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Exchange Market Pressure and Monetary Policy: Asia and Latin America in the 1990s

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Abstract

Exchange market pressure (EMP), the sum of exchange rate depreciation and reserve outflows (scaled by base money), summarizes the flow excess supply of money in a managed exchange rate regime. Examining Brazil, Chile, Mexico, Indonesia, Korea, and Thailand, this paper finds that monetary policy affects EMP as generally expected: contractionary monetary policy helps reduce EMP. The monetary policy stance is best measured by domestic credit growth (since interest rates contain both policy- and market-determined elements). In response to higher EMP, monetary authorities boosted domestic credit growth both in Mexico (confirming previous research) and in the Asian countries.

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I. Introduction

The term *exchange market pressure* (EMP) generally refers to movements in two key external sector variables, namely (official) international reserve holdings and the (nominal) exchange rate.[2] More precisely, Girton and Roper's (1977) seminal paper defined EMP as the *sum* of exchange rate depreciation and reserve outflows (scaled by base money).[3] Such a measure summarizes the difference between the growth rates of money supply and demand under managed exchange rate regimes.[4]

Recent difficulties in Asia and Latin America highlight several issues regarding EMP. For example, the relative importance of foreign and domestic factors on EMP in these countries is widely debated. To be sure, most observers believe that certain fundamental domestic factors, like monetary, fiscal, and financial policies, affect a country's external sector. However, so do shocks from abroad, in both asset and goods markets. In this vein, many observers have stressed the importance of *contagious* elements in global markets, especially during the 1990s.[5]

A critical issue regards the policy measures to be taken by countries when they face such external strains. Certain fundamental domestic remedies, like fiscal adjustment and financial sector reform, may require time to implement (often under political stress). Instead, with few options in the short term, the domestic money supply and interest rates are often

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[2] Of course, strains on a country's external sector might also be measured by the differential between domestic and world interest rates. In this vein, Eichengreen, Rose, and Wyplosz (1996) construct an EMP measure that includes the interest differential. Here, the interest differential will be treated as a determinant of EMP.

[3] Other literature that presents models of EMP include Connolly and Da Silveira (1979) for Brazil, Brisimis and Leventakis (1984), for Greece, Weymark (1995), for Canada, Wohar and Lee (1992), for Korea, and Burkett and Richards (1993), for Paraguay. More recently, several papers have used EMP *indirectly* to construct a discrete crisis indicator. These include Eichengreen, Rose, and Wyplosz (1996) and Kaminsky, Lizondo, and Reinhart (1998). However, unlike other papers, this one examines the recent behavior of EMP in emerging markets, and it does so *directly*.

[4] Under managed or dirty floats, authorities limit exchange rate flexibility by purchasing or selling international reserves. Under such a regime, it would be misleading to focus on either exchange rate growth or reserves movements alone.

[5] For a test of contagious effects on interest rates in Mexico, Chile, and Argentina, see Edwards (1998).

adjusted to defend a country's currency and/or protect its international reserves (i.e., reduce EMP).

This paper addresses three related questions regarding the relationship between EMP and monetary policy in several Asian and Latin American countries. [6] First, does monetary policy affect EMP in the way that standard monetary frameworks predict? For example, does contractionary monetary policy help reduce EMP? [7] Second, how should the stance of monetary policy be measured? Currently, the preferred approach emphasizes interest rates. [8] However, older literature emphasized monetary aggregates. For example, in the traditional monetary approach to the balance of payments, the domestic credit component of the monetary base was considered to be the variable controlled by policy makers. This paper proposes a compromise that emphasizes domestic credit growth as the policy variable but also includes the differential between domestic and U.S. interest rates. Third, in what sense is the stance of monetary policy itself a function of EMP? Do monetary authorities respond to increases in EMP by tightening monetary policy? Or, do they sterilize EMP increases with more domestic credit, as several recent papers concerning balance of payments crises suggest (Flood, Garber and Kramer (1996), Calvo and Mendoza (1996))?

To address these questions, this paper develops a vector autoregression (VAR) framework whose variables include EMP, domestic credit growth, and the differential between domestic and foreign interest rates. [9] Typically, VARs show the responses of a vector of variables to *innovations* in these variables. A VAR framework is well suited to address questions of exchange rates, monetary policy, and reserves, for several reasons. Regarding the first question, the framework shows the response of EMP to *innovations* in the other two variables. With respect to the second question, such a framework helps to measure the stance of monetary policy. A policy variable is considered to be 'exogenous' in the sense that current innovations of policy reflect the preferences of policy makers. Such an idea is

[6] The countries examined are Indonesia, Korea, Thailand, Brazil, Chile, and Mexico. All data are monthly, covering the period 1990:1 through end-1998.

[7] According to the traditional monetary approach to the balance of payments, under a fixed exchange rate system, contractionary monetary policy should increase reserves. With a floating exchange rate regime, contractionary monetary should boost a currency's value. Since the countries under examination employ dirty floats, it is better to examine EMP than either reserves or exchange rates in isolation.

[8] See, for example, Bernanke and Blinder (1992), who use the Federal Funds rate to measure the stance of monetary policy in the United States.

[9] In a monetary framework, a scale variable for money demand should also be included. Most frequently, this variable is gross domestic product (GDP). However, this study uses monthly data, for which GDP is not available. A proxy, the industrial production index, is available for some countries. Difficulties in using this variable are discussed in the paper.

expressed in the form of certain restrictions. [10] Here, the restriction used assumes that domestic credit growth is the exogenous policy variable. Also, while interest differentials have an endogenous component (reflecting their nature as market-determined variable), the responses of EMP to lagged innovations in interest rates are also examined. Finally, regarding the third question, a VAR framework yields a policy reaction function that summarizes the effects of *lagged* innovations in both EMP and the interest differential on domestic credit growth.

The issues raised in this paper are closely related to several recent debates. For example, during the Asian difficulties, many have asked whether policy makers can successfully defend exchange rates with tight monetary policy, and specifically with high interest rates. [11] Some have even suggested that a 'Laffer curve' exists under certain conditions: contractionary policy may cause panic among investors and thus a loss (rather than a gain) of a currency's value. [12]

This paper helps test such a proposition. [13] However, unlike other papers, this one focuses on EMP rather than exchange rates. Since the Asian countries in this study did not pursue either fixed or freely floating exchange rate policies, it may be misleading to examine exchange rate behavior without considering reserves as well. For example, Korea gained international reserves during 1998, and EMP was *negative*, even as the Won depreciated. Since the EMP measure includes *both* exchange depreciation and reserves, it provides a more complete picture than either variable alone.

Another related issue is whether monetary policy was 'tight' or 'loose' in emerging market economies during and after the recent crises. Regarding the Mexican crisis of 1994-5,

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[10] More precisely, in a VAR, an 'exogenous' variable is one whose error term is *contemporaneously uncorrelated* with the error term of any other variable. (Correlations may be computed either by a standard Choleski decomposition or by a technique such as Bernanke's (1986).) Note that, in this context, an 'exogenous' variable may nonetheless be determined by *lagged* values of other variables. Thus, such a variable is commonly treated as the 'policy' variable. Several other authors have applied such techniques to US monetary policy, including Bernanke and Mihov (1998). For an application to Mexico, see Edwards and Savastano (1998).

[11] See Sachs and Radetlet (1998), Furman and Stiglitz (1998), Goldfajn and Baig (1998), Goldfajn and Gupta (1998), and Lane et. al. (1999). Another, broader question sounded during the recent crises was whether the benefits of contractionary monetary policy outweighed their costs. This paper, however, does not address that question.

[12] See, for example, Corsetti, Pesenti, and Roubini (1998).

[13] This issue is addressed by Corsetti, Pesenti, and Roubini (1998), Krugman (1998), and tested by Goldfajn and Gupta (1998).

there is much agreement that reserve outflows were initially sterilized with increases of domestic credit by the central bank (see for example Calvo and Mendoza (1996), Flood, Garber, and Kramer (1996), and others). Regarding Asia, there is considerable debate as to whether monetary policy was 'tight' or 'loose'. The popular press highlighted episodes of tight monetary policy. However, according to an International Monetary Fund study (Lane, et. al. (1999)) the post-crisis monetary targets in Korea and Thailand, which both countries met, were contractionary, but not drastically so. (By contrast, money growth in Indonesia exceeded its targets.) Elsewhere, Goldfajn and Baig (1998) find no evidence that post-Crisis monetary policy in Asia was 'overly-tight'. At another extreme, Corsetti, Pesenti, and Roubini (1998) characterize monetary policy in these countries as 'loose', at least in the early stages of the crisis. The current framework addresses this question somewhat differently: it asks whether monetary policy was systematically tightened or loosened in response to higher EMP.

The remainder of the paper is organized as follows. In Part 2, EMP is motivated in a monetary framework. In Part 3, a vector autoregression approach is presented. In Part 4, the data are previewed. In Part 5, empirical estimates are presented. In Part 6, a summary and some conclusions are presented. The paper's main findings may be summarized as follows. First, monetary policy affects EMP in the direction predicted by standard frameworks: contractionary monetary policy helps reduce EMP. Second, the stance of monetary policy is best measured in this context by domestic credit growth, rather than interest rates (which contain both policy- and market- determined elements). Third, as a response to higher EMP, monetary authorities appeared to increase domestic credit growth, generating a vicious circle. Such a policy reaction, generally agreed to have been present during the Mexican crisis of 1994-5, is also evident in the Asian countries. This policy reaction, while clearly destabilizing, may have been difficult to avoid given political constraints.

II. EXCHANGE MARKET PRESSURE (EMP): A MOTIVATION

Many countries pursue a mixed exchange rate regime, somewhere between fixed and freely floating exchange rates. That is, many authorities allow some degree of exchange rate flexibility, intervening in markets with purchases or sales of international reserves. For such intermediate regimes, it is misleading to focus on either exchange rate growth or reserves movements alone. Instead, under a managed exchange rate regime, exchange market pressure (EMP) represents the difference between the growth rates of domestic money supply and money demand, reflected in both exchange rate and reserve movements. To see this, consider the following simple monetary model. On the demand side, the growth of real base money (m_t) is:

$$m_t = \Delta M_t/M_{t-1} - \pi_t \tag{1}$$

where M_t is nominal (base) money at time t and π_t is the inflation rate ($\Delta P_t/P_{t-1}$, where P_t is the price level at time t).[14] The inflation rate is linked to world inflation π_t^* through the rate of growth of the nominal exchange rate e_t (units of the country's currency per U.S. Dollar):

$$e_t = \pi_t - \pi_t^* + z_t \tag{2}$$

where z_t is the deviation from purchasing power parity. On the supply side, the two components of nominal base money are international reserves R_t and net domestic assets D_t. Thus,

$$\Delta M_t/M_{t-1} = (\Delta R_t + \Delta D_t)/ M_{t-1} = r_t + \delta_t \tag{3}$$

where $r_t = \Delta R_t/M_{t-1}$ and $\delta_t = \Delta D_t/ M_{t-1}$. The above equations restate the traditional monetary approach. Assuming that purchasing power parity holds and world inflation equals zero ($z_t = \pi_t{*} = 0$), substitute (2) and (3) into (1) and rearrange to obtain an expression for EMP:

$$e_t - r_t = \delta_t - m_t \tag{4}$$

According to equation (4), exchange rate depreciation plus reserve outflows (scaled by base money) equals the difference between the growth rates of the domestic component of the monetary base (δ_t) and money demand (m_t).[15] Under a fixed exchange rate regime, $e_t = 0$; with freely floating exchange rates, $r_t = 0$.

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[14] Of course, while not explicitly modeled here, the growth rate of money demand m_t is determined by the growth of transactions (i.e. gross domestic product) and opportunity costs (i.e. interest rates).

[15] This definition may also be obtained for the more general case of non-zero π^*. An even more general definition of EMP ($e - \alpha r$) where α is reduced-form coefficient that depends on several underlying structural parameters. Under standard assumptions of the monetary approach to exchange rates and the balance of payments, α should be unity. Subsequently, other authors relaxed these assumptions (see, for example Weymark (1998)) and found that α might be difficult to obtain. Therefore, α is nonetheless commonly set to unity, as doing so yields an informative indicator (although perhaps not one consistent with a deeper structural model).

