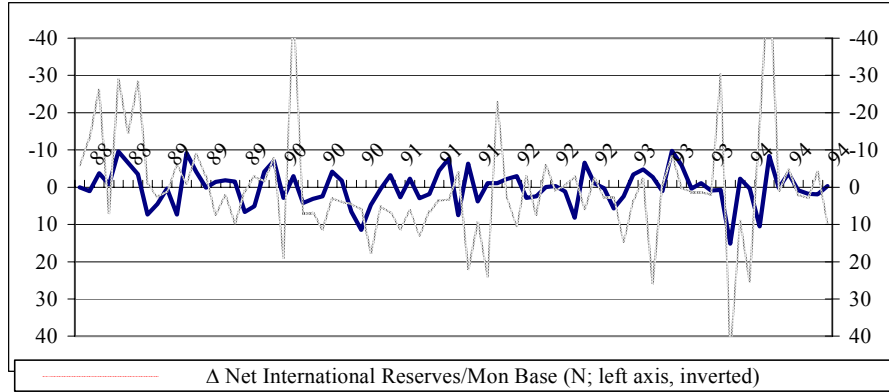
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²⁷ In a previous version of this paper, estimates for the entire post-Real period (1994:8–2001:5) were also presented. There is not sufficient data to study the post-1999 period.

²⁸ However, such comovements are not perfect; nor should they be, since e_N is a shock term from which effects of domestic variables have been filtered out. .

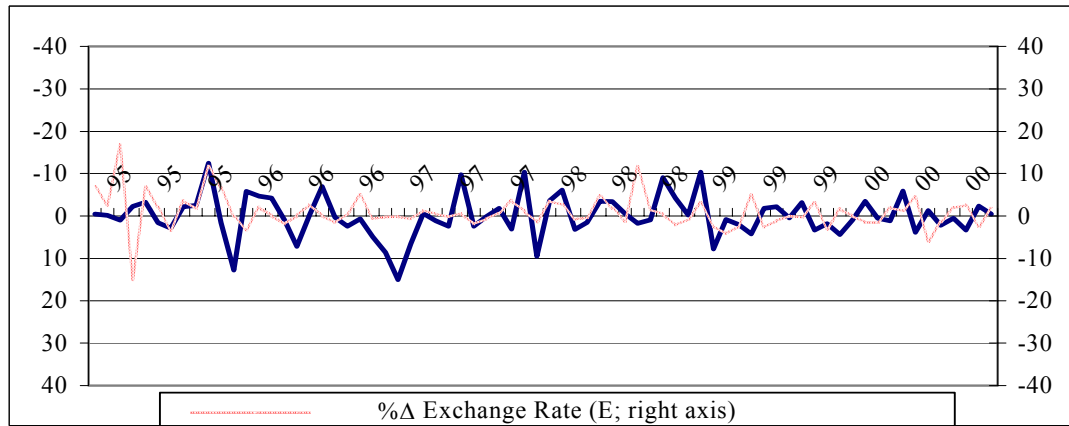
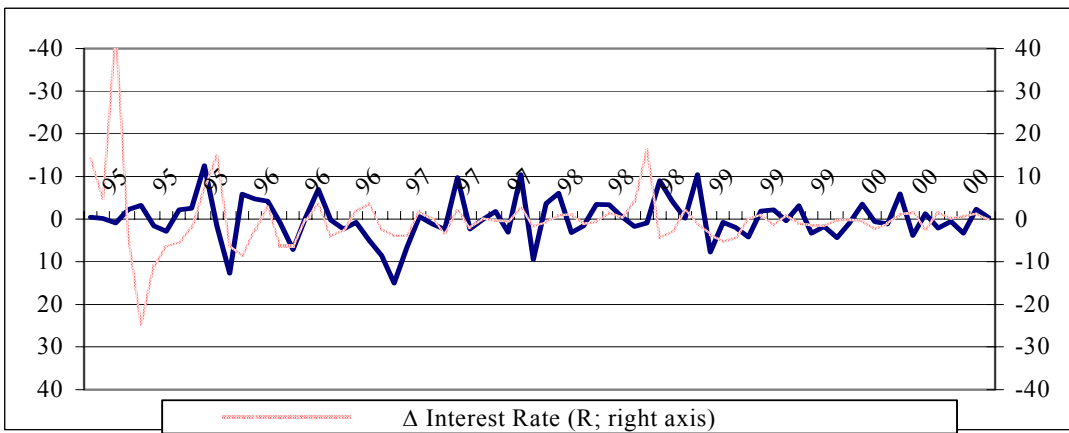
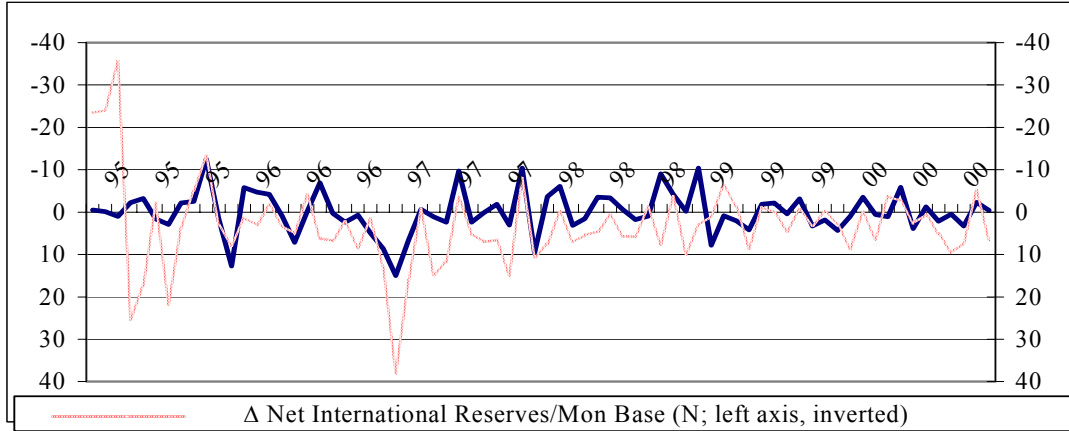
evident: comovements between interest rate movements N and e_N appear to be greater during the post-crisis period (Figure 2) than the pre-crisis period (Figure 1).

Figure 1: Mexico, 1988:5–1994:10
Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)



In all boxes above:
Capital account shock (e_N ; left axis, inverted) —

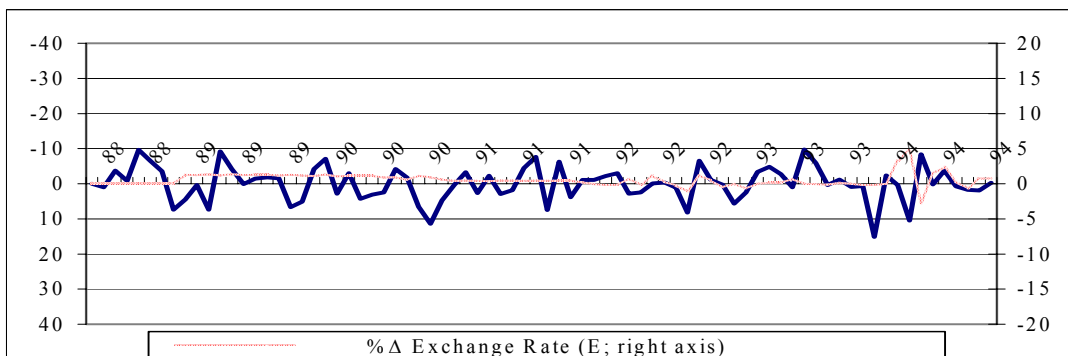
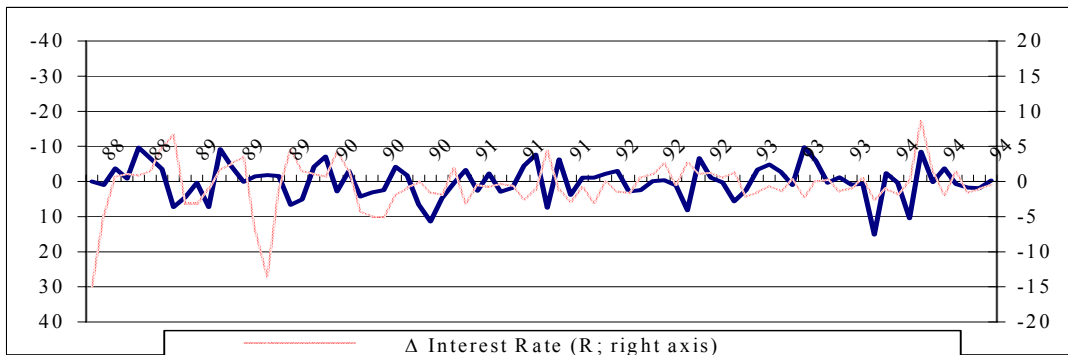
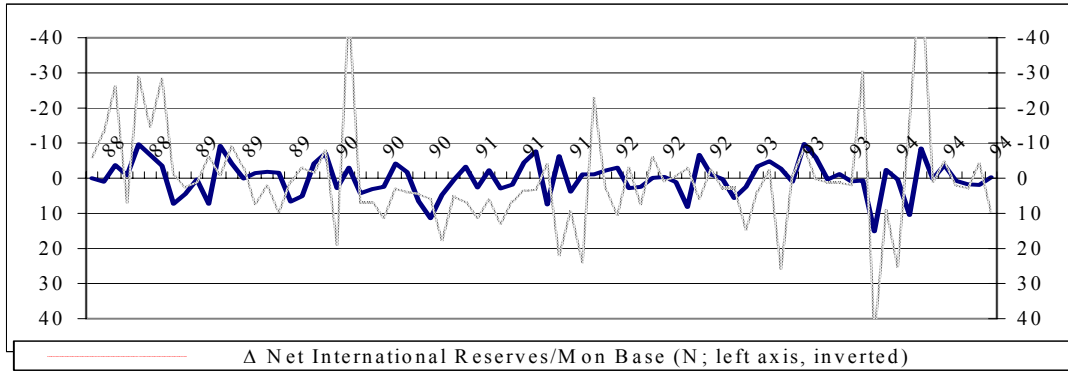
Figure 2. Mexico, 1995:1–2000:12
Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)



