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Exchange Market Pressure, Currency Crises, and Monetary Policy: Additional Evidence from Emerging Markets

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Abstract

This paper extends my previous work by examining the relationship between monetary policy and exchange market pressure (EMP) in 32 emerging market countries. EMP is a gauge of the severity of crises, and part of this paper specifically analyzes crisis periods. Two variables gauge the stance of monetary policy: the growth of central bank domestic credit and the interest differential (domestic versus U.S. dollar). Evidence suggests that monetary policy plays an important role in currency crises. And, in most countries the shocks to monetary policy affect EMP in the direction predicted by traditional approaches: tighter money reduces EMP.

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I. Introduction

In emerging markets, currency crises have occurred more frequently in recent years and continue to concern policy makers.[2] To explain currency crises, much early work emphasized the role of monetary policy at or around the time of the crisis. In a familiar example, if the increase of the domestic credit portion of the monetary base (usually the counterpart of an unsustainable fiscal deficit) outstrips that of base money demand, foreign exchange reserves will be depleted and the exchange rate regime will collapse.[3] Extending this logic, Krugman (1979) and many others thereafter explored the implications of market speculation against an exchange rate regime, including the precise timing of a regime's collapse.[4]

Recent *empirical* work on currency crises has used a broader list of explanatory variables, often with the goal of forecasting currency crises over a medium-term horizon. For example, early warning systems developed by several authors have suggested that certain fundamental indicators (including real exchange rate overvaluation and growth rates of GDP, exports, and banking sector credit) help forecast exchange rate crises in advance (as much as two years).[5]

In recent years, as Kaminsky and Reinhart (1999) argue, currency crises have been increasingly associated with financial fragilities, like the Mexican and Asian crises. Accordingly, financial sector variables may also help to predict exchange rate crises. And, several researchers have tested for external common shocks or market contagion.[6]

While fiscal and financial fundamentals may help predict exchange rate crises over the medium term, and contagion may be important, monetary policy may nonetheless play an important role in exchange rate crises, especially *at or around the time of the crisis*. For example, a country's central bank might accommodate pressures on the banking system and/or adverse external

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[2] According to Kaminsky and Reinhart (1999), the number of crises rose from about 2.6 per year during 1970–79 to about 3.1 per year from 1980 to 1995.

[3] This idea is central to the traditional monetary approach to the balance of payments (see, for example Frenkel and Johnson (1976)).

[4] See also Flood and Garber (1984), Connolly and Taylor (1984), and others.

[5] See, among others, Kaminsky, Lizondo, and Reinhart (1997), Sachs, Tornell, and Velasco (1996), Tornell (1999), and Berg and others (2000).

[6] There is no single definition of contagion. Some link contagion to certain market fundamentals, rather than irrational herd behavior by investors. For example, Eichengreen, Rose, and Wyploz (1996) and Rose and Glick (1998) link regional contagion to international trade. Also, Sachs, Tornell, and Velasco (1996) and Tornell (1999) develop models of contagion in which investors use fundamental variables to inform their speculation.

shocks, expanding the domestic portion of the money supply and sterilizing outflows as it provides liquidity to the banking system.[7]

In this light, the question of whether monetary policy is effective in preventing or forestalling crises has recently received renewed theoretical attention (Bensaid and Jeanne (1997), Drazen (1999), Furman and Stiglitz (1998), Flood and Jeanne (2000), and Lahiri and Végh (2000). For example, some have suggested that higher interest rates might place undue pressure on the banking system, thus causing a recession and exacerbating problems in exchange markets. Others have noted that without a fiscal adjustment, tighter monetary policy increases the burden on the intertemporal budget and may hence be counterproductive.