III. EMP and Monetary Policy: A Vector Autoregression Approach

As discussed above, one question that this paper seeks to answer is whether monetary policy affects EMP in the direction presumed by standard monetary theory. In this section, a vector autoregression (VAR) framework is developed to address this question. As a preliminary step, the question of how to gauge the stance of monetary policy must also be addressed. One approach would be to examine movements in an interest rate, rather than a monetary aggregate: higher interest rates reflect tighter monetary policy. [16] Such an approach appears to be the preferred one in recent research on both industrialized and developing countries.

However, it is also natural to think of a monetary aggregate, namely δ_t, as a policy variable: it is the portion of the monetary base controlled by domestic policy makers. To be sure, central banks often directly set interest rates in order to control δ_t. Nonetheless, interest rates are also market-determined variables with expected exchange depreciation and risk premia components. For the countries studied here, there are several reasons why interest rates may be too noisy to indicate central bank policy. For example, suppose that the banking system's demand function for central bank credit (negatively related to the interest rate) shifts frequently. [17] If the supply of credit from the central bank is invariant to the interest rate (implying a vertical credit supply function), interest rate movements will reflect demand shifts rather than policy changes. [18] Also, central banks may passively supply credit to the public sector or failing banks at below-market interest rates.

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[16] For the United States, many authors, including Bernanke and Blinder (1992) argue that the stance of the Federal Reserve is best measured by the Federal Funds Rate. For a review of recent work on the identification of monetary policy shocks in the United States, see Christiano, Evans and Eichenbaum (1998). According to their work, whether the stance of US monetary policy is measured by interest rate changes or shocks to a monetary aggregate, their conclusions about the effects of monetary policy on the economy are similar. To examine recent monetary policy in Asia, several authors, including Radetlet and Sachs (1998), Furman and Stiglitz (1998), Goldfajn and Baig (1998), and Goldfajn and Gupta (1999) also focus on interest rates.

[17] Note that this is not the same as a country's money demand function. For example, when money demand falls and there is a run on deposits, the banking system's demand for central bank credit *rises*.

[18] For industrialized countries, interest rates better reflect monetary policy than monetary aggregates due to large shifts in the demand for the latter. Note, however, this presumes that the money supply is endogenous (i.e. that the money supply curve is not vertical).

As a compromise strategy, the analysis includes both δ and an interest rate variable, namely the *differential* between domestic and world (U.S.) interest rates, ϕ. [19] Such an interest rate measure is appropriate for a small, open economy, as it indicates both expected exchange depreciation and a premium required to satisfy the marginal investor, but contains a policy component as well. All else equal, an increase in ϕ due to contractionary monetary policy should encourage capital inflows and thus should *reduce* EMP. Therefore, consider the following vector autoregression (VAR) system: [20]

$$\mathbf{X}_t = \mathbf{a}_0 + \mathbf{a}_1 \mathbf{X}_{t-1} + \mathbf{a}_2 \mathbf{X}_{t-2} + \ldots + \mathbf{v}_t \tag{5}$$

where $\mathbf{X} = (\delta, \text{EMP}, \phi)$ is a matrix of variables, $\mathbf{a}_i$ is a vector of coefficients, and $\mathbf{v}_t = (v_\delta, v_E, v_\phi)$ is a vector of error terms.[21] A system like (5) permits testing for effects of past values of $\mathbf{X}$ on current values. Assumptions regarding the exogeneity of certain variables (like a policy variable) are easily incorporated into a system like (5). To do so, first assume that each element of the error vector $\mathbf{v}_t$ is in turn composed of "own" error terms $\mathbf{w}_t = (w_\delta, w_E, w_\phi)$ and contemporaneous correlations with "other" errors. That is:

$$\mathbf{v}_t = \mathbf{B}\,\mathbf{w}_t \tag{6}$$

where $\mathbf{B}$ is a 3 x 3 matrix whose diagonal elements ("own correlations") equal one and whose nonzero off-diagonal elements reflect contemporaneous correlations among the error terms. Now, assumptions regarding the exogeneity of certain variables may be incorporated in restrictions on the matrix $\mathbf{B}$.[22]

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[19] Note that interest rates help explain both money supply and demand. It would be more correct to include also a scale variable like gross domestic product (GDP). However, unlike the other variables discussed here, GDP is not available on a monthly basis. To be sure, a proxy for GDP, namely industrial production, is available for some countries. But, when included, this variable did not change the basic nature of the results.

[20] For industrialized countries, other studies that use a VAR methodology to examine monetary policy include Christiano and Eichenbaum (1992), Friedman and Kuttner (1992), Kashyap, Stien, and Wilcox (1993), Eichenbaum (1995), Strongin (1995) and Bernanke and Mihov (1998).

[21] Since ϕ_t is nonstationary in levels but stationary in first differences for Mexico and Korea, it is entered accordingly as $\Delta\phi$.

[22] To implement these restrictions, either a Choleski decomposition or a procedure like

As discussed above, the domestic credit growth variable δ is assumed to be exogenous. That is, *in any period*, innovations to δ (i.e., v_δ) reflect only the tastes and preferences of the policymaker:

$$v_{\delta t} = w_{\delta t} \tag{7}$$

Next, shocks to exchange market pressure (v_E) contain two elements: the "own" shock (w_E) plus one related to innovations in domestic credit:

$$v_{Et} = w_{Et} + b_{21} w_{\delta t} \tag{8}$$

Thus, w_E may be thought of as a shock to the demand for a country's currency, due perhaps to changes in investor confidence and sentiment. Thus $b_{21} w_{\delta t}$ represents the portion of shocks to EMP that is contemporaneously correlated with domestic credit growth.

Finally, shocks to the change in the interest rate differential (w_ϕ) is the sum of three elements: the "own" shock (w_E) plus ones related to innovations in domestic credit and EMP:

$$v_{\phi t} = w_{\phi t} + b_{31} w_{\delta t} + b_{32} w_{Et} \tag{9}$$

According to equation (10), innovations to domestic credit w_δ affect the interest rate differential through either standard liquidity or Fisher channels. (Thus, the predicted sign of b_{31} is ambiguous.) Second, the interest rate differential should respond to changes in EMP: a rise in EMP may signal either further exchange rate depreciation in the future, or additional risk, or both. Such effects are captured in the term $b_{32} w_{Et}$ and b_{32} should be greater than zero. The "own" shock w_ϕ thus contains other factors not contained in either w_δ or w_E. This component should be thought of as a "hybrid" that potentially contains both policy- and market- determined elements.[23]

In addition to the contemporaneous relationships shown in equations (7)–(9), impulse response functions (IRFs) summarize the effect of past innovations (i.e., *lagged* elements of

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Bernanke's (1986) may be used. For a review of issues regarding the estimation and identification of VARs, see also Enders (1995), Chapter 5.

[23] An alternative assumption would be for EMP to be contemporaneously determined by both δ and $\Delta\phi$. In this case equation (8) would be rewritten as: $v_{Et} = w_{Et} + b_{21} w_{\delta t} + b_{23} w_{\phi t}$. Since ϕ represents the opportunity cost of holding money, $b_{23} > 0$. However, under this assumption, for the system also to be just identified, b_{31} must be zero in equation (9).

w) to current values of **X**. Thus, IRFs provide two additional ways to evaluate the effect of monetary policy on EMP. First, IRFs show effects on EMP of both current and past innovations to domestic credit (w_δ). Second, IRFs also show effects on EMP of past (but not current) innovations to the interest rate differential (w_ϕ). But, this latter IRF may only be thought of as a policy relationship insofar as innovations to the interest rate differential represent policy shocks. (Note also that IRFs show effects on $\Delta\phi$ of both current and past innovations to domestic credit and EMP, (w_δ) and (w_E), respectively.)

However, the framework discussed above also helps address the paper's third main question, namely how the stance of monetary policy is determined. Specifically, the IRFs provide a *policy reaction function*: they show effects on current δ of past (but not current) innovations to EMP (w_E) and changes in the interest rate differential ($w_{\phi t}$).[24] For example, when faced by positive innovations to EMP (for example, a decrease in investor confidence) policymakers may respond "prudently" with contractionary policy (reducing δ). However, policymakers might face pressures to act otherwise. This is especially true if the authority attempts to defend the exchange rate during a financial panic. As investors reduce holdings of a country's currency, both financial system deposits and central bank reserves fall (EMP rises). At the same time, the central bank is also pressured to provide liquidity to the financial system, raising δ. Such a sequence of events, in the context of balance of payments crises and speculative attacks, is discussed in several papers, including Flood, Garber, and Kramer (1996) and Calvo and Mendoza (1996).

IV. An Overview of the Data

Before estimating system (5) , this section presents an overview of the data. All data in this study are monthly, obtained from the International Monetary Fund's International Financial Statistics.[25] The data are presented in several ways. Tables 1 and 2 present data for EMP, δ, and ϕ, for six countries (Brazil, Chile, and Mexico in Table 1, Indonesia, Korea, and

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[24] Note that the issue addressed here is similar to that of exchange rate targeting. For example, Edwards and Savastano (1998) also estimate a policy reaction function for Mexico during the mid-1990s. However, they examine the effect of changes in the exchange rate (rather than EMP) on M1 (rather than domestic credit of the central bank).

[25] For all countries, international reserves and the monetary base are defined as Series 1l.d and 14, respectively. For Brazil, Indonesia, and Thailand, domestic credit is defined as the sum of central bank credit to the government (Series 12a) and to the financial system (for Indonesia, 12e; for Thailand and Brazil,12e and 12f). For Chile, Mexico, and Korea, domestic credit is defined as the difference between the monetary base and net foreign assets (Series 14 minus series 12 plus 16c plus 16cl.) In all cases, ϕ is measured as the difference on deposit interest rates.

Thailand 2), for both 1990 - 1998 period and selected episodes of high EMP. The data for the period 1994 – 98 are also plotted in Charts 1 – 6. EMP is plotted against δ in the upper half (Charts 1a, 2a, 3a, etc.) , and against ϕ in the lower half (Charts 1b, 2b, 3b, etc.).[26] Finally, detailed discussions of selected episodes are discussed in Boxes 1 – 3.

Stationarity tests (not presented) reveal that both EMP and δ are level stationary for all countries, while ϕ is level stationary for all countries except Korea and Mexico, where the difference $\Delta\phi$ is stationary. Thus, unless where noted , estimations for these countries will include the first difference of the interest differential, $\Delta\phi$.

Are there comovements of EMP with either δ or ϕ that are either 'visible to the naked eye' or evident from a simple bivariate regression? Visual inspection of Charts 1 – 6 suggest that, in general, EMP appears to move more closely with δ than with ϕ. This observation is borne out by simple bivariate regressions, of EMP on δ and ϕ (or $\Delta\phi$), as presented in Table 1. In all countries, the slope coefficient $\partial EMP/\partial \delta$ exceeds zero (the predicted sign), and this estimate is significantly different from zero for all countries except Indonesia. By contrast, the slope coefficient $\partial EMP/\partial\phi$ (or $\partial EMP/\partial \Delta\phi$ where appropriate) is negative (the predicted sign if an increase in ϕ indicates contractionary monetary policy) but insignificant in 3 countries (Chile, Indonesia, Thailand), and positive in the remaining countries (but significant only in Mexico).

Latin American countries prior to the Asian crisis further illustrate relationships between EMP, δ and ϕ (see Table 2 and Box 1). Mexico's severe crisis of 1994-95 was preceded by two less severe episodes, namely November 1993 and March – April of 1994 (Table 2). During all episodes, as EMP rose, so did δ while ϕ fell. However, in mid-1995, while EMP and δ fell, ϕ remained high. In Brazil, EMP falls dramatically with the Real plan of July 1994. Likewise, in Chile EMP has declined during the decade of the 1990s, while suffering less from the 'Tequila Spillover' than many other Latin countries.[27] Nonetheless during mid-1995 as EMP rose, so did δ, while ϕ fell.

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[26] In order to aid visual display, the time period shown differs among countries. In particular, For Brazil (Charts 1a-b), the period prior to the Real plan is omitted.

[27] On this point, see Edwards (1998).