In all boxes above:
Capital account shock (e_N ; left axis, inverted)

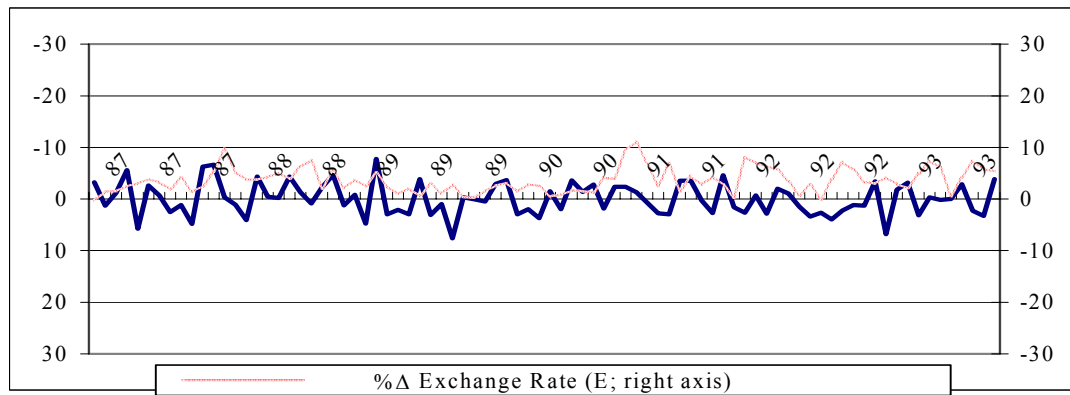
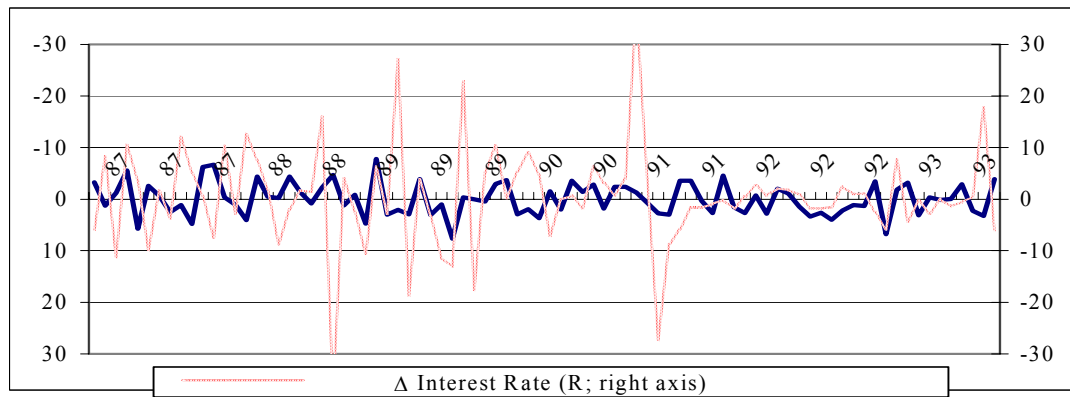
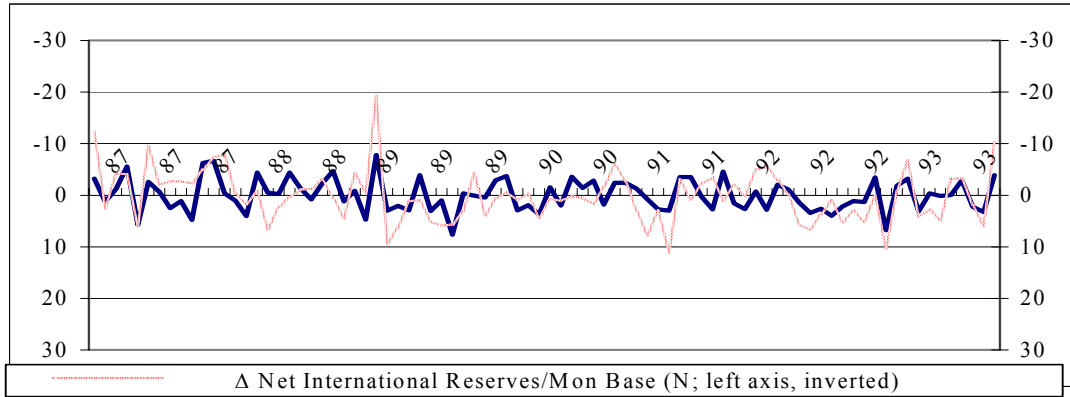


Figure 3. Brazil, 1994:8–1998:12
Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)



In all boxes above:
Capital account shock (e_N ; left axis, inverted) —

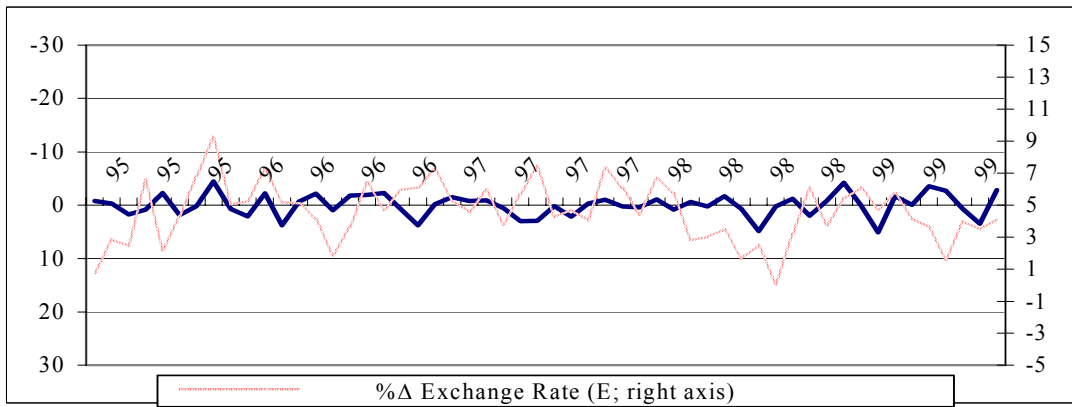
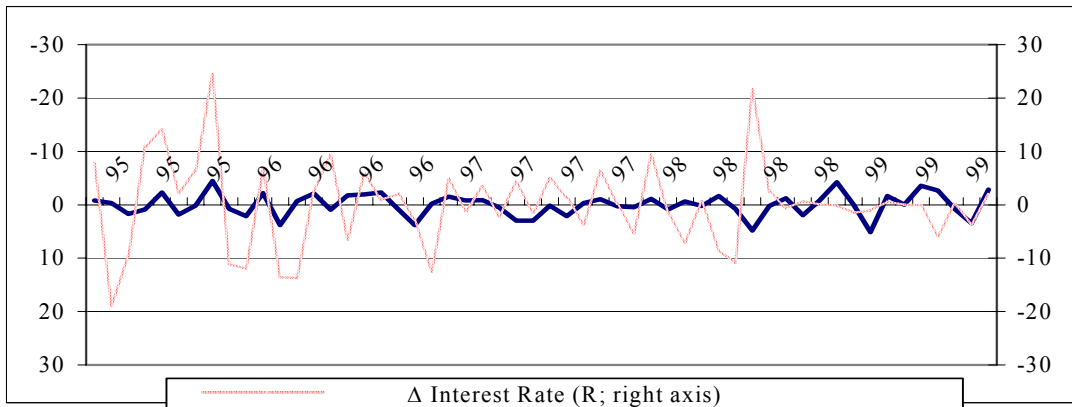
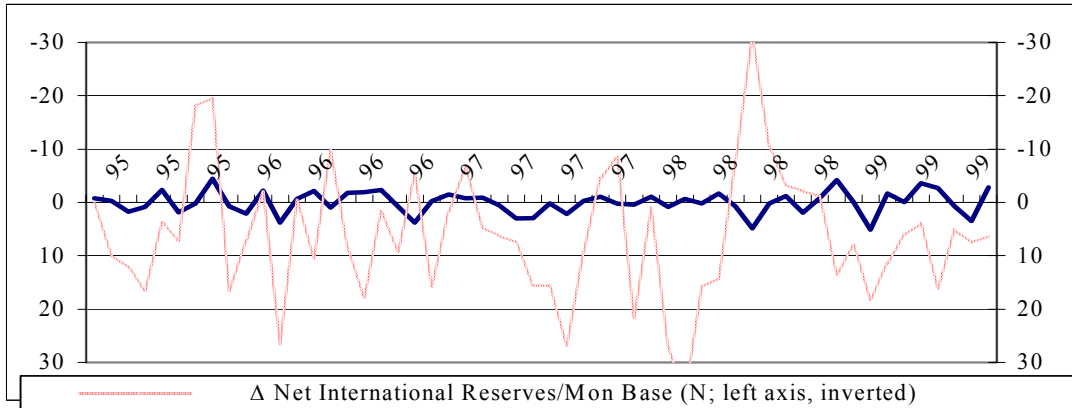
Figure 4. Turkey, 1987:1–1993:12
Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)



In all boxes above:
Capital account shock (e_N ; left axis, inverted)



Figure 5. Turkey, 1995:5 - 1999:10
Estimates of Capital Market Shock (e_N) and Exchange Market Pressure Variables (N,R,X)



In all boxes above:
Capital account shock (e_N ; left axis, inverted) —————

For Brazil's managed float (Figure 3), comovements between e_N and reserves (N) and interest rate changes (R)—but not exchange depreciation (E)—are especially evident during the Asian and Russian crises of 1997 and 1998.