To empirically address questions like these, many authors have used measures of exchange market pressure (EMP) that include exchange rate depreciation and movements of international reserves (and, in some cases, the interest rate differential). Such a variable can be used for different exchange rate regimes, providing a more complete picture than either exchange depreciation or reserve movements in isolation.[8]

This paper extends a previous one also written by myself (Tanner (2001)). Like that paper, this one addresses several questions regarding EMP and monetary policy. For example, are substantial movements in EMP, including exchange rate crises and other periods of turbulence, due mainly to changes in money demand or money supply? Do the relationships between EMP, money supply, and money demand change during periods of common shocks or turbulence in

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[7] The implications of outflow sterilization have been incorporated into (modified) first generation models (see Flood and Marion (1998) and second generation of crisis models (including *inter alia* Flood, Garber, and Kramer (1996)). Several authors have suggested such a policy was implemented in both Mexico (Calvo and Mendoza (1996), Flood, Garber, and Kramer (1996)) and in the Asian countries (Tanner (2001)).

[8] For example, several authors have recently attempted to ascertain the ability of policy makers to defend *exchange rates* with tight monetary policy, and specifically with high interest rates. See, among others, Goldfajn and Gupta (1999), Dekle, Hsiao, and Wang (1999), Gould and Kamin (2000), Kraay (1999), and Zettlemeyer (2000). This paper helps test a related proposition. However, this paper examines *EMP* rather than exchange rates. Other papers that use EMP or a similar *continuous* index include Girton and Roper (1977), Sachs, Tornell and Velasco (1996), Tornell (1999), Bussière and Mulder (1999), Ahluwalia (2000) and Tanner (2001). By contrast, other papers, including Eichengreeen, Rose, and Wyploz (1996), Kaminsky, Reinhart, and Lizondo (1997), and Kaminsky and Reinhart (1999) use EMP to construct *discrete* a crisis dummy variable (0 = no crisis, 1 = crisis). Van Rijckeghem and Weder (1999) use both. A continuous EMP variable, generally contains more information than a discrete crisis dummy. A continuous variable permits a comparison of the severity of crises to be compared, both over time within a given country and across countries.

global capital markets? If so, do these relationships change in a consistent way? What can we say about the stance of monetary policy at or around the time of exchange rate crises?

As in the previous paper, EMP is defined herein as the sum of exchange depreciation (in percent) and reserve losses (in percent of the monetary base).[9] However, this paper examines 32 countries, as compared to 6 in the previous one. This measure of EMP has three components: a real money demand component, a money supply component and a real exchange rate component.[10] Accordingly, this decomposition is well suited to address questions like those posed above.

Next, the relationship between EMP and monetary policy is examined in a vector autoregression (VAR) system that is estimated for most countries in the data sample.[11] Such a framework is well suited to examine relationships between monetary policy and EMP in both directions. Does monetary policy affect EMP as expected direction? And, in the other direction, what, if any, is the feedback relationship from EMP to monetary policy? Is outflow sterilization, like that found in Mexico and certain Asian countries, evident elsewhere?

The paper is organized as follows. In Part II, measures of exchange market pressure (EMP) and the stance of monetary policy are discussed. Summary statistics regarding EMP and monetary policy are presented for 34 emerging market countries, including through selected common-shock windows, namely Mexican, Asian, Russian, and Brazilian Crises. In Part III, the VAR model is developed and estimated. Part IV presents a summary and some policy implications.

II. Exchange Market Pressure (EMP) and Its Components

Many countries limit exchange rate flexibility with purchases or sales of international reserves. In such regimes, when measuring exchange market pressures (EMP), the exchange rate and international reserves must be considered jointly. In this regard, Table 1 presents average values for the growth of the nominal exchange rate measured in domestic currency units per dollar (ε) and the change in international reserves (NIR) as a fraction of the monetary base

[9] This is Girton and Roper's (1977) definition. As mentioned in the text, while other definitions are used in the literature, the one proposed here has certain desirable properties.