Table 1: Bivariate Regressions of EMP
Independent Variables: credit growth (δ) and interest differential (ϕ or Δϕ)
Estimates with standard errors (in parentheses)

	Right Hand Side Variable: δ		Right Hand Side Variable: (ϕ or Δϕ)	
Brazil	Constant	∂EMP/∂δ	Constant	∂EMP/∂ϕ
Estimate	1.83	0.10	7.61	0.00
Std. Err	1.29	0.01	1.28	0.00
T-stat	1.42	11.79	5.93	8.36
	Adj. R^2 =	0.57	Adj. R^2 =	0.39
Chile	Constant	∂EMP/∂δ	Constant	∂EMP/∂ϕ
Estimate	-0.48	0.52	-0.12	-0.01
Std. Err	0.24	0.13	0.43	0.03
T-stat	-1.99	4.03	-0.28	-0.54
	Adj. R^2 =	0.12	Adj. R^2 =	-0.01
Mexico	Constant	∂EMP/∂δ	Constant	∂EMP/∂Δϕ
Estimate	-0.95	0.81	-0.84	1.58
Std. Err	1.32	0.08	1.79	0.56
T-stat	-0.72	10.21	-0.47	2.83
	Adj. R^2 =	0.49	Adj. R^2 =	0.06
Indonesia	Constant	∂EMP/∂δ	Constant	∂EMP/∂ϕ
Estimate	-0.10	0.13	3.29	-0.21
Std. Err	1.51	0.09	3.26	0.21
T-stat	-0.07	1.53	1.01	-1.03
	Adj. R^2 =	0.01	Adj. R^2 =	0.00
Korea	Constant	∂EMP/∂δ	Constant	∂EMP/∂Δϕ
Estimate	-0.49	0.54	-0.99	1.96
Std. Err	0.93	0.07	1.14	1.80
T-stat	-0.53	7.39	-0.87	1.09
	Adj. R^2 =	0.34	Adj. R^2 =	0.00
Thailand	Constant	∂EMP/∂δ	Constant	∂EMP/∂ϕ
Estimate	-2.55	0.54	-1.49	-0.05
Std. Err	0.87	0.11	3.16	0.59
T-stat	-2.95	5.05	-0.47	-0.09
	Adj. R^2 =	0.19	Adj. R^2 =	-0.01

Table 2
Exchange Market Pressure and Related Variables, Latin America
Means, by country and period , in percent.

	EMP	Domestic Credit Growth (δ)	Interest Differential (ϕ)	Remarks
Brazil				
1990-1998	10.8	82.0	2289.7	
1990:1 - 1994:6	21.3	165.2	4507.2	Pre-Real Period
1994: 7 and after	0.1	5.3	30.4	Post-Real Period
1995:4	15.7	13.6	64.7	Most Severe Tequila Spillover
1995: 5 and after	-0.3	5.4	24.7	Post Tequila Period
1997:9 to 1997:11	7.8	4.4	21.8	Asian Crisis Spillover
1998:9 to 1998:10	21.1	5.4	29.5	Russian Crisis Spillover
Chile				
1990-1998	-0.3	0.3	13.5	
1994-1998	-0.4	0.4	8.5	
1995:7 to 1995:10	4.2	1.7	11.1	
1995:7 to 1996:1	2.6	0.9	8.5	
1997:11 to 1998:1	4.7	1.0	9.7	Asian Crisis Spillover
1998:6 to 1998:8	3.8	0.6	9.5	
Mexico				
1990-1998	-1.0	-0.1	14.4	
1990:1 – 1995:4	0.2	1.4	13.5	
1994-1998	0.8	-1.8	15.5	
1993:11	31.9	36.5	9.6	First Period of Pressure
1994:3 – 1994:4	41.8	37.1	7.2	Colosio Assassination
1994:8 – 1994:10	-2.0	-2.7	8.7	Three Months Prior to Severe Period
1994:11-1994:12	66.0	46.3	8.6	Most Severe Period
1995:1 – 1995:4	-5.2	13.2	33.3	Four Months After Crisis
1995:5 and after	-3.0	-2.3	15.7	Post Crisis Period
1997:11	8.7	1.5	7.8	Asian Crisis Spillover
1998:8 to 1998:9	14.6	4.1	9.6	Russian Crisis Spillover

Notes: 1. EMP is defined as exchange rate depreciation plus change in international reserves divided by monetary base. 2. Interest Differential (ϕ)is domestic currency deposit rate minus US (Libor) rate (3-month). 3. Credit variable (δ) is change in central bank credit divided by the monetary base. EMP and δ are percent per month; interest rates are percent per year.

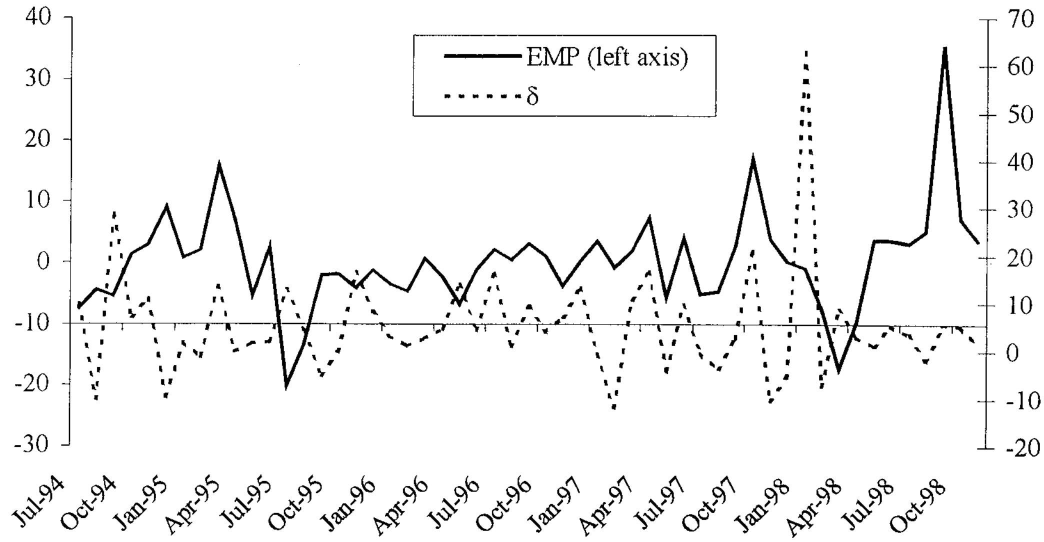
Table 3
Exchange Market Pressure and Related Variables, Asia
Means, by country and period , in percent.

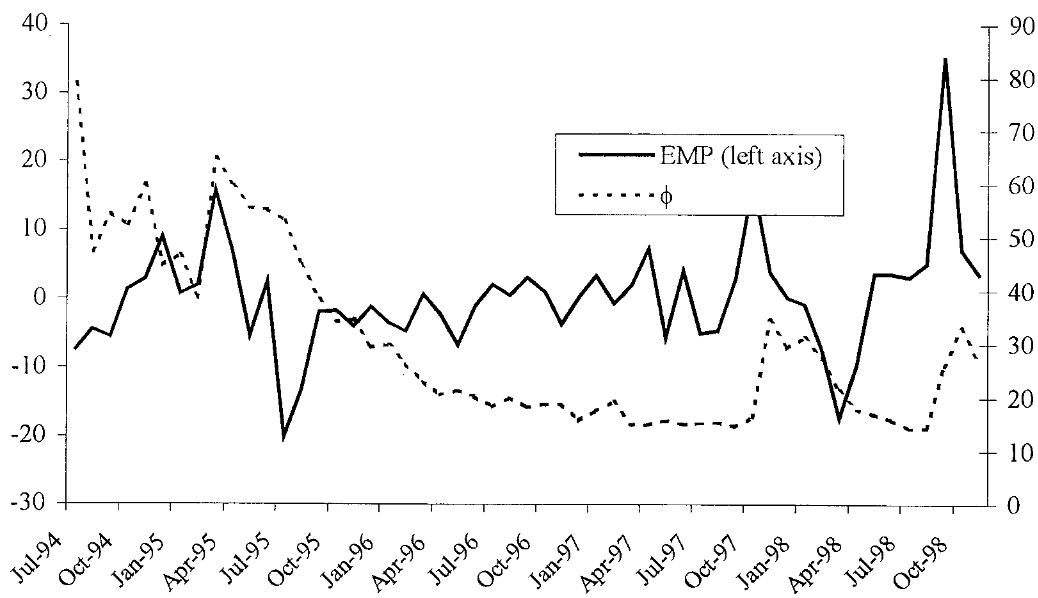
	EMP	Domestic Credit Growth (δ)	Interest Differential (ϕ)	Remarks
Korea				
1990-1998	-1.0	-0.8	4.4	
1990:01 to 1997:07	-0.5	-0.3	3.9	
1997:08 to 1997:10	7.0	7.1	5.0	Three Months Prior to Severe Period
1997:11 to 1997:12	57.8	34.0	5.9	Most Severe Period
1998:1 and after	-22.5	-12.7	8.9	Post Crisis
Indonesia				
1990-1998	0.3	1.3	14.0	
1990:1 to 1997:4	-1.5	-0.1	11.9	
1997:5 to 1997:7	0.9	2.5	10.1	Three Months Prior to Severe Period
1997:8 to 1998:2	32.6	18.7	18.9	Most Severe Period
1998:3 and after	-8.6	26.7	34.3	
Thailand				
1990-1998	-1.8	0.2	5.1	
1990:1 to 1997:1	-3.4	0.2	5.1	
1997:2 to 1997:4	3.8	7.8	4.0	Three Months Prior to Crisis
1997:5 to 1997:8	24.6	18.7	4.6	First Severe Period
1997:9 to 1997:10	-11.7	7.8	5.8	
1997:11 to 1998:1	23.5	9.1	5.6	Second Severe Period
1998:2 and after	-5.4	0.3	5.4	Post Crisis

Notes: 1. EMP is defined as exchange rate depreciation plus change in international reserves divided by monetary base. 2. Interest Differential (ϕ)is domestic currency deposit rate minus US (Libor) rate (3-month). 3. Credit variable (δ) is change in central bank credit divided by the monetary base. EMP and δ are percent per month; interest rates are percent per year.