Turkey behaves somewhat differently from either Mexico or Brazil. In the earlier period (Figure 4), e_N and N move together closely; great variation is evident in interest rate movements (R), while little variation is evident in exchange depreciation (E). In the later period, however, N varies more than in the first, but appears to covary less with e_N .

Table 1 presents point estimates of the impact multipliers of foreign reserve accumulation, interest rate changes, and exchange depreciation to capital account shocks e_N : the parameters λ , β and α . Table 1 also presents the tradeoff parameters for reserves against interest rate changes and exchange depreciation, $(1-\lambda)/\lambda*\beta$ and $(1-\lambda)/\lambda *(1-\beta)$ respectively, and interest rates against exchange depreciation $-(1-\beta)/\beta$. Lastly, Table 1 presents the variance ratio statistic given by $\text{var}(e_N)/[\text{var}(N) + \text{var}(R) + \text{var}(E)]$. This statistic indicates informally how important are capital account shocks in explaining the total variability of the *components* of exchange market pressure (N, R and E).²⁹ The dynamic responses of three key variables are summarized by impulse responses (IRF's) in Figures 6–8.

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²⁹ As emphasized in the text, this is an informal measure. An alternative one might be $\text{var}(e_N)/\text{var}(N + R + E)$.

Table 1. Contemporaneous Central Bank Responses to e_N

		Post-Real Managed Float 1994:8-1998:12	Pre-Crisis, Low Inflation 1988:1-1994:10	Post-Crises 1995:1-2000:12	First Period 1987:1-1993:12	Second Period 1994:5-2001:1
Central Bank response to e_N						
Quantities vs. Prices	λ	0.80 (0.05)	1.02 (0.01)	0.78 (0.09)	0.78 (0.18)	0.54 (0.09)
Internal Rate vs. Exchange Rate	β	0.90 (0.04)	-0.81 (1.04)	0.55 (0.15)	0.72 (0.91)	0.87 (0.07)
Dom. Credit	α	1.24 (0.19)	0.17 (0.38)	0.05 (0.53)	0.54 (0.32)	0.54 (0.11)
Tradeoffs (changes)						
Reserves vs. Int Rat: $(1-\lambda)/\lambda*\beta$		0.23	0.02	0.16	0.20	0.74
Reserves vs. Exch. Dep: $(1-\lambda)/\lambda*(1-\beta)$		0.03	-0.04	0.13	0.08	0.11
Int. Rat vs. Exch. Dep: $-\beta/(1-\beta)$		-0.11	2.23	-0.82	-0.39	-0.15
Variance Ratio Statistic: $\text{var}(e_N)/[\text{var}(N)+\text{var}(R)+\text{var}(E)]$						
		0.07	0.10	0.14	0.08	0.02

Note: **Boldface** indicates estimate is statistically different from zero at 90 percent level or higher. Standard errors in parentheses

In the figures, solid lines indicate the response while dotted lines indicate 90 percent probability bands.³⁰ Where appropriate, axes use common scales. The impact multipliers results confirm that all three countries intervene in exchange markets: in all cases, λ is statistically different from zero; the lowest value is found in Turkey's late period where $\lambda = 0.54$. However, the results also illustrate alternative strategies to support exchange rates—as reflected in different combinations of λ and β . The estimated tradeoffs $(1-\lambda)/\lambda*\beta$, $(1-\lambda)/\lambda*(1-\beta)$, and $-(1-\beta)/\beta$ are in the expected direction for all cases except Mexico's pre-crisis period:

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³⁰ A 90 percent confidence band is equivalent to ± 1.65 times the standard error (see, for example Kim (2002)). Standard errors are calculated in RATS by the Monte Carlo algorithm due to Kloek and van Dijk (1978).

the central bank gains more reserves through some combination of interest rate hikes or currency depreciation, and raising the interest rates defends the exchange rate. Note finally, in all cases the signs of α are as expected: an adverse shock is associated with increases in domestic credit creation ($-\lambda\alpha < 0$) with α significant for Brazil and Turkey.³¹

According to the variance ratio statistic, $\text{var}(e_N)/[\text{var}(N) + \text{var}(R) + \text{var}(E)]$, across countries and time periods, the shocks to e_N account for varying proportions of the exchange market pressure variables (N, R and E). In Brazil, this statistic indicates that e_N explains about 7 percent of the total variance; in Mexico's pre- and post-crisis periods, these figures are about 10 and 14 percent; for Turkey's early and later periods, these figures are about 8 and 2 percent respectively.

The case where the authorities were least willing to adjust either interest rates or exchange rates was Mexico prior to the 1994 crisis. Here, λ was estimated to be 1.02 but not statistically different from unity. So, the central bank in Mexico responded to an adverse shock mostly by market intervention.³²

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³¹ The failure to find a α significant for Mexico presents a minor puzzle: since several authors including Calvo and Mendoza (1996) and Tanner (2000) had characterized the Mexican policy to be one of sterilized intervention, and especially so for the pre-crisis period. By contrast, these results indicate the sensitivity of this result to alternative model specifications. Other results, not presented here but available from the authors, indicate that domestic credit movements instead reflected responses to fiscal financing requirements.

³² However, the IRF reveals a statistically significant negative reaction of the interest rate at the first lag. That is, it also raised interest rates a little.

However, after the 1994 crisis, Mexico's policy changed dramatically. The estimate of λ falls to 0.78 (statistically different from zero). Thus, relative to the pre-crisis period, the authority was more willing to permit price movements (interest rates, exchange rates or both) to adjust in response to an external shock. Note also that β is estimated to be 0.55 (significantly different from zero). This suggests that the remaining portion of the shock—that not absorbed by reserve movements—was distributed almost equally between interest rate and exchange rate movements. As in the pre-Crisis period, the IRF for the post-Crisis period (Figure 6, right hand column) reveals a significant negative interest rate response at one lag.

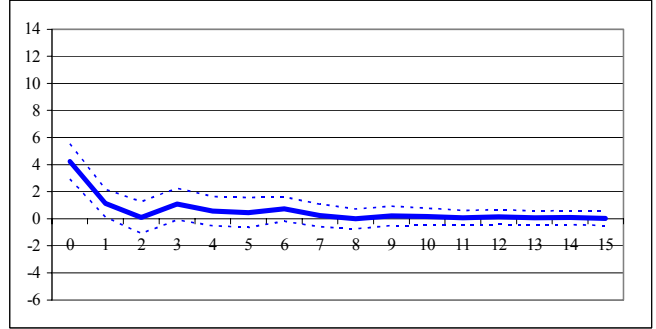
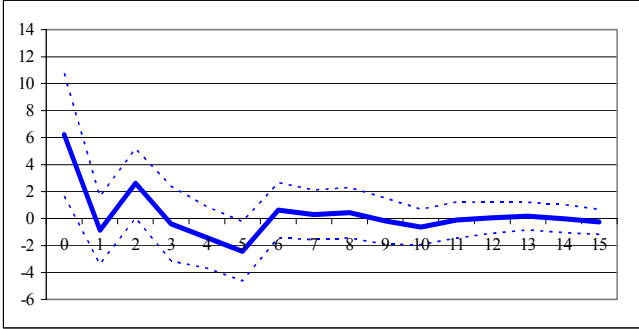
Regarding the impact tradeoff discussed above, the central bank gained an additional unit of international reserves (1 percent of the monetary base) by permitting the change in interest rates to rise about .16 percent ($\beta*(1-\lambda)/\lambda$) and the currency to depreciate by about .13 percent ($((1-\beta)*(1-\lambda)/\lambda)$). These results confirm Edwards and Savastano's (1998) conclusion that the Mexican central bank managed exchange rates, both before and after the 1994 crisis.