[10] Most other research use broader measures of the money supply to measure the stance of monetary policy. For example, Kaminsky and Reinhart (1999) use a measure of excess M1 balances as an indicator, but they find it to be a noisy indicator. By contrast, this paper this paper uses a narrower measure, namely the domestic credit component of the monetary base (like earlier literature on the monetary approach of the balance of payments and a recent paper by Aziz, Caramazza, and Salgado (2000)).

[11] The model is similar one to developed by Tanner (2001).

(MB, $r = \Delta NIR/MB$), for 34 emerging market countries in the Western Hemisphere (Latin America and Jamaica, hereafter referred to as WH), Asia, and Europe.

Table 1 presents weighted regional averages (including calculations for WH countries that omit Argentina, Brazil, and Mexico for WH countries).[12] For WH countries, calculations are presented only for the more recent period of lower inflation. Data are presented for both the entire sample period and certain subsamples that correspond to periods generally associated with common global shocks, namely "Tequila Spillover" (94:9–95:5, hereafter referred to as TS), Asian (97:4–98:4), and Russian/Brazilian (98:7–99:7) periods.[13]

Table 1 also presents calculations of an intervention index, INTIND, defined as the variance of (scaled) reserve movements r as a *ratio* of the sum of the variances of scaled reserves and exchange depreciation: $INTIND = var(r)/[var(r)+var(\varepsilon)])$. INTIND thus summarizes the degree of exchange market intervention. Under a perfectly fixed exchange rate regime, INTIND is unity.[14]

This table suggests most countries intervene to some degree in their foreign exchange markets. In this context, several authors have suggested using measures or indices of EMP that include both variables.[15] One definition of EMP, due to Girton and Roper (1977) is the sum of exchange rate depreciation and reserve outflows (scaled by base money):

$$EMP_t = \varepsilon_t - r_t \qquad (1)$$

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[12] Weights are computed with 1995 nominal U.S. dollar GDP.

[13] Choosing windows in this way provides data series long enough to calculate variances. But, crisis windows for different countries are identical, both troughs and recoveries may potentially be placed within the same window if crises occur sequentially. For this reason, other calculations that use shorter, country-specific windows for periods of peak EMP are also presented below. Nonetheless, in most cases that EMP is higher and more variable during the selected windows. An exception is Asian countries during the 1997–8 Asian crisis, where variance of EMP rises dramatically but mean falls since crises occurred sequentially.

[14] Other recent papers, including Levy-Yeyati and Sturnzegger (1999), Fischer (2001), Hernandez and Montiel (2001), and Poirson (2001) have also developed measures of exchange market intervention, or effective (rather than stated) exchange rate regime.

[15] And, unless INTIND is zero, it would not be appropriate to test for the effect of monetary policy on exchange rates, as do several recent papers (see Footnote 8).