Charts 1 a - b

Brazil: EMP, Credit Growth (δ) and Interest Differential (ϕ), 1994-98

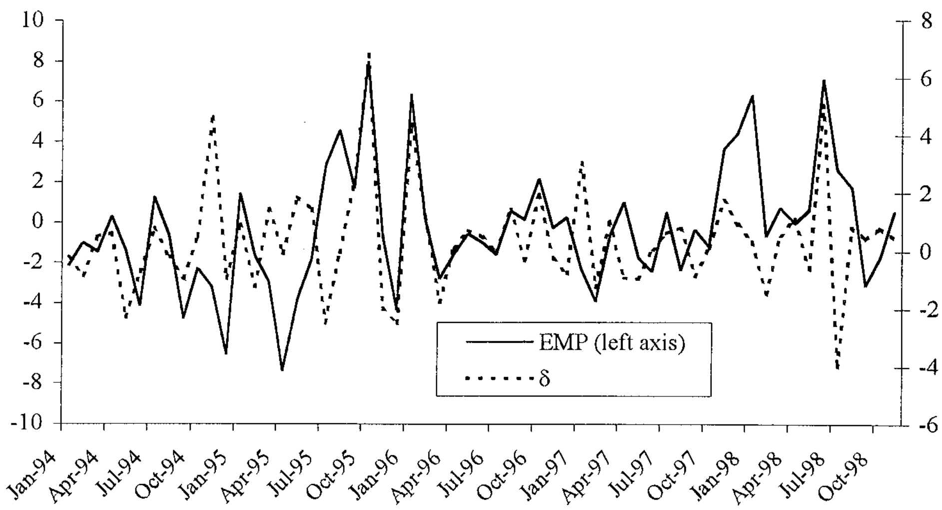


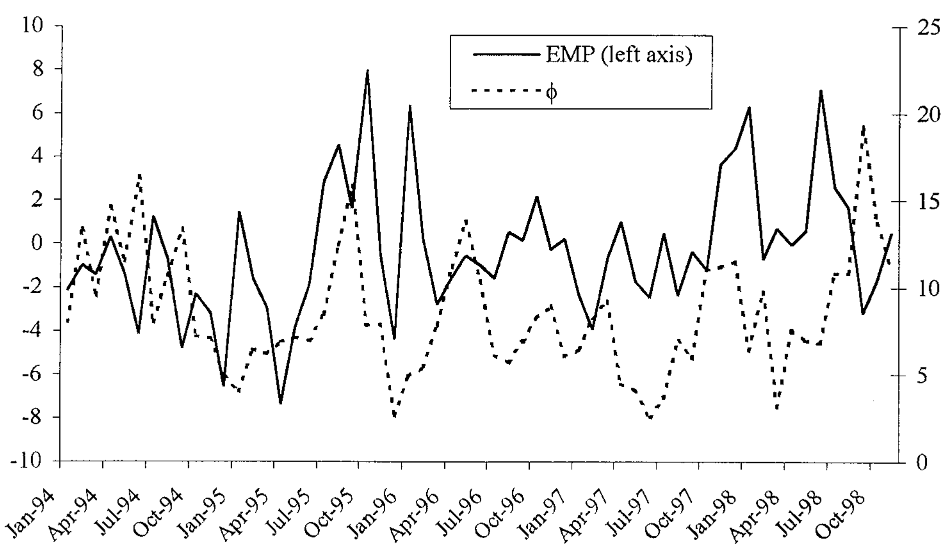


Sources: IMF/IFS

Charts 2 a - b

Chile: EMP, Credit Growth (δ) and Interest Differential (ϕ), 1994-98

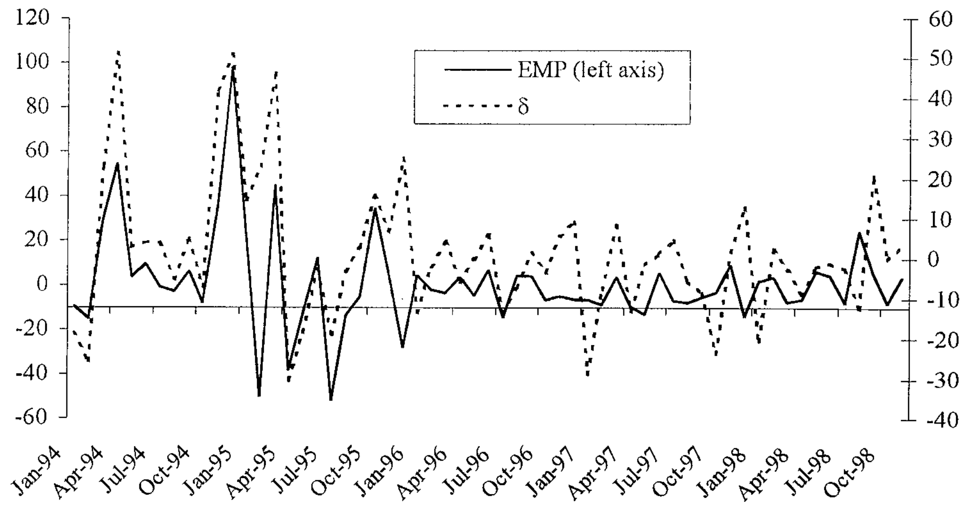


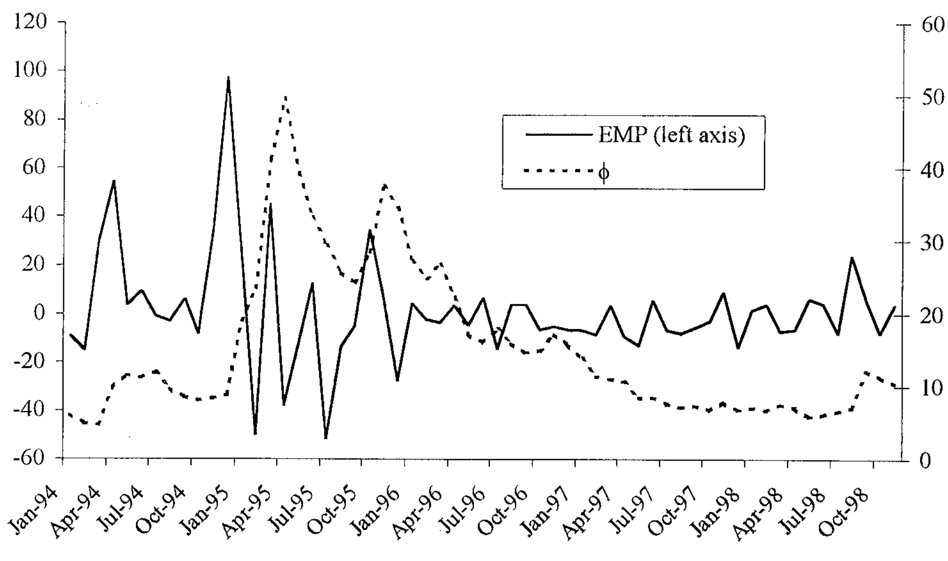


Sources: IMF/IFS

Charts 3 a – b

Mexico: EMP, Credit Growth (δ) and Interest Differential (ϕ), 1994-98

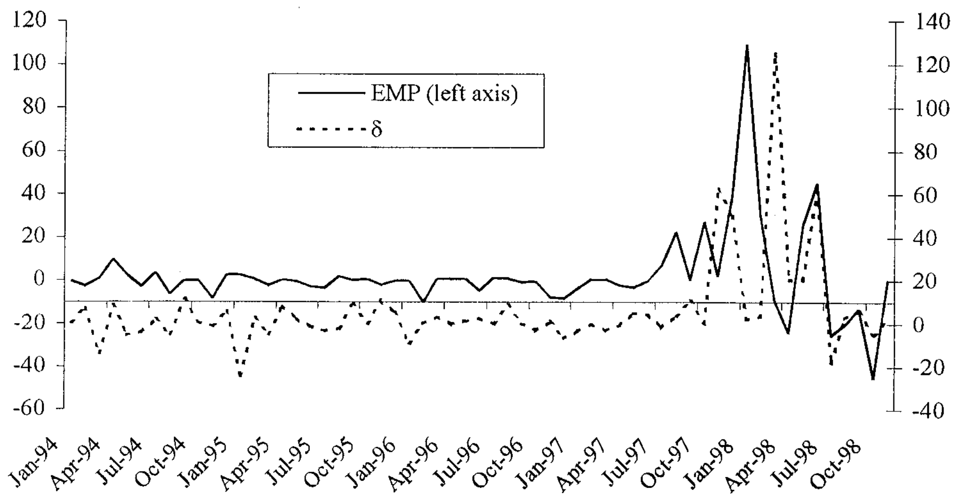


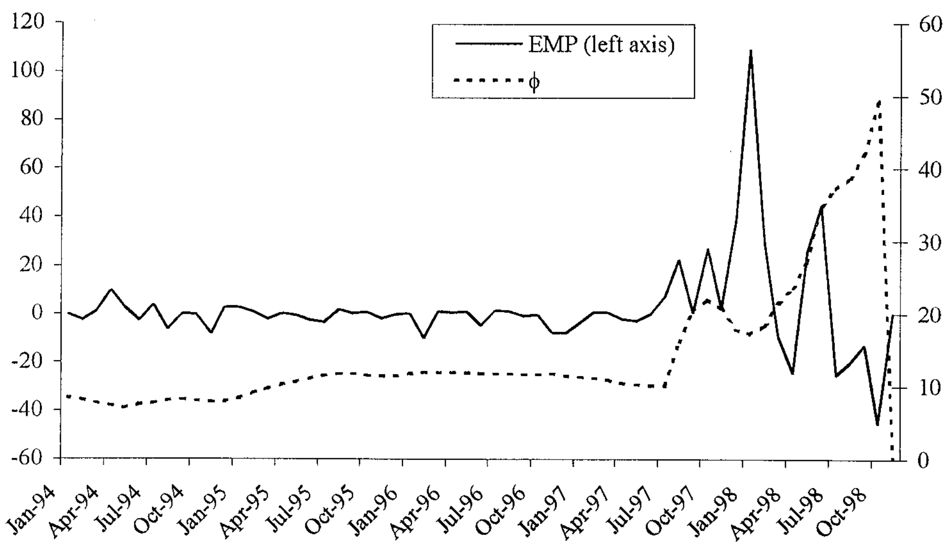


Sources: IMF/IFS

Charts 4 a – b

Indonesia: EMP, Credit Growth (δ) and Interest Differential (ϕ), 1994-98

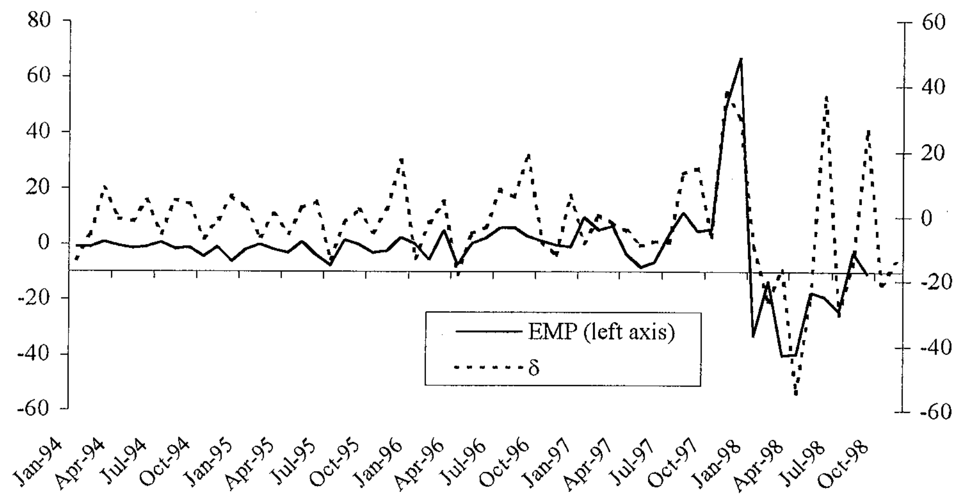


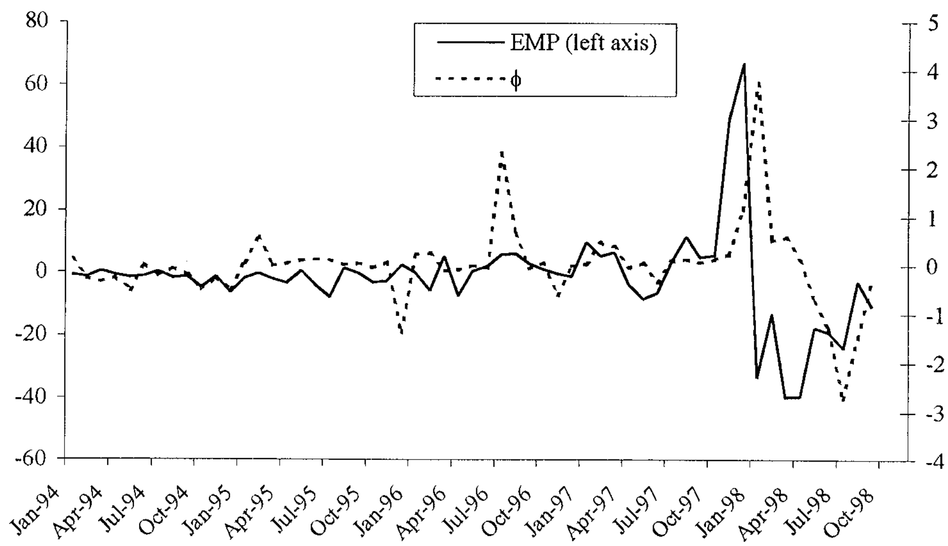


Sources: IMF/IFS

Charts 5 a – b

Korea: EMP, Credit Growth (δ) and Interest Differential (ϕ), 1994-98

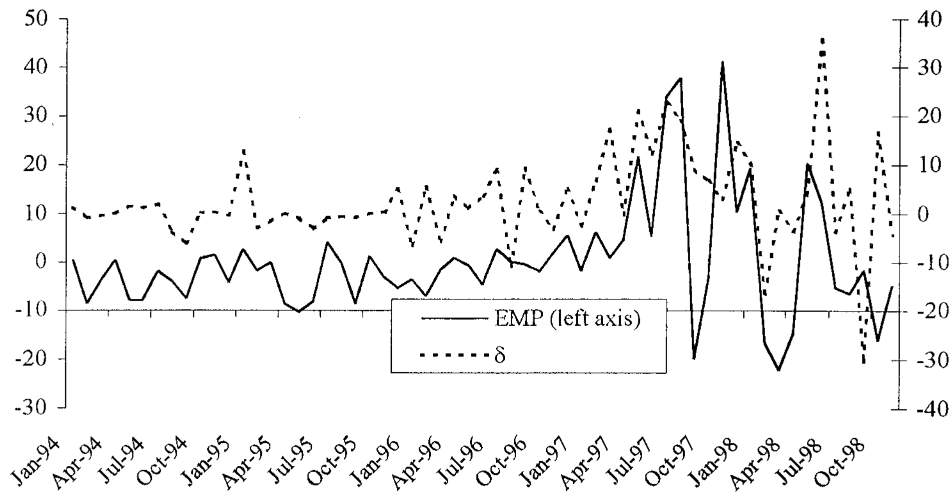


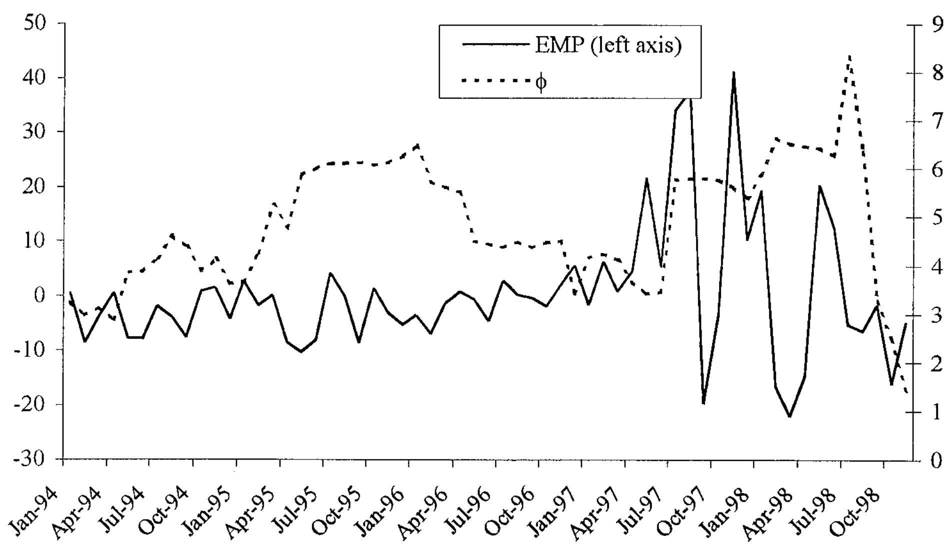


Sources: IMF/IFS

Charts 6 a – b

Thailand: EMP, Credit Growth (δ) and Interest Differential (ϕ), 1994-98





Sources: IMF/IFS

Box 1: Mexico, Brazil, and Chile Prior to the Asian Crisis (see also Table 2).

In **Mexico**, two less severe episodes foreshadowed the crisis of late 1994. In both cases, EMP and δ rose while ϕ fell:

- In **November 1993**, EMP reached 32 percent (reserves fell $4 Billion) while δ rose to 36.5 percent and ϕ fell to 10 percent.
- In **March – April 1994**, with the Colosio assassination, EMP reached about 41 percent (reserves fell by $11 billion), δ rose to 37.1 percent and ϕ fell to just about 7 percent.

Pressures in Mexico were most severe in November and December of 1994: EMP averaged 66 percent, δ rose to 46.3 percent and ϕ was about 8.6 percent.

- In **December alone**, as reserves fell by $6 billion and the peso was devalued by 54 percent, EMP rose to 100 percent.
- **Aftermath (January - April 1995)**: EMP fell and monetary policy tightened. Also, ϕ rose, not returning to its pre-crisis level until mid-1997.

In **Brazil,** EMP fell with the Real plan but rose briefly in early 1995:

- **Pre-Real plan (January 1990 – June 1994):** EMP averaged about 21.3 percent per month, δ averaged about 160.5 percent per month, and the interest differential ϕ averaged about 4500 percent.
- **Real plan (June 1994 and after):** Inflation fell, monthly EMP dropped to about 0.1 percent, δ fell to about 2 percent per month and the interest differential ϕ fell to about 30 percent.
- **March 1995**: EMP rose to 15.7 percent, δ rose to almost 14 percent and ϕ rose to about 65 percent.

In **Chile** EMP has declined during the decade of the 1990s (like in Mexico and Brazil).

- **1990 through 1998**: EMP averaged minus 0.3 percent, δ averaged about 0.3 percent per month and the interest differential ϕ averaged about 13.5 percent.
- **July – October 1995**: EMP rose to about 4.2 percent per month, δ rose to about 1.7 percent per month and the interest differential ϕ fell to 11.1 percent.

Box 2: Thailand, Indonesia, and Korea (see also Table 3).

Thailand:

- **From 1990 to January 1997**, monthly EMP averaged minus 3.4 percent, δ averaged 0.2, and the interest differential averaged 5.1.
- **February - April 1997**: EMP rose to 3.8 percent per month, δ rose to almost 8 percent per month, and ϕ fell to about 4 percent.
- **Initial crisis, May - August 1997**: EMP averaged 24.6 percent per month, δ rose to 18.7 percent, and ϕ rose to 4.6 percent, reflecting an interest rate hike in July.
- **September – October 1997**: EMP fell (to minus 11.6 percent), while δ fell to about 8 percent, ϕ rose to about 5.8 percent. [28]
- **Second crisis, November 1997 – January 1998**: EMP rebounded to 23.5 percent per month, δ jumped to about 9.1 percent, while ϕ remained near post-July levels, 5.6 percent.
- **Remainder of 1998**: Pressures diminished and monetary policy tightened: EMP fell to minus 5.4 percent per month, δ fell to about 0.3 percent, while ϕ remained at about 5.4 percent.

Indonesia:

- **From 1990 to April 1997**, monthly EMP averaged minus 1.5 percent, δ averaged minus - 0.1 percent, and ϕ averaged 11.9 percent.
- **May – July 1997**: monthly EMP rose to 0.9 percent, δ rose to 2.5 percent, and ϕ fell to 10.1 percent.
- **Most severe period, August 1997 - February 1998**: monthly EMP averaged 32.6 percent, δ rose to 17.7 percent, and ϕ rose to 18.9 percent, under an IMF program approved in November but whose performance criteria were not met (Ghosh and Phillips, (1999, p. 40)).
- **Remainder of 1998:** while pressures subsided (EMP fell to minus 8.6 percent), credit continued to rise (δ averaged about 26.7 percent), and ϕ rose to over 34 percent.

[28] Ghosh and Phillips (1999) discuss the 'stop-and-go' nature of Thai monetary policy during this period. Note also (Chart 6 a – b) that an interest differential of this about 5.8 percent was not unprecedented in Thailand. For example, in late 1995 and early 1996, well before the crisis, the interest differential was about 6 percent.

Box 2 (continued): Thailand, Indonesia, and Korea (see also Table 3).