Figure 6. Mexico: Impulse Responses to e_N , Monetary variables

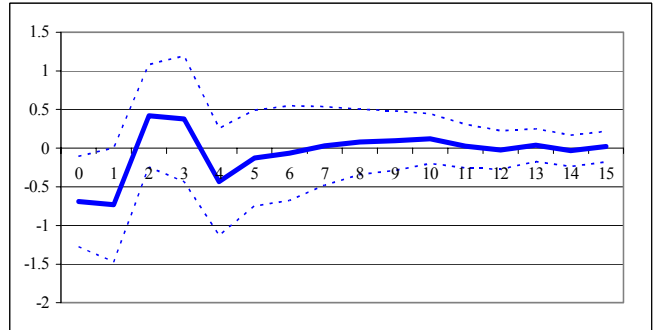
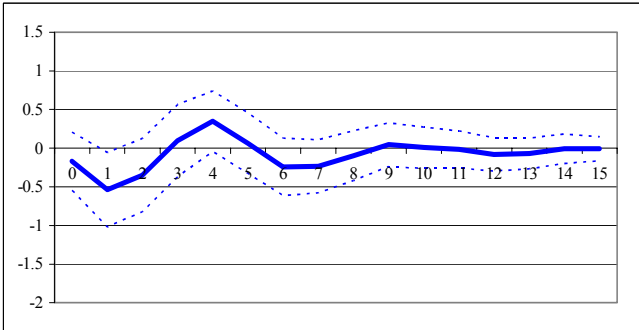
Pre-1994 Crisis

Post-1994 Crisis

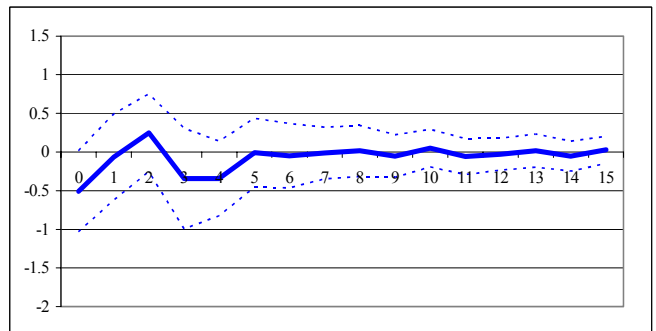
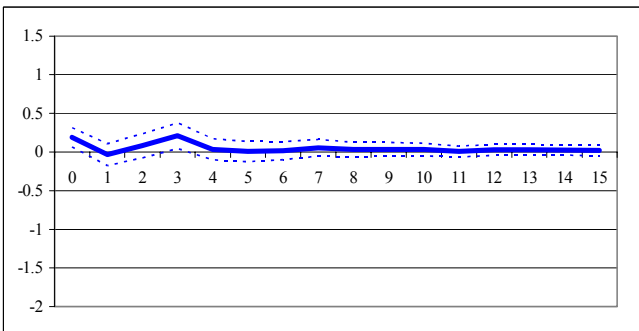
Net International Reserves (N)



Interest Rate (R)



Exchange Depreciation (E)

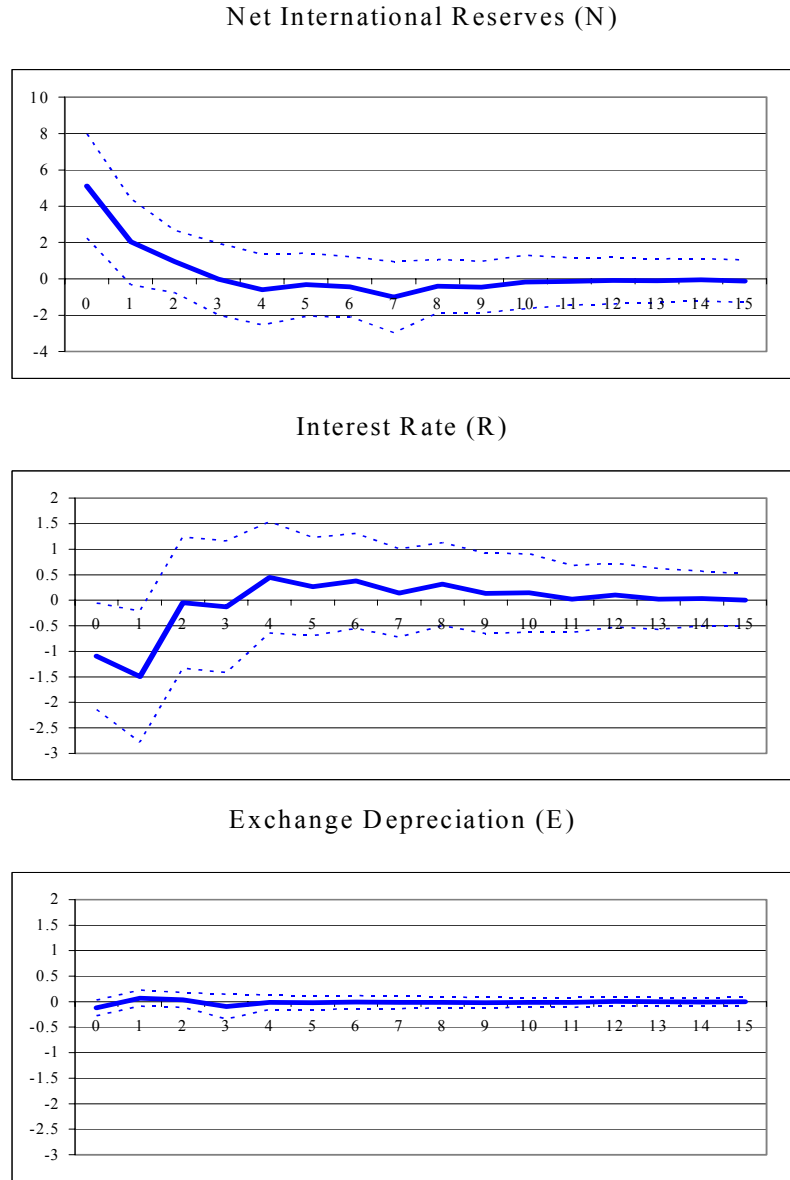


Note: Dotted lines indicate 90 percent confidence bands (1.65 times standard error).

For Brazil's managed float period, the authorities were slightly more willing to permit price adjustments than in post-crisis Mexico ($\lambda = 0.80$, statistically different from zero). At the same time, the authorities appear to be more willing to use the interest rate than in Mexico: the parameter β was estimated to be 0.90 (statistically different from zero). The IRF in Figure 7 also reveal a statistically significant negative response of interest rate changes at one lag. As an impact tradeoff, the central bank gained an additional unit of international reserves (1 percent of the monetary base) by permitting the change in interest rates to rise about 0.22 percent ($\beta*(1-\lambda)/\lambda$) and also permitting exchange depreciation to rise about 0.02 percent $((1-\beta)*(1-\lambda)/\lambda)$.

In Turkey, as in Mexico, there is a striking contrast in central bank policy between the early and later periods. In the early period, the authority seemed less willing to permit *immediate* price adjustments ($\lambda = 0.93$, significant) than in the later ($\lambda = 0.54$, significant). However, according to the IRF in Figure 8, there is a negative response at the first lag during the earlier period, but no response (contemporaneous or lagged) during the later period. Note also that the authority relies less on interest rate adjustments in the earlier period ($\beta = 0.72$, not significant) than in the latter ($\beta = 0.87$, significant). And, the IRF's also reveal a negative impact on interest rate changes at one lag for the later period.

Figure 7. Brazil: Impulse Responses to e_N , Monetary variables



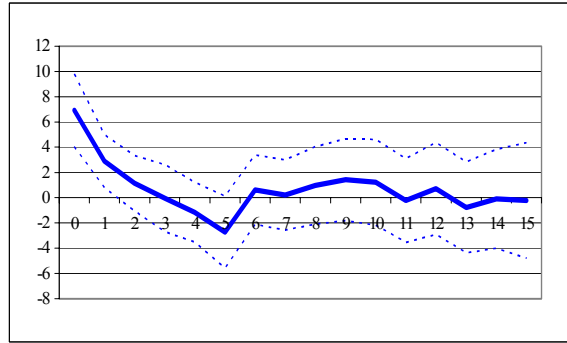
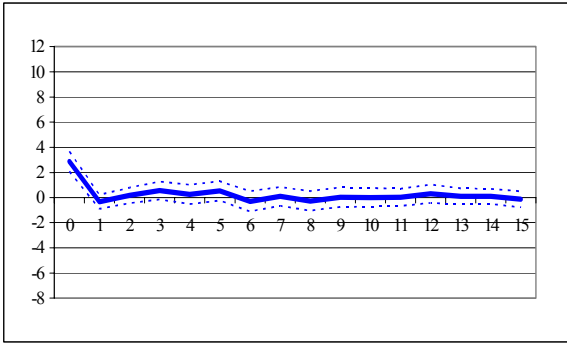
Note: Dotted lines indicate 90 percent confidence bands (1.65 times standard error).