Table 1. Summary Indicators of Exchange Rate Regime

	Whole Period* (varies by country)			Tequila Window (94:9–95:5)			Asia Window (97:4–98:4)			Russia/Brazil Window (98:7–99:7)		
	INTIND	r	ε	INTIND	r	ε	INTIND	r	ε	INTIND	r	ε
Western Hemisphere												
Argentina	1.00	2.15	0.00	1.00	-4.51	0.01	1.00	1.74	0.00	1.00	1.37	0.00
Bolivia	0.99	1.21	0.67	0.99	-1.49	0.21	1.00	1.79	0.36	1.00	-0.39	0.44
Brazil	0.54	1.37	1.10	0.89	2.05	0.24	1.00	2.17	0.60	0.33	-4.11	4.61
Chile	0.54	1.04	0.46	0.38	1.56	-1.16	0.72	0.22	0.68	0.54	0.34	0.82
Colombia	0.82	2.97	1.27	0.57	2.37	0.81	0.82	2.49	1.99	0.75	2.73	2.24
Costa Rica	0.97	0.65	1.04	0.99	0.01	1.23	1.00	3.01	0.84	1.00	1.92	0.91
Dominican Republic	0.88	0.74	0.27	0.29	0.89	0.40	0.56	0.51	1.22	0.90	1.44	0.29
Ecuador	0.98	2.79	3.04	1.00	38.25	1.00	0.96	4.75	2.26	0.67	-2.36	6.70
El Salvador	0.96	1.51	0.08	1.00	-1.50	0.06	1.00	3.75	0.00	1.00	0.97	0.00
Guatemala	0.98	1.65	0.39	0.46	-0.31	-0.09	1.00	6.58	0.37	0.98	2.41	1.27
Honduras	0.99	2.40	0.92	0.99	4.25	0.35	1.00	8.82	0.29	1.00	5.02	0.50
Mexico	0.85	2.31	1.16	0.61	-11.38	8.26	0.94	6.10	0.57	0.59	2.17	0.37
Paraguay	0.95	1.65	0.88	0.99	3.37	0.32	0.83	0.44	1.97	0.97	3.51	1.37
Peru	0.97	3.63	0.88	0.99	1.38	0.01	0.92	2.32	0.51	0.84	-0.21	1.03
Uruguay	0.91	1.54	1.59	0.71	2.04	1.73	0.98	2.37	0.98	0.96	1.22	0.73
Venezuela	0.77	6.63	2.56	1.00	2.47	0.03	1.00	4.98	0.89	0.99	1.26	0.87
Jamaica	0.66	0.87	1.67	0.85	2.49	0.14	0.99	-0.44	0.32	0.94	-0.46	0.67
Weighted Average	0.73	2.07	1.00	0.82	-0.98	1.58	0.96	2.93	0.62	0.60	-0.87	2.38
Excl. Arg., Mexico, Brazil	0.82	3.07	1.31	0.74	3.37	0.19	0.88	2.77	1.09	0.82	1.17	1.43

INTIND = var (r)/[var(r)+(var(ε)], r = ΔR/MB, R = reserves, MB = monetary base, e = %ΔE, E = nominal exchange rate (domestic currency units per dollar).

* For WH countries, calculations are limited to recent low inflation periods. For further information, see bottom of next page.

Table 1 (continued). Summary Indicators of Exchange Rate Regime

	Whole Period (varies by country)			Tequila Window (94:9–95:5)			Asia Window (97:4–98:4)			Russia/Brazil Window (98:7–99:7)		
	INTIND	r	ε	INTIND	r	ε	INTIND	r	ε	INTIND	r	ε
Asia												
Bangladesh	0.96	-0.15	0.47	1.00	1.16	-0.04	0.96	0.33	0.54	0.95	-0.07	0.52
Sri Lanka	0.61	1.20	0.78	0.95	1.28	0.12	1.00	2.02	0.68	0.99	0.08	0.71
India	0.31	0.45	0.51	0.99	0.69	0.02	0.33	0.80	0.79	0.82	0.99	0.15
Indonesia	0.78	2.71	1.15	1.00	0.97	0.31	0.74	14.08	12.59	0.89	-8.74	-5.14
Korea	0.81	1.83	0.42	0.93	1.80	-0.58	0.64	10.02	4.00	0.91	7.67	-0.88
Malaysia	0.89	1.90	0.09	0.99	-5.38	-0.38	0.11	-1.30	3.57	0.95	8.28	-0.67
Pakistan	0.20	0.32	0.80	1.00	0.63	0.12	0.61	0.54	0.75	0.48	0.68	0.89
Philippines	0.87	1.88	0.48	0.73	-1.62	-0.25	0.81	3.98	3.46	0.93	2.72	-0.70
Singapore	0.95	4.28	-0.15	0.99	6.17	-0.84	0.32	2.83	0.77	0.89	2.89	-0.06
Thailand	0.91	1.80	0.20	0.99	3.00	-0.17	0.90	2.33	3.78	0.82	1.01	-0.96
Weighted Average	0.70	1.66	0.48	0.96	1.18	-0.23	0.58	5.69	3.92	0.86	2.37	-1.03
Emerging Europe												
Greece	0.88	1.48	0.66	0.96	4.85	-0.70	0.94	0.24	1.40	0.81	1.06	0.01
Malta	0.60	0.87	0.04	0.74	-0.59	-0.65	0.09	0.28	0.49	0.62	1.33	0.11
Turkey	0.61	0.04	3.33	0.96	5.10	2.93	0.99	12.27	5.30	0.98	1.67	3.74
Albania	0.92	5.63	2.12	0.33	-0.46	0.83	0.11	0.90	0.80	0.27	0.50	-0.89
Bulgaria	0.67	7.76	6.26	0.82	5.40	1.64	0.96	15.26	1.06	0.88	-3.10	0.12
Czech Republic	0.67	2.35	0.35	0.84	3.95	-0.96	0.63	0.77	1.04	0.21	0.94	0.39
Poland	0.75	2.94	1.26	0.95	4.85	0.04	0.86	4.82	0.79	0.76	1.93	0.87
Romania	0.61	2.20	4.08	0.85	-1.85	1.45	0.98	8.68	1.39	0.71	0.57	4.94
Weighted Average	0.71	1.66	2.03	0.93	4.35	0.87	0.90	6.33	2.49	0.79	1.32	1.82