Korea:

- **From 1990 to July 1997**: monthly EMP averaged -0.5 percent, δ averaged -0.3 percent, and ϕ averaged 3.9 percent.
- **August – October 1997**: EMP rose to 7 percent, δ rose to 7.1 percent, and ϕ rose to 5 percent. 29
- **Most severe period, November – December 1997**: monthly EMP jumped to 57.8 percent, δ rose to 34 percent, and ϕ averaged 5.9 percent.
- **In 1998**: EMP fell to –22.5 percent per month and δ fell to about minus 12.7 percent but interest rates remained high during 1998, ϕ averaged about 9 percent. [30]

In Thailand, Indonesia, and Korea (Table 3, Box 2) EMP was historically much lower than in Latin America. Nonetheless, by the mid-1990s, there were growing fragilities in all three countries (see Corsetti, Pesenti and Roubini (1998), Lane et. al. (1999), and Baliño and Ubide (1999)). Exchange market pressures rose in early-to-mid 1997, affecting these countries in succession. In all three countries, both EMP and δ rise, at first gradually for several months and then more rapidly, culminating in crises. Afterwards, with tighter monetary policy, both EMP and δ fall, while ϕ rises and generally remains high for several months thereafter.

Both the Asian events of 1997-98 and the Russian default of 1998 spilled over to Latin American financial markets. However, as discussed in Box 3, (see also Table 2) countries responded somewhat differently. In Mexico, as EMP rose, so did δ, while ϕ fell. By contrast, in Brazil, as EMP rose, δ fell, and ϕ rose. In Chile, as EMP rose, so did both δ and ϕ.

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[29] For a discussion of the fragilities in the Korean financial system see Baliño and Ubide (1999).

[30] During this period, there is some debate as to whether there was a 'credit crunch' in the Korean banking system as a whole (see Domaç and Ferri (1998) and Ghosh and Ghosh (1999)).

Box 3: Spillovers from Asia and Russia to Latin America

Both the Asian events of 1997-98 and the Russian default of 1998 affected Latin American financial markets (Table 2).

In **Mexico,** between May 1995 and December 1998, monthly EMP averaged -3 percent, δ averaged -2.3 percent, and ϕ averaged 15.7 percent.

- **Most severe effects of Asian crisis, November 1997**: when EMP jumped to 8.7 percent, δ rose to 3.7, and ϕ fell to 7.8 percent.

- **Most severe effects of Russian default, August – September 1998**: EMP rose to 14.6 percent, δ rose to 4.1 percent, and ϕ averaged 9.6 percent.

In **Brazil**, EMP also rose noticeably during the Asian and Russian episodes, but responses of δ and ϕ were different from Mexico's:

- **April 1995 to end-1998**: monthly EMP averaged minus –0.3, δ averaged 5.4 percent, and ϕ averaged 24.7 percent.

- **Asian spillover, September - November 1997:** EMP rose to 7.8 percent per month and δ fell to about 4.4 percent.

- **In November 1997**, ϕ jumped to about 34 percent, and did not return to previous levels until July 1998, even though EMP had fallen several months earlier.

- **Russian spillover (September and October 1998)**: EMP rose to about an average of 21.1 percent per month, δ averaged about 5.4 percent, and ϕ rose slightly to about 29.5 percent.

Chile was also affected by these events, but less so than either Brazil or Mexico.

- **Between 1994 and 1998**, EMP in Chile averaged about minus 0.4 percent from 1994 to 1998, while δ averaged about 0.4 and ϕ averaged about 8.5.

- **Asian spillover (November 1997 to January 1998)**: EMP rose to about 4.7 percent per month, δ rose to about 1 percent , and ϕ rose to 9.7 percent.

V. ESTIMATION RESULTS

Individual country estimates, presented in Part 5.a, use data from 1990 to end-1998. To focus on the recent crisis period, pooled estimates, using data from 1996 to 1998, are presented in Part 5.b. For all estimations, 4 lags are used. [31]

5.a Individual Country Estimates, 1990 – 1998

Estimation results, including adjusted R-Squares and exclusion (Granger causality) tests are summarized in Table 4. Impulse response functions, or IRFs, (generated by the Choleski decomposition as discussed in Part 3) and corresponding standard errors are presented in Tables 5 through 7. [32]

Shocks to the domestic credit growth variable (w_δ) are important for explaining EMP. The estimates suggest that shocks to δ affect EMP positively, as expected. As Table 4 shows, for four out of six countries (Indonesia, Korea, Thailand, Brazil) the hypothesis that lagged δ does not help explain current EMP is rejected at the 95 percent level or better. However, as Table 5 shows, for all countries, there are positive and significant IRFs for at least the current period (period 0). [33] For all countries except Chile, the magnitude of the initial shock exceeds one. That is, a one-percent shock to domestic credit leads to a change in exchange market pressure that exceeds one-percent. For Indonesia, Thailand, and Brazil, there are lagged positive effects. Korea, however presents an anomaly, as some lagged effects are negative and significant.