Figure 8. Turkey: Impulse Responses to e_N , Monetary variables

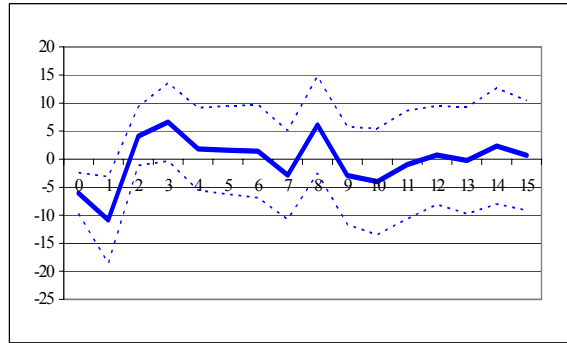
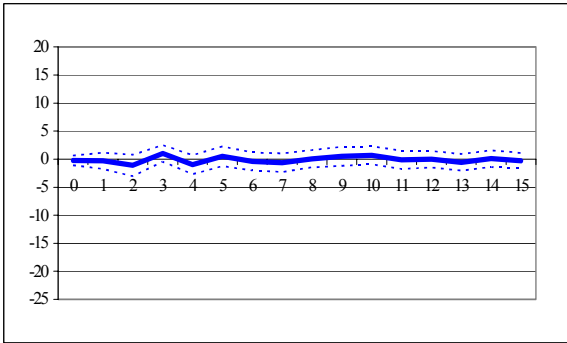
Early Period

Late Period

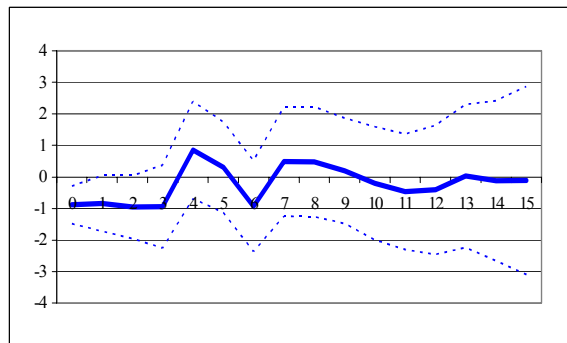
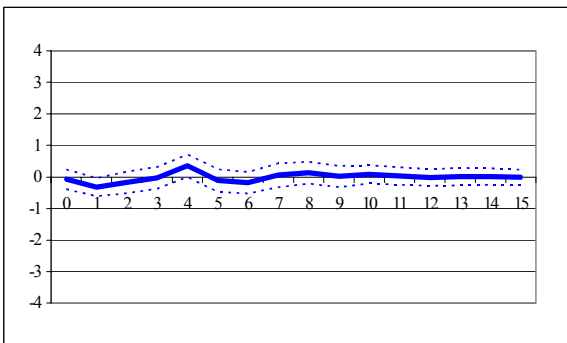
Net International Reserves (N)



Interest Rate (R)



Exchange Depreciation (E)



Note: Dotted lines indicate 90 percent confidence bands (1.65 times standard error).

As a tradeoff, the Turkish central bank gained each additional unit of international reserves by permitting the change in interest rates to rise about 0.75 percent $(1-\lambda)/\lambda*\beta$ and exchange depreciation to rise about 0.11 percent $(1-\lambda)/\lambda*(1-\beta)$ ³³

B. The Transmission of Capital Account Shocks e_N to the Domestic Economy

One reason why authorities choose a particular exchange rate regime is that they wish to shield the domestic economy from external shocks, especially capital account shocks (e_N). Accordingly, we now investigate how capital account shocks (e_N) are transmitted to key domestic variables: the growth of economic activity (Y), inflation (P), and the primary fiscal balance (F) by examining the impulse response functions.

The outcome should depend on the exchange rate regime. For example, if the central bank reduces exchange rate flexibility by raising β (permitting more interest rate flexibility), the IRF should reveal larger impacts of e_N on output, through the interest rate channel. Likewise, if β rises, the IRF should also reveal smaller impacts of e_N on inflation, through the exchange rate pass-through channel.

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³³ Turkey suffered an exchange rate crisis at the end of this period (early 2001). Our findings suggest that, even if the central bank responds to capital account shocks with interest rates movement (instead of reserve sales) it still may be unable to prevent a currency crisis.

Figures 9 and 10 present the responses of Y , P , and F to capital account shocks e_N for Mexico and Turkey, respectively.³⁴ Evidence presented below suggests capital account shocks often have significant impacts on the domestic economy.

Consider first the effects of e_N on output growth (Y) in Mexico (Figure 9, first row). In the pre-Crisis period, there are no statistically significant impacts of e_N on Y . By contrast, there is statistically significant impact of e_N on Y —with a three month lag—in the post-crisis period. These findings support the idea that the exchange rate regime affects the transmission of capital market shocks to the domestic economy as discussed above. The central bank did not permit interest rates to respond to capital account shocks in the pre-Crisis period, but did so in the post-Crisis period. Thus, stabilizing the exchange rate through interest rate movements (as happened in the post-Crisis period) *may* have made output growth more positively related to capital account shocks and more volatile than it otherwise would have been. However, such an explanation must be viewed cautiously. An alternative explanation, that the structure of the economy might have changed, should not be immediately discarded.

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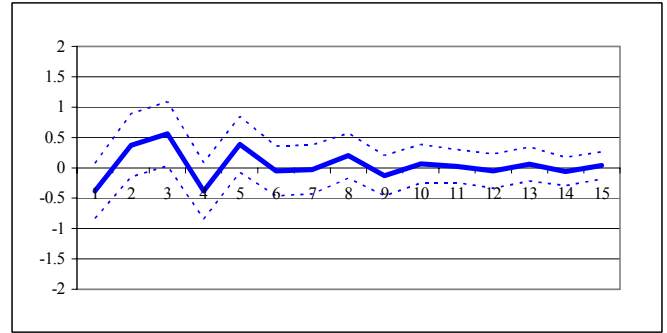
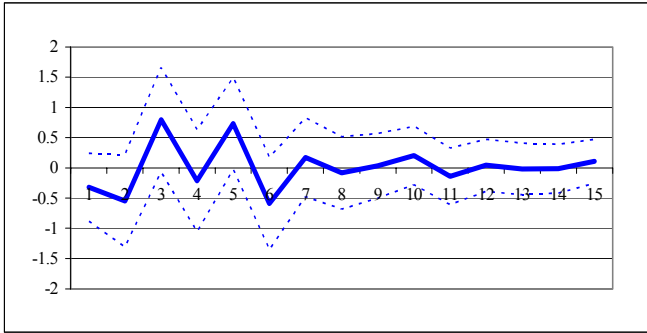
³⁴ These results are not presented for Brazil, since there were no significant IRF's.

Figure 9. Mexico: Impulse Responses to e_N , Non-monetary variables

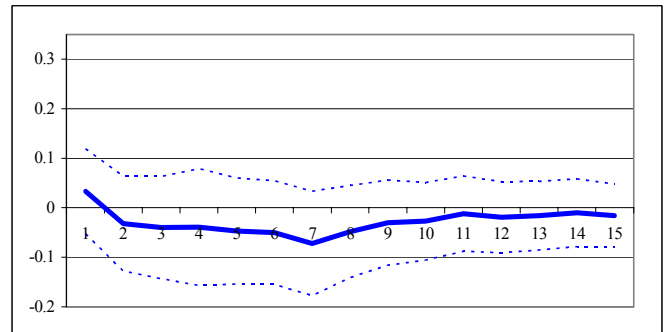
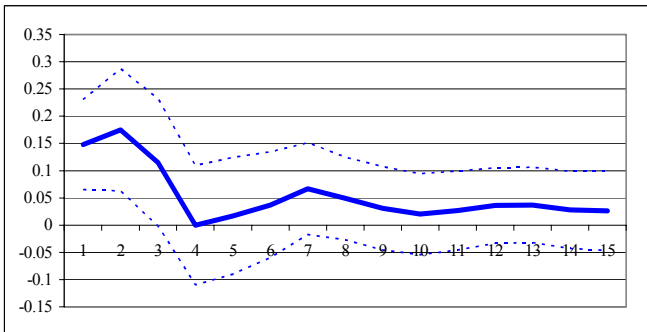
Pre-1994 Crisis

Post-1994 Crisis

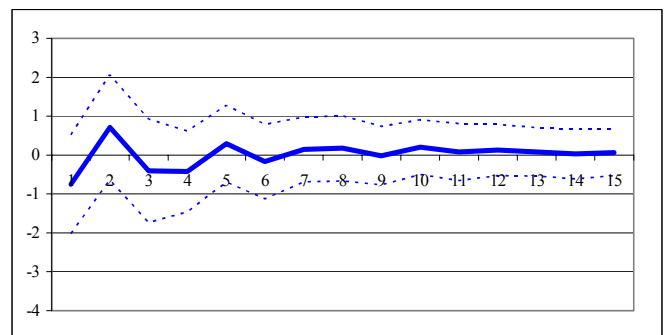
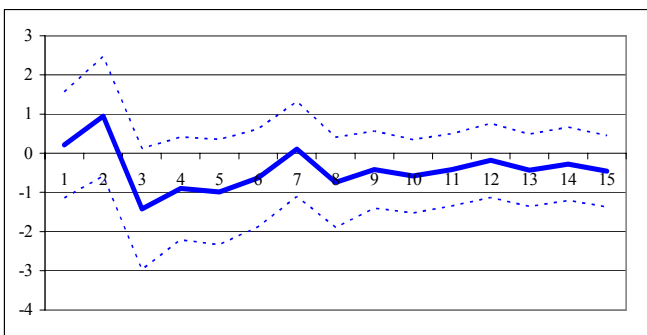
Economic Activity (Y)



Inflation (P)



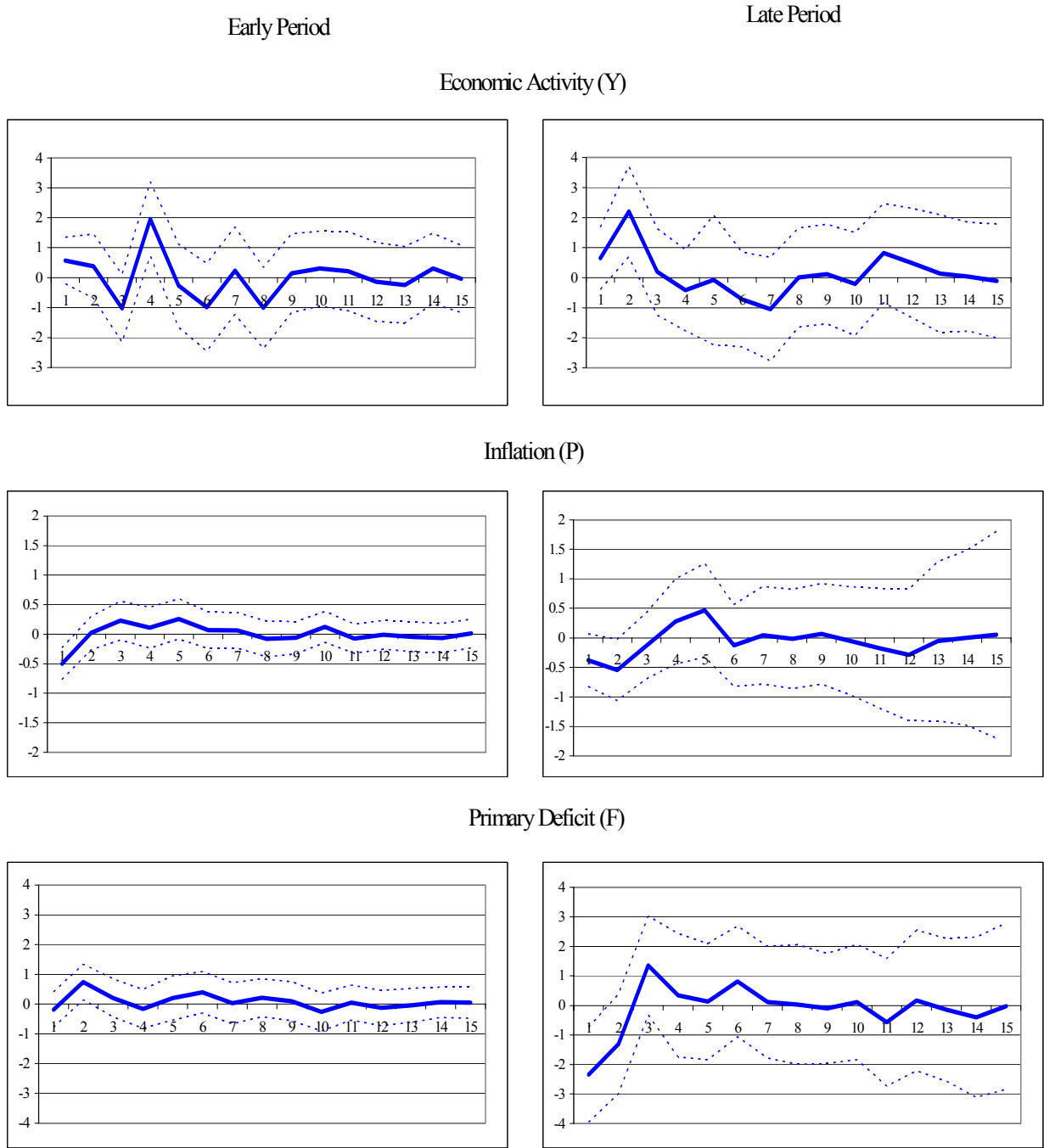
Primary Deficit (F)



Note: Dotted lines indicate 90 percent confidence bands (1.65 times standard error).

Note: Dotted lines indicate 90 percent confidence bands (1.65 times standard error).

Figure 10. Turkey: Impulse Responses to e_N , Non-monetary variables



Note: Dotted lines indicate 90 percent confidence bands (1.65 times standard error).

Next note the effects of e_N on inflation in Mexico (Figure 9, second row). In the pre-crisis period, when exchange rates were tightly pegged, shocks to e_N had a positive impact on inflation. By contrast, under a fixed exchange rate system (or a band) capital inflows ($e_N > 0$) are generally associated with an appreciation of the real exchange rate.

These empirical results are also broadly consistent with the general presumption of how the exchange rate regime affects the transmission of capital market shocks to the domestic economy. In the pre-Crisis, fixed exchange rate period, the appreciation takes place through (the nontradable component of) domestic inflation. However, in the post-crisis period, when exchange rates were more flexible, the real appreciation instead took place through a nominal appreciation. This reduces inflation through the tradable goods component.

Finally, in Mexico, there is no significant response of the primary deficit (F) to e_N in either the pre- or post-Crisis periods (Figure 9, third row).

We now turn to responses for Turkey, which are presented in Figure 10. As in Mexico, behavior of output growth (Y , Figure 10, first row) differs across exchange rate regimes. In the early period, when e_N is

primarily distributed by the central bank to reserve flows (high λ , β not significant), e_N also impacts output positively and significantly after four months.³⁵ Note that in the later period, the positive impact of e_N on Y occurs sooner (two months later rather than four) and is somewhat greater in magnitude. This finding may reflect the fact that authorities used more flexible interest rates to manage exchange rates during this period (lower λ and higher β).

Note next, the responses of inflation (P) to e_N shocks. Unsurprisingly, inflation mirrors the exchange rate regime. In the early period, there is a negative and significant impact of e_N on inflation at lag one. This corresponds precisely to the impact of e_N on exchange depreciation (E) at this same lag mentioned in the previous section. By contrast, in the second period, there are no significant impacts of e_N on inflation (P)—or for exchange depreciation (E), as mentioned in the previous section.

Finally, note the effects of e_N on the primary deficit (F) in Turkey (Figure 10, third row). This finding suggests dramatic differences in fiscal policy across regimes. During the earlier period, e_N has a positive and significant impact on the primary deficit, at two lags. It suggests that the government increased the fiscal deficit when foreign capital became more accessible. By contrast, during the later period, e_N has a negative and significant impact on the primary deficit, at both the first and second lags. This indicates a kind of countercyclical policy: to

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³⁵ A possible explanation for this finding might be credit rationing: capital outflows cause tightening in credit markets (but not directly through interest rates).

compensate for lower output growth and higher interest rates, the government adopted an expansionary fiscal stance.

IV. WHAT IF THE EXCHANGE RATE HAD BEEN MORE (OR LESS) FLEXIBLE? A COUNTERFACTUAL ANALYSIS.

In the latter half of the 1990s, the countries included in this paper faced some common factors in their choice of exchange rate regime. Brazil and Mexico both desired to restrain inflation under their relatively young stabilization plans, while Turkey was attempting a more dramatic stabilization. At the same time, all countries sought to limit the adverse effects of global shocks on domestic economic activity. Nonetheless, in the aftermaths of exchange rate crises, many countries relied less on reserve movements (lower λ) but more on interest rate movements (higher β) to manage exchange rates.³⁶

A counterfactual question naturally arises: how would inflation and output have behaved in these countries *if* the central bank had chosen a different exchange rate regime—different values for λ and β ?

The analysis in the previous section indirectly addresses this question. However, the question may be more directly addressed by *simulating* impulse response functions (IRF's) associated

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³⁶ Tests showed this for Mexico and Turkey. This was also true for Brazil in 1999 and afterwards, although we did not estimate parameters for this time period due to insufficient data.

with counterfactual values for λ and β . Such an IRF shows by how much the impact of a shock e_N on other variables would have changed *had the exchange rate regime (summarized by λ and β) been different*. Of course, an analysis of this nature should be regarded as useful but only suggestive. Market participants may change their decision rules—and thus system dynamics—in response to changes of λ and/or β .³⁷

For Brazil and Turkey, we simulate a policy of increased exchange rate flexibility by reducing β . For Mexico, we simulate policies of both increasing and decreasing exchange rate flexibility by raising and lowering β . Similar experiments with λ were conducted but not reported here. For Mexico and Turkey, the analysis uses data from only the more recent periods.³⁸

Counterfactual IRFs for output and inflation are presented in Figures 11 and 12, respectively. Results for output were mixed. Presumably, in the case of an adverse shock (symmetric for positive), a less positive response function would be expected when β is reduced. An interest

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³⁷ That is, this analysis should be regarded only as suggestive since it may be subject to the “Lucas critique.”