Some evidence also suggests that shocks to the interest differential (w_ϕ) affect EMP. However, this evidence is weaker than that linking EMP to δ, above. Like domestic credit, the hypothesis that lagged ϕ does not help explain current EMP is rejected at the 90 percent level or better in four out of six countries (Indonesia, Thailand, Brazil, Mexico). However, the IRFs in Table 6 provide somewhat weaker evidence than that for domestic credit growth δ. For four out of six countries (Indonesia, Thailand, Brazil, and Mexico) there are significant impulse response functions (IRFs) for at least one period. These effects are negative, suggesting that positive innovations in the domestic interest rate help increase and support the exchange rate (i.e. reduce EMP). However, unlike the corresponding effects for δ, these

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[31] Other lag lengths were also tried, with qualitatively similar results.

[32] An impulse response function (IRF) summarizes the response of a variable in **X** to a one-unit innovation in **w**.

[33] An IRF is significant if its t-statistic exceeds $|2|$.

Table 4
Summary of Estimates, Vector Autoregression System (5)

(5) $$\mathbf{X}_t = \mathbf{a}_0 + \mathbf{a}_1 \mathbf{X}_{t-1} + \mathbf{a}_2 \mathbf{X}_{t-2} + ... + \mathbf{v}_t, \quad \mathbf{X} = (\delta, \text{EMP}, \phi)$$

Individual Country Estimates, 1990 - 1998 (Monthly Data)

Dependent Variable: δ

F-Test, Exclusion of:	**Brazil**	**Chile**	**Mexico**	**Indonesia**	**Korea**	**Thailand**
Lagged δ	34.65	2.78	2.15	1.70	10.04	1.11
	(0.00)	(0.03)	(0.08)	(0.16)	(0.00)	(0.36)
Lagged EMP	6.54	2.29	3.12	11.63	9.69	4.32
	(0.00)	(0.07)	(0.02)	(0.00)	(0.00)	(0.00)
Lagged ϕ	33.12	2.55	1.05	2.09	1.47	0.46
	(0.00)	(0.04)	(0.39)	(0.09)	(0.22)	(0.77)
R^2 Adjusted	0.87	0.11	0.05	0.43	0.43	0.10

Dependent Variable: EMP

F-Test, Exclusion of:	**Brazil**	**Chile**	**Mexico**	**Indonesia**	**Korea**	**Thailand**
Lagged δ	4.04	0.34	0.70	6.46	3.22	3.55
	(0.00)	(0.85)	(0.59)	(0.00)	(0.02)	(0.01)
Lagged EMP	8.21	2.86	0.15	2.50	2.41	3.40
	(0.00)	(0.03)	(0.96)	(0.05)	(0.06)	(0.01)
Lagged ϕ	5.82	0.65	2.78	6.71	1.83	2.12
	(0.00)	(0.63)	(0.03)	(0.00)	(0.13)	(0.09)
R^2 Adjusted	0.64	0.03	0.03	0.49	0.28	0.16

Dependent Variable: ϕ

F-Test, Exclusion of:	**Brazil**	**Chile**	**Mexico**	**Indonesia**	**Korea**	**Thailand**
Lagged δ	16.50	1.10	0.39	12.23	2.37	2.07
	(0.00)	(0.36)	(0.81)	(0.00)	(0.06)	(0.09)
Lagged EMP	0.76	1.58	2.26	2.86	17.31	0.59
	(0.55)	(0.19)	(0.07)	(0.03)	(0.00)	(0.67)
Lagged ϕ	25.97	25.64	4.00	16.48	1.50	1.27
	(0.00)	(0.00)	(0.00)	(0.00)	(0.21)	(0.29)
R^2 Adjusted	0.76	0.50	0.29	0.64	0.60	0.16

Note: For all estimates, 4 lags are used. P-statistics in parentheses. δ = growth of domestic credit (scaled by base money). EMP = exchange depreciation plus reserves loss (scaled by base money). ϕ = change in interest differential. For Korea and Mexico, since ϕ is non-stationary, system includes first-difference (Δϕ) instead.

Table 5
Impulse Response Functions, Vector Autoregression System (5)
Responses of EMP to shocks to domestic credit (w_δ) and interest differential (w_ϕ)
T-Statistics in Parentheses

	Brazil	Chile	Mexico	Indonesia	Korea	Thailand
Shock to δ						
Period 0	2.18	0.73	13.84	2.29	4.62	4.61
	(2.39)	(2.95)	(8.77)	(2.30)	(5.19)	(6.35)
Period 1	1.07	0.04	0.47	2.92	3.54	2.15
	(1.25)	(0.18)	(0.27)	(2.93)	(3.69)	(2.16)
Period 2	0.66	0.04	-2.23	3.27	0.50	1.89
	(0.92)	(0.16)	(-1.29)	(2.65)	(0.47)	(1.69)
Period 3	1.55	0.06	0.63	1.99	2.34	1.83
	(2.36)	(0.26)	(0.39)	(1.85)	(2.24)	(1.68)
Period 4	0.50	0.10	-1.33	-2.09	-0.66	2.03
	(0.69)	(0.48)	(-0.67)	(-1.84)	(-0.71)	(1.65)
Period 5	-0.93	-0.05	-1.82	0.69	-1.98	0.28
	(-1.38)	(-0.46)	(-1.36)	(0.64)	(-2.32)	(0.34)

	Brazil	Chile	Mexico	Indonesia	Korea	Thailand
Shock to ϕ						
Period 1	1.11	0.31	-3.71	-2.51	0.58	-0.95
	(1.35)	(1.29)	(-2.09)	(-2.65)	(0.69)	(-1.20)
Period 2	-0.31	0.15	2.67	-1.20	-1.63	-2.02
	(-0.38)	(0.57)	(1.63)	(-1.15)	(-1.62)	(-2.11)
Period 3	-2.86	-0.13	-0.78	-2.76	-2.09	-0.74
	(-3.20)	(-0.51)	(-0.40)	(-2.72)	(-1.91)	(-0.73)
Period 4	-4.22	-0.14	-2.96	2.30	-1.05	1.68
	(-4.93)	(-0.64)	(-1.74)	(2.17)	(-1.22)	(1.65)
Period 5	-3.06	-0.06	-0.60	3.74	-0.01	0.63
	(-3.69)	(-0.29)	(-0.48)	(3.15)	(-0.01)	(0.75)
Period 6	-2.80	-0.11	0.19	2.02	0.00	-0.63
	(-3.37)	(-0.69)	(-0.18)	(1.86)	(0.00)	(-0.93)

Table 6
Impulse Response Functions, Vector Autoregression System (5)
Responses of Interest Differential ($\Delta\phi$) to shocks to domestic credit (w_{δ}) and EMP (w_E)
T-Statistics in Parentheses

Shock to δ	Brazil	Chile	Mexico	Indonesia	Korea	Thailand
Period 0	1139.11	0.33	0.93	0.18	-0.04	-0.95
	(3.37)	(0.50)	(3.97)	(2.45)	(-1.13)	(-1.20)
Period 1	753.51	0.02	0.91	-0.06	0.04	-2.02
	(1.96)	(0.03)	(3.52)	(-0.61)	(0.83)	(-2.11)
Period 2	2001.58	-0.27	0.25	0.05	0.14	-0.74
	(6.42)	(-0.35)	(0.95)	(0.43)	(2.87)	(-0.73)
Period 3	827.85	-0.88	0.33	0.40	0.04	1.68
	(2.89)	(-1.06)	(1.30)	(3.91)	(0.69)	(1.65)
Period 4	-157.70	-1.49	0.39	0.20	0.17	0.63
	(-0.64)	(-1.77)	(1.33)	(2.29)	(2.99)	(0.75)
Period 5	-65.31	-0.96	-0.26	0.21	0.12	-0.63
	(-0.29)	(-1.53)	-(1.18)	(2.23)	(2.38)	(-0.93)

Shock to EMP	Brazil	Chile	Mexico	Indonesia	Korea	Thailand
Period 1	803.81	-1.42	0.48	0.14	-0.02	-0.04
	(2.59)	(-2.24)	(2.08)	(1.98)	(-0.38)	(-0.54)
Period 2	319.09	0.59	0.53	0.01	0.27	-0.08
	(0.84)	(0.67)	(1.79)	(0.16)	(6.04)	(-1.19)
Period 3	19.84	0.21	0.19	-0.19	0.23	0.04
	(0.05)	(0.23)	(0.75)	(-2.23)	(4.64)	(0.62)
Period 4	-15.08	-0.62	0.78	-0.12	0.12	0.07
	(-0.03)	(-0.68)	(2.74)	(-1.39)	(1.88)	(1.08)
Period 5	-129.44	-0.64	0.22	0.15	0.09	-0.11
	(-0.29)	(-0.69)	(0.71)	(1.73)	(1.41)	(-1.64)
Period 6	383.85	-0.38	-0.28	0.37	0.05	-0.01
	(0.95)	(-0.43)	-(1.22)	(3.66)	(0.80)	(-0.28)

Table 7
Impulse Response Functions, Vector Autoregression System (5)
Responses of Domestic Credit Growth (δ) to shocks to EMP (w_E) and interest differential (w_ϕ)
T-Statistics in Parentheses

	Brazil	Chile	Mexico	Indonesia	Korea	Thailand
Shock to EMP						
Period 1	6.44	-0.09	1.62	0.35	5.44	2.37
	(1.61)	(-0.54)	(1.00)	(0.31)	(5.20)	(3.43)
Period 2	3.60	-0.26	5.29	7.04	-0.41	0.34
	(0.87)	-(1.51)	(3.45)	(5.25)	(-0.37)	(0.44)
Period 3	13.71	0.46	0.01	2.02	-1.51	-1.06
	(2.59)	(2.67)	(0.01)	(1.63)	(-1.31)	(-1.41)
Period 4	-2.16	-0.07	-1.91	1.86	-0.95	0.12
	(-0.39)	(-0.37)	(-1.22)	(1.40)	(-0.69)	(0.17)
Period 5	10.38	-0.03	-0.80	1.64	-2.99	0.05
	(2.05)	(-0.32)	(-0.72)	(1.41)	(-2.66)	(0.10)
Period 6	4.28	-0.06	-0.27	2.13	-1.49	0.15
	(0.78)	(-0.56)	(-0.25)	(1.85)	(-1.49)	(0.34)

	Brazil	Chile	Mexico	Indonesia	Korea	Thailand
Shock to ϕ						
Period 1	8.77	0.47	0.44	-1.24	0.15	0.59
	(2.11)	(3.20)	(0.27)	(-0.92)	(0.19)	(0.83)
Period 2	-5.95	0.13	-0.21	-1.85	0.88	-1.11
	(-1.44)	(0.81)	(-0.14)	(-1.55)	(0.85)	(-1.36)
Period 3	-31.56	0.06	-1.76	1.76	-2.75	-0.66
	(-6.68)	(0.37)	(-1.02)	(1.25)	(-2.73)	(-0.91)
Period 4	-23.50	-0.10	-1.70	-1.71	-2.15	0.16
	(-4.49)	(-0.75)	(-1.26)	(-1.13)	(-2.27)	(0.20)
Period 5	-21.31	-0.01	-0.19	-3.77	0.75	0.63
	(-3.99)	(-0.13)	(-0.18)	(-3.03)	(1.05)	(1.24)
Period 6	-22.02	-0.10	-0.20	1.54	0.03	0.46
	(-3.97)	(-1.02)	(-0.21)	(1.26)	(0.04)	(0.97)

effects happen immediately in only two countries, Indonesia and Mexico. In Thailand, effects occur with a one-month lag, while in Brazil, effects take place after two months.

In most cases, shocks to EMP (w_E) affect the interest differential positively. This should not be surprising, since an increase in EMP is generally associated with an increase in either expected exchange depreciation, risk, or both. For three of the six countries (Indonesia, Korea, Mexico) the hypothesis that EMP does not help explain current $\Delta\phi$ is rejected at the 95 percent level or better (as Table 3 shows). For all countries except Thailand, there are significant (IRFs) for at least one period (as Table 5 shows). Of these, responses are positive in Korea, Brazil, and Mexico. For Indonesia, there is an initial positive response whose t-statistic equals 1.98, offset by a negative response after 3 months but a positive response after 6 months. For Chile, the initial response is negative.

Domestic credit shocks (w_δ) affect interest differentials (ϕ) negatively in some countries (consistent with a liquidity effect), but positively in others (consistent with a Fisher effect). Such a finding should not be surprising, given the theoretically ambiguous nature of the link between these two variables, as mentioned in the previous section. For four of the six countries (Indonesia, Korea, Thailand, and Brazil) the hypothesis that δ does not help explain current ϕ is rejected at the 95 percent level or better (see Table 4). For all countries except Mexico, there are significant responses for at least one period, as Table 5 shows. For Indonesia, Korea, Brazil, and Chile, the responses are positive, suggesting that the Fisher effect dominates the liquidity effect in these countries. (Such a response is not surprising for Brazil and Chile, where inflation rates are typically higher than in the Asian countries).

As a policy reaction function, in most cases, EMP shocks (w_E) affect domestic credit (δ) positively. For four of the six countries (Indonesia, Korea, Thailand, and Brazil) the hypothesis that lagged EMP does not help explain current δ is rejected at the 99 percent level or better, as Table 3 shows. Moreover, for all there are significant responses for at least one period, as shown in Table 7. In all cases, these are positive, suggesting that the authorities respond, on average, to increased EMP by providing additional liquidity to the banking system (rather than contracting the money supply). Note, however, that responses for Brazil and Chile come later than the other countries (after 3 months). Note also that among all countries, responses for Chile are the weakest. By contrast, there are relatively strong responses within two months for Indonesia, Korea, Thailand, and Mexico.

For the case of Mexico, findings here confirm one of the key elements of the 1994-95 crisis, namely sterilization of reserve outflows by the monetary authority (see Flood, Garber, and Kramer (1996)). [34] Moreover, these finding suggest that, in Asia, like Mexico, such sterilization also occurred.

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[34] Indeed, this finding is somewhat stronger than that of Calvo and Mendoza (1996), who report that, while domestic credit growth Granger causes reserve outflows, the reverse is not true.

Evidence regarding responses of δ to interest differential shocks ($\Delta\phi$) is weaker than that regarding δ and EMP, above. For three of the six countries (Indonesia, Brazil, Chile) the hypothesis that lagged $\Delta\phi$ does not help explain current δ is rejected at the 99 percent level or better (see Table 3). However, the direction of the responses is mixed, as Table 6 shows. In both Chile and Brazil, there are positive and significant responses after one month. That is, in these cases, the authorities respond to higher interest rates with higher growth to domestic credit. In Brazil, however, there are strong negative effects after 3 months. Also, in Indonesia, there is a negative effect, but with a 5-month lag.

5.b Pooled Estimates, 1996 - 1998

Unlike individual country estimates, pooled estimates can provide a sense of the *average* relationships among the variables during the recent round of crises. Results of pooled estimates for the recent period (1996 - 98) including adjusted R-Squares, exclusion (Granger causality) tests, and impulse response functions (with corresponding standard errors) are summarized in Table 8. [35] Impulse response functions and their corresponding standard errors are also presented visually, in Charts 7 through 12.

Like individual country estimates, shocks to the credit variable (δ) are positively associated with movements in EMP. As Part A of Table 8 shows, the hypothesis that lagged δ do not help explain current EMP is rejected at better than the 99 percent level (with an F-statistic of 5.08). And, as Part B of the same table shows (see also Chart 13), there is a positive and significant contemporaneous response: a one-percent shock to domestic credit leads to a change in exchange market pressure that exceeds 5 percent, consistent individual country estimates.

Unlike individual country estimates, the evidence suggests that shocks to the interest differential ($\Delta\phi$) do not affect EMP. As Part A of Table 7 shows, the hypothesis that lagged $\Delta\phi$ do not help explain current EMP is not rejected at conventional levels. And, as Part B of the same table shows (see also Chart 14), there are no significant impulse response functions.

Like individual country estimates, some evidence suggests that shocks to EMP affect the interest differential positively. As Part A of Table 7 shows, the hypothesis that EMP does not help explain current $\Delta\phi$ is not rejected at conventional levels. However, as Part B shows (see also Chart 15), there are significant, positive responses, after four months.

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[35] Estimates include country intercepts, not reported. In the pooled estimates, the interest differential is entered as a first difference ($\Delta\phi$) for all countries.

Table 8
Summary of Estimates, Vector Autoregression System (5)
(5) $\mathbf{X}_t = \mathbf{a}_0 + \mathbf{a}_1 \mathbf{X}_{t-1} + \mathbf{a}_2 \mathbf{X}_{t-2} + ... + \mathbf{v}_{t,}$, $\mathbf{X} = (\delta, EMP, \Delta\phi)$
Pooled Estimates, 1996 - 1998 (Monthly Data)

A. F-Tests for Exclusion (P-statistics in Parentheses)

Dependent Variable:	δ	*EMP*	$\Delta\phi$
F-Test, Exclusion of:			
Lagged δ	2.16	5.08	1.03
	0.08	0.00	0.39
Lagged EMP	10.65	8.63	0.79
	0.00	0.00	0.53
Lagged Δϕ	1.28	0.45	122.31
	0.28	0.78	0.00
R^2 Adjusted	0.21	0.18	0.89

B. Impulse Response Functions (T-statistics in parentheses)

	Responses of:					
	EMP		$\Delta\phi$		δ	
Shock to:	δ	$\Delta\phi$	δ	*EMP*	*EMP*	$\Delta\phi$
Period 0	5.07	-	0.07	0.10	-	-
	(5.48)	-	(0.42)	(0.58)	-	-
Period 1	0.71	-1.29	0.41	0.34	4.43	-0.89
	(0.64)	(-1.32)	(1.78)	(1.46)	(3.56)	(-0.71)
Period 2	1.36	-0.41	0.48	0.52	6.15	2.42
	(1.23)	(-0.41)	(1.82)	(1.98)	(4.89)	(1.97)
Period 3	-1.03	-0.18	0.68	0.55	1.82	-0.98
	(-0.99)	(-0.18)	(2.32)	(1.71)	(1.46)	(-0.72)
Period 4	-2.96	0.08	0.83	0.75	2.49	-0.67
	(-2.95)	(0.13)	(2.69)	(2.09)	(2.07)	(-0.71)
Period 5	-0.51	-0.42	0.65	0.93	1.41	0.49
	(-0.85)	(-0.58)	(2.17)	(2.61)	(1.56)	(0.52)
Period 6	0.24	-0.70	0.58	0.90	-0.19	-0.37
	(0.43)	(-1.14)	(1.97)	(2.71)	(-0.22)	(-0.49)

Response of EMP to one unit shock to credit growth (δ)

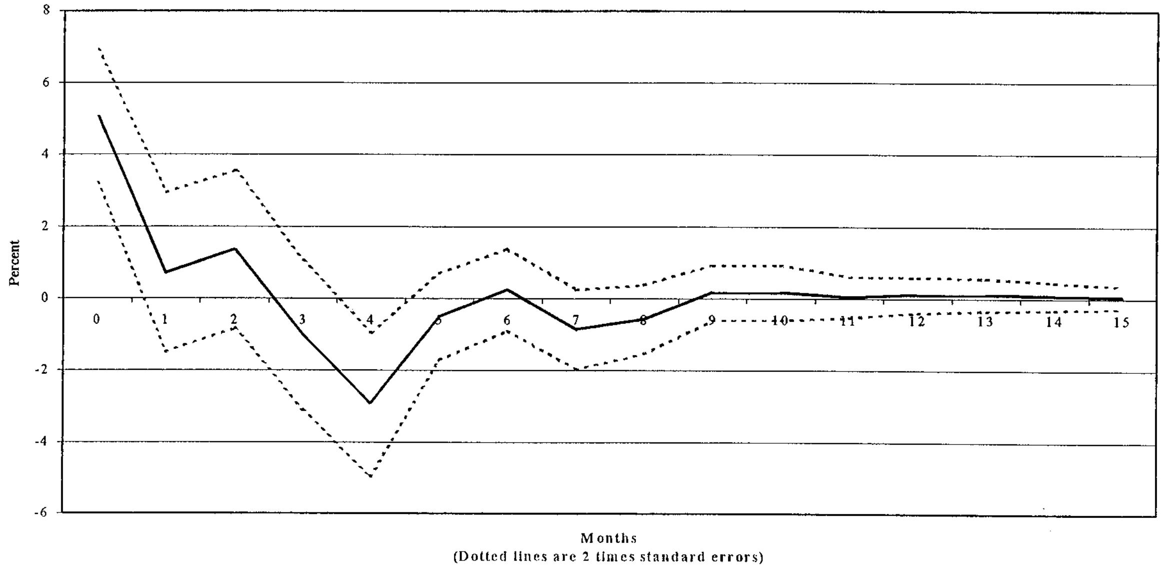

Chart 7

Response of EMP to one unit shock to interest differential (Δϕ)