³⁸ In both Mexico and Turkey, the later periods were ones of relative exchange rate flexibility. However, for Mexico, the estimated β is about 0.55 (see Table 1). Counterfactual exchange rate regimes are $\beta=0.3$ (more flexible) and $\beta=0.7$ (less flexible). By contrast, for Turkey, the estimate of β was higher—about 0.9. The counterfactual exchange rate regimes are $\beta=0.7$ and $\beta=0.3$ (both more flexible). For Brazil, the central bank defended the exchange rate within a narrow, moving band, with β estimated to be about 0.9. Counterfactual exchange rate regimes of $\beta=0.7$ and $\beta=0.5$ both would be consistent with a widening of the band.

rate hike is the outcome of an adverse shock and is presumed to reduce growth. Thus, lower β means a lower interest rate hike and an accordingly lower output drop.³⁹ For Brazil and Turkey (but not Mexico) this result is observed, but only for later lags, and only after observing a more positive response in the initial periods.⁴⁰ Thus, these results suggest that more exchange rate flexibility (lower β) means more variable output growth in the initial stages, but less so at later lags. Note that, for Mexico, even as β was raised or lowered dramatically, the impact of e_N on output growth was largely unchanged.

However, results for inflation were stronger than those for output, yielding few surprises. As the exchange rate regime became more flexible (lower β), the link between e_N and inflation became unambiguously stronger and more negative. This occurs after the first lag in Brazil and Turkey, but only after the second lag for Mexico. These effects reflect additional pass through from the exchange rate to depreciation.

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³⁹ Note that this interpretation is consistent with the idea that, as exchange rate are more flexible, so are real wages, thus reducing output variability.

⁴⁰ In the case of Brazil (Figure 11, top panel), impacts on output growth for lags 1 and 2 exceed those in the baseline. But, at later lags, more exchange rate flexibility appears to make output somewhat less variable, relative to the baseline. Likewise, for Turkey (Figure 11, bottom panel), impact on output growth a lags 4 through 6 exceed those in the baseline.

Figure 11. Simulated responses of output growth (Y) to shock ε_N :
Estimated versus counterfactual values of β .

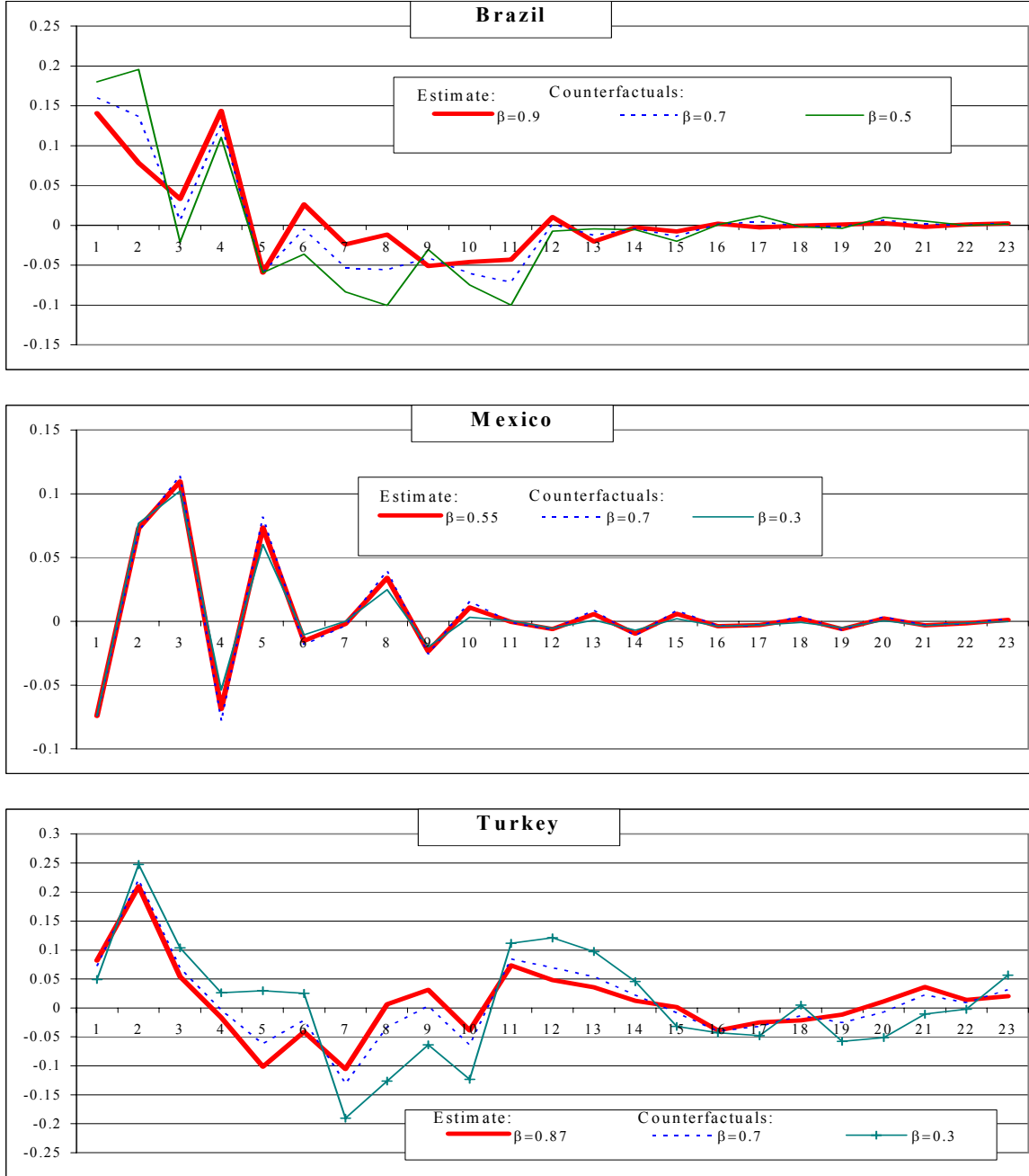
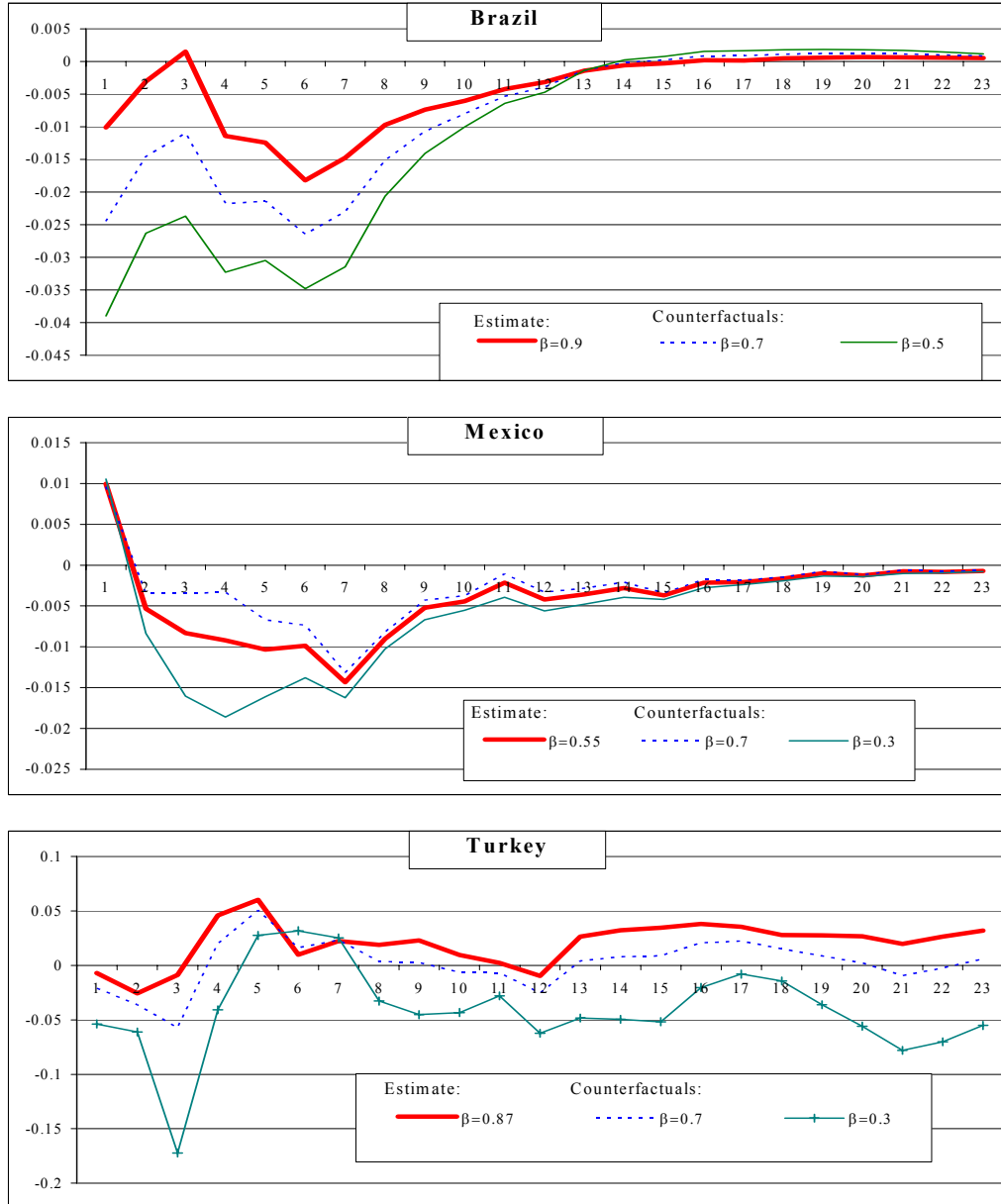


Figure 12. Simulated responses of inflation (P) to shock ϵ_N :
Estimated versus counterfactual values of β .



Thus, with more flexible exchange rates (lower β), when any of these countries suffers an adverse capital account shock, they will also suffer higher inflation, in all periods. However, the costs in terms of output loss are ambiguous: the country suffers somewhat lower output loss in the initial periods, but not necessarily in subsequent periods. Results in this section are not necessarily consistent with those in the previous ones. Thus, the combined evidence in the previous and current section regarding cross-regime differences of capital shocks on the domestic economy is inconclusive. This topic would be a suitable one for future research.

V. SUMMARY AND CONCLUSIONS

This paper examined the relationship between the exchange rate regime and capital account shocks in three emerging market economies: Brazil, Mexico, and Turkey. The exchange rate regime was characterized by how a central bank distributes external capital account shocks across three variables: exchange depreciation, interest rate changes, and reserve accumulation. While other authors have recently attempted to provide quantitative indices of exchange rate regime (including Levy-Yeyati and Sturzenegger (2002), Bubula and Otker-Robe (2002), and Reinhart and Rogoff (2002)), we believe that ours uses a more complete methodology and should provide a better metric with which regimes might be compared. Also, the paper presented an alternative way to calculate exchange market pressure (EMP). While several authors present EMP as a weighted index of exchange depreciation, reserve movements, and interest rates, there is no consensus as to what weights should be used. We present a method where weights are derived from central bank reactions.

This paper examined several kinds of exchange rate regimes. At one extreme, Mexico before the 1994 crisis, λ was approximately unity, indicating that external shocks were completely reflected in reserve flows. At the other extreme, in Turkey's later period, λ was lower but β was higher, indicating that the central bank responded to external shocks (and hence managed exchange rates) through interest rate movements.

By extension, this paper also attempted to characterize the effects capital account shocks on three key domestic variables, namely output growth, inflation, and the primary fiscal balance. Results suggested that capital account shocks may have substantial impacts on the domestic economy. To investigate how the nature and magnitude of such impacts may depend on the exchange rate regime, both direct and counterfactual estimates were examined.

The evidence indicated, in large part, that with additional exchange rate flexibility, capital account shocks have more impact on inflation. By contrast, evidence indicating that, with additional exchange rate flexibility, capital account shocks have less impact on output, was not entirely consistent. Nonetheless, this area seems promising for future research.

DATA CONSTRUCTION

Variables were constructed as follows:

1. Industrial production growth (Y): monthly percentage change in industrial production index. Source: country central banks.
2. Terms of Trade Growth (T): Brazil, Mexico, monthly percent change in ratio of export prices to import prices. Turkey: monthly percent change in petroleum prices.
3. Interest Rate, first difference (R): Brazil: Money Market Rate (Series 60b.z); Mexico: Banker's Acceptance Rate (Series 60b.z); Turkey: Interbank Rate (Series 60b.z); Source: International Monetary Fund, International Financial Statistics.
4. Monetary Base: Source: International Monetary Fund, International Financial Statistics, Reserve Money (Series 14).
5. Exchange Rate, end of period, period average: International Monetary Fund, International Financial Statistics, Reserve Money (Series ae and rf respectively).
6. Net Foreign Reserves (N); change with respect to previous month, divided by monetary base of previous month. *Level* of net foreign assets is from International Monetary Fund, International Financial Statistics, (Series 11 minus series 16).
7. Net Domestic Credit (D); change with respect to previous month, divided by monetary base of previous month. *Level* of net foreign assets is from International Monetary Fund, International Financial Statistics, (Series 14 minus 11 plus series 16).
8. Fiscal deficit (F): primary deficit scaled by monetary base. Source: country central banks.

REFERENCES

- Blustein, Paul (2001), *The Chastening: Inside the Crisis that Rocked the Global Financial System and Humbled the IMF* (New York: Public Affairs Press).
- Bubula, Andrea and Inci Otker-Robe, (2002) “The Evolution of Exchange Rate Regimes Since 1990: Evidence From De Facto Policies,” *International Monetary Fund Working Paper* No. 02/155.
- Calvo, Guillermo A., Leonardo Leiderman, and Carmen M. Reinhart, 1993, “Capital Inflows and Real Exchange Rate Appreciation in Latin America: The Role of External Factors,” *International Monetary Fund Staff Papers* v40, n1 (March): 108-51.
- Calvo, Guillermo and Enrique Mendoza, 1996, “Mexico’s Balance-of-Payments Crisis: A Chronicle of a Death Foretold,” *Journal of International Economics*, Vol. 41, pp. 235–264.
- Calvo, Guillermo A., and Carmen M. Reinhart, 2002, “Fear of Floating: Exchange Rate Policy in Emerging Markets,” *Quarterly Journal of Economics* v117, n2 (May): 379-408.
- Cushman, David O. and Tao Zha, 1997, “Identifying Monetary Policy in a Small Open Economy under Flexible Exchange Rates,” *Journal of Monetary Economics* v39, n3 (August): 433-48.
- Edwards, Sebastian, 2000, “Capital Flows, Real Exchange Rates, and Capital Controls: Some Latin American Experiences,” S. Edwards, ed, *Capital flows and the emerging economies: Theory, evidence, and controversies* (2000): 197-246 NBER Conference Report Series. (Chicago and London: University of Chicago Press).
- Edwards, Sebastian and Miguel A. Savastano, 1998, “The Morning After: The Mexican Peso in the Aftermath of the 1994 Currency Crisis,” National Bureau of Economic Research Working Paper: 6516.
- Edwards, Sebastian and Miguel A. Savastano, 1999. “Exchange Rates in Emerging Economies: What Do We Know? What Do We Need to Know?” National Bureau of Economic Research Working Paper: 7228.
- Eichengreen, Barry, Andrew Rose, and Charles Wyplosz, 1996, “Contagious Currency Crises: First Tests,” *Scandinavian Journal of Economics*, Vol. 98, No. 4, pp. 463–84.
- Fernandez-Arias, Eduardo, 1996, “The New Wave of Private Capital Inflows: Push or Pull?” *Journal of Development Economics* v48, n2 (March): 389-418.

- Fischer, Stanley, 2001, "Exchange Rate Regimes: Is the Bipolar View Correct?," Speech delivered at the Meetings of the American Economic Association, <http://www.imf.org/external/np/speeches/2001/010601a.htm>
- Girton, Lance, and Don Roper, 1977, "A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience," *American Economic Review*, Vol. 67 No. 4, pp. 537-48.
- Khamis, May and Alfredo M. Leone, 2001, "Can Currency Demand Be Stable Under a Financial Crisis? The Case of Mexico," *IMF Staff Papers*, Volume 48, Number 2 (December).
- Kim, Soyoung and Nouriel Roubini, 2000, "Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach," *Journal of Monetary Economics*, v45, n3 (June): 561-86.
- Kim, Soyoung, 2001, "International Transmission of U.S. Monetary Policy Shocks: Evidence from VAR's," *Journal of Monetary Economics* v48, n2 (October): 339-72.
- Kim, Soyoung, 2002, "Monetary Policy, Foreign Exchange Intervention, and the Exchange Rate in a Unifying Framework." *Journal of International Economics*, forthcoming.
- Kletzer, Kenneth and Mark M. Spiegel, Mark M., 1998, "Speculative Capital Inflows and Exchange Rate Targeting in the Pacific Basin: Theory and Evidence," in Reuven Glick, ed., *Managing capital flows and exchange rates: Perspectives from the Pacific Basin*: 409-35 (Cambridge, New York, Melbourne: Cambridge University Press).
- Kloek, Tuen and Herman K. van Dijk (1978), "Bayesian Estimates of Equation System Parameters: An Application of Integration by Monte Carlo," *Econometrica* v 46, n1 (Jan): 1-19.
- Kouri, Pentti, J. K. and Michael G. Porter, 1974, "International Capital Flows and Portfolio Equilibrium," *Journal of Political Economy* v82, n3 (May/June 1974): 443-67.
- Lahiri, Amartya and Carlos Végh, 2001, "Living with the Fear of Floating: An Optimal Policy Perspective," NBER Working Paper No. 8391. (Cambridge, MA: National Bureau of Economic Research).
- Levy-Yeyati, Eduardo and Federico Sturzenegger, 2002, "Classifying Exchange Rate Regimes: Deeds vs. Words" Working Paper, Department of Economics, Universidad Torcuato di Tella, <http://www.utdt.edu/~ely/DW2002.PDF>.
- Parrado, Eric, and Andrés Velasco, 2002, "Optimal Interest Rate Policy in a Small Open Economy," *National Bureau of Economic Research Working Paper* 8721.

Reinhart, Carmen and Kenneth Rogoff, 2002, "The Modern History of Exchange Rate Arrangements: A Reinterpretation" Manuscript, Research Department (Washington: International Monetary Fund).

Sachs, Jeffery D., Aaron Tornell, and Andrés Velasco, 1996, "Financial Crises in Emerging Markets: The Lessons from 1995," *Brookings Papers on Economic Activity I*, pp. 147–215.

Tanner, Evan, 2000, "Exchange Market Pressure and Monetary Policy: Asia and Latin America in the 1990s ," *IMF Staff Papers*, Vol. 47, pp. 311-33.