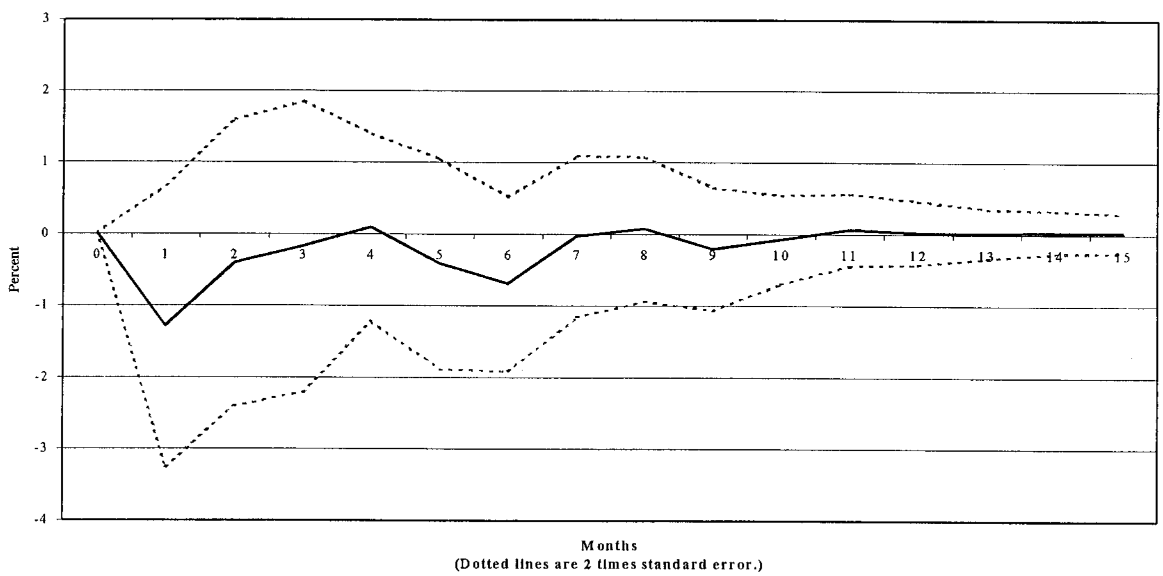

Chart 8

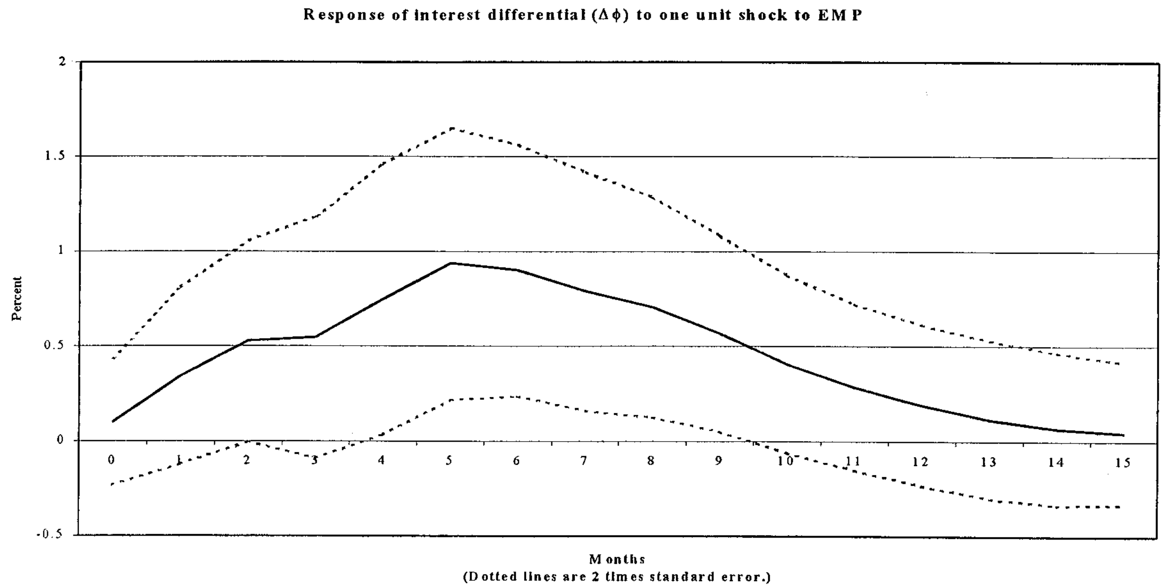

Chart 9

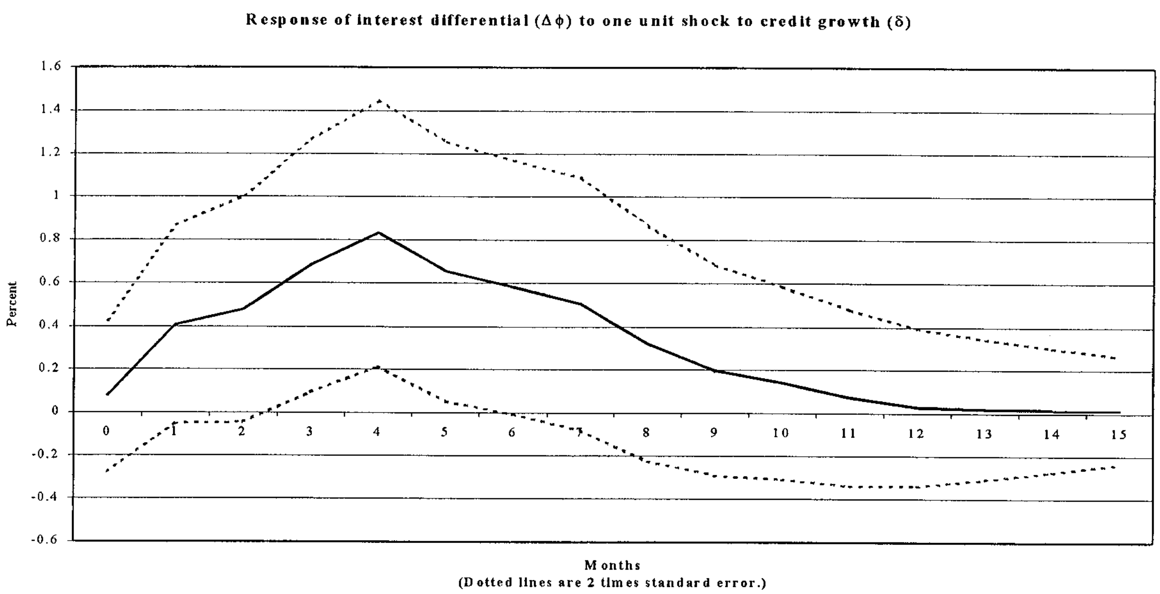

Chart 10

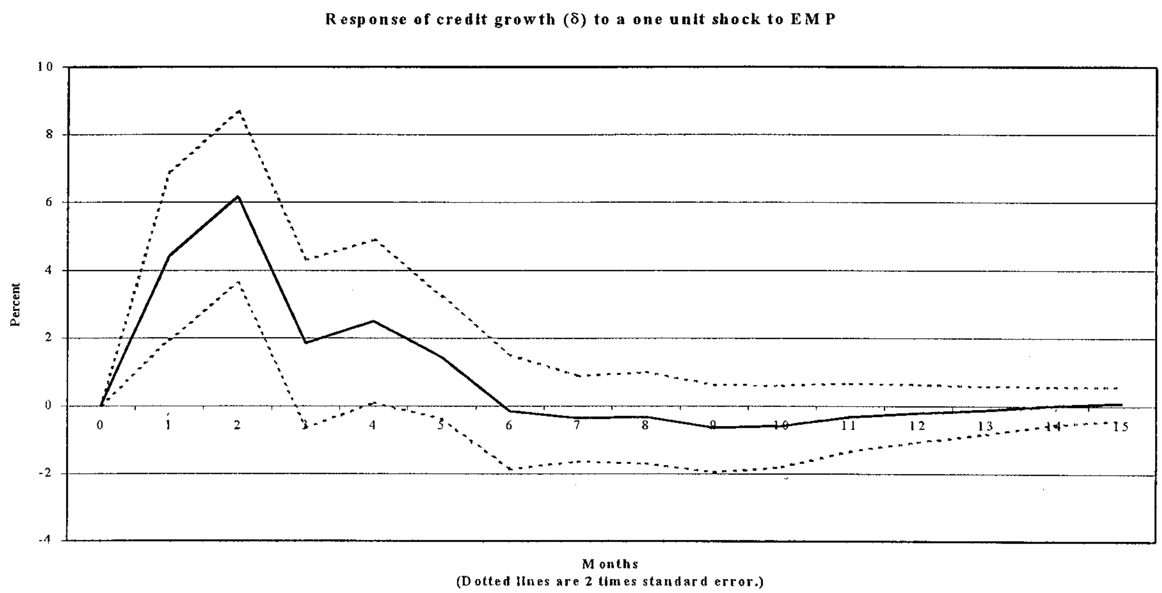

Chart 11

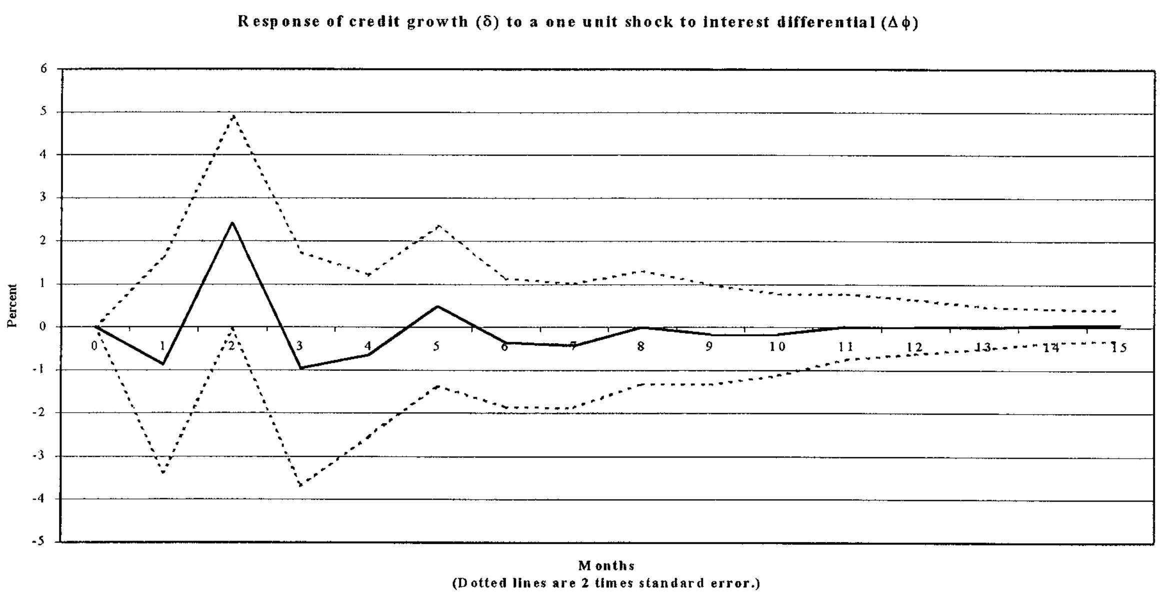

Chart 12

Some evidence also suggests that domestic credit shocks (δ) affect interest differentials ($\Delta\phi$) positively (consistent with a Fisher effect). The hypothesis that δ does not help explain current $\Delta\phi$ is not rejected at conventional levels (Part A, Table 7). However, there are significant, positive responses after three months (Part B, Table 7, and Chart 16).

As is the case for most individual country estimates, EMP shocks affect domestic credit (δ) positively. As Part A of Table 7 shows, the hypothesis that lagged EMP does not help explain current δ is rejected at better than the 99 percent level (with an F-statistic of 10.65). And, as Part B of the same table shows (see also Chart 17), there are significant, positive responses after one month.

However, δ does not appear to respond to interest differential shocks ($\Delta\phi$). As Part A of Table 7 shows, the hypothesis that lagged $\Delta\phi$ does not help explain current δ is not rejected at conventional levels. And, as Part B of the same table shows (see also Chart 18), there are no significant responses.

VI. Summary, Conclusions, and Policy Implications

This paper examined the relationship between exchange market pressure (EMP) and monetary policy during the 1990s, in several emerging market economies, namely Brazil, Chile, Mexico, Indonesia, Korea, and Thailand. Since exchange rate regimes in these economies were neither perfectly fixed nor freely floating, it would be misleading to focus exclusively on either reserve or exchange rate movements. Rather, EMP is more appropriate as it summarizes the difference between the growth rates of money supply and demand under managed exchange rate regimes.

This paper addressed three main questions. First, does monetary policy affect EMP in the expected direction? That is, does contractionary monetary policy help reduce EMP (i.e. defend a country's currency and/or its foreign exchange reserves)? Second, what variable best measures the policy stance taken by the monetary authority? In particular, should a monetary aggregate (like the domestic credit component of the monetary base) or an interest rate (like the differential between domestic and world interest rates) be used? While older literature (like the monetary approach to the balance of payments) most often uses domestic credit, newer work tends to focus on interest rates. A compromise approach, developed in this paper, includes both variables. Third, how does EMP affect monetary policy? Do policy makers tighten, when faced with increases to EMP? Or, as suggested by recent work on balance of payments crises (Flood, Garber, and Kramer (1996), Calvo and Mendoza (1996)), do policy makers exacerbate exchange market pressures with sterilization (increases in the domestic credit component of the monetary base)?

To answer the first question, evidence presented in the paper suggests that one measure of monetary policy, domestic credit growth, has powerful impacts on EMP in the 'right' direction: a reduction in the domestic credit component of the money supply helps reduce EMP (either by increasing the value of a country's currency, or its stock of international reserves, or both). This finding held for both individual country and pooled estimates. This finding also supports evidence by Goldfajn and Gupta (1998) that contractionary monetary policy helps support the exchange rate , but not work by Sachs and Radetlet (1998) and Furman and Stiglitz (1998), whose research finds the opposite.

Related to both the first and second questions, evidence regarding the response of EMP to interest shocks was somewhat weaker than that linking EMP and domestic credit growth. There is some evidence from some individual countries (but not from pooled estimates) that positive interest differential shocks also help reduce EMP. This finding, however, should not cast doubt on the effectiveness of monetary policy for affecting EMP. Rather, this finding underscores the fact that interest rates have market-determined (as well as policy-determined) elements. [36] In a related vein, the paper provided some insights into the determinants of interest differentials. There is some evidence, both from individual country and pooled estimates, that shocks to EMP positively affect interest rates. This makes sense, given that higher EMP may signal both exchange depreciation and risk. However, the effect of domestic credit shocks on the interest differential works positively for higher inflation countries like Brazil and Chile (reflecting a Fisher effect) and for the pooled estimates, but negatively for lower inflation countries like Korea and Thailand (reflecting a liquidity effect).

Finally, regarding the third question, the paper provided some evidence (in both individual country and pooled estimates) that monetary authorities respond to increases of EMP by expanding rather than contracting domestic credit, a finding discussed by others in the context the Mexican crisis of 1994-95.

Such a policy reaction may represent an error in perception that results in a vicious circle, since an initial rise in EMP may be due to a fall in money demand that the central bank incorrectly perceives to be temporary. However, such a policy may also reflect a weak financial system. In both Mexico and Asia, such weakness was evident prior to the crises. Nonperforming assets in the financial system represent implicit liabilities of the public sector. Since compensating fiscal adjustments did not occur before the crises, and it was politically impossible to let unsound institutions fail, policy makers may have had few alternatives other than extending credit to such institutions, even though doing so was destabilizing. Put differently, prior to the crises, monetary policies were 'too loose' in a systematic way. Other preventative measures, and a different political environment, might have provided central bankers with more options.

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[36] Also, the policy maker and the econometrician have two distinct datasets. For the econometrician, it is often difficult to distinguish policy and market determined components of interest rates.

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