Notes: All variables are computed on a monthly basis. INTIND = var (r)/[var(r)+(var(e)], r = DR/MB, R = reserves, MB = monetary base, e = %DE, E = nominal exchange rate (domestic currency units per dollar).

where ε is the growth of the nominal exchange rate measured in domestic currency units per dollar and r is the change in international reserves as a fraction of the monetary base (ΔNIR/MB).[16] To demonstrate the intuition behind this definition of EMP, suppose that the excess supply of money rises by 1 percent. Under a fixed exchange rate, r = -1 percent; under a flexible exchange rate regime, $\varepsilon = 1$ percent, and under a mixed regime, these two variables would move in some combination.[17]

In an appendix, EMP is shown to contain three elements, namely a nominal money supply element, a real money demand element, and a residual term that includes changes in both the bilateral real exchange rate and foreign (U.S.) inflation:

$$EMP_t \equiv \delta_t - m_t + \lambda_t \qquad (2)$$

where, δ_t is the change in net domestic credit scaled by the monetary base (ΔNDA/MB), m_t is the growth of real base money, and $\lambda_t = \pi_t^* + z_t$, where z_t is the change in the bilateral real exchange rate and π_t^* is foreign inflation. Thus, λ_t may be thought of as a residual term that includes real exchange rate changes.

Equation (2) underscores the question of how to gauge whether monetary policy is "tight" or "loose." Much recent work, applied to the U.S. and other industrialized countries, has emphasized interest rates (like the Federal Funds Rate in the U.S.) as an indicator of the stance of monetary policy (higher interest rates mean tighter money) since interest rates are the policy instrument, reflecting the tastes and preferences of policy makers.[19]

By contrast, older literature emphasizes monetary aggregates to gauge the stance of monetary policy.[18] However, for open economies with fixed or managed exchange rates there are

[16] Other papers that present models of EMP include Connolly and Da Silveira (1979) for Brazil, Brissimis and Leventakis (1984), for Greece, Weymark (1995), for Canada, Wohar and Lee (1992), for Korea, and Burkett and Richards (1993), for Paraguay. Several authors, including Sachs, Tornell and Velasco (1996), Tornell (1999), Bussière and Mulder (1999), Van Rijckeghem and Weder (1999) and Ahluwalia (2000) construct a variant of EMP for several countries. 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).

[17] Note that papers mentioned previously use a somewhat different weighting scheme. For these other measures, this interpretation may not apply.

[18] Most often, the monetary aggregate is a broad measure but could also be narrow money or even the monetary base. Some recent work for the U.S. focuses on unborrowed reserves (see Bernanke and Mihov (1998). Christiano, Evans, and Eichenbaum (1998) compare these different measures of monetary policy and their ability to explain aggregate fluctuations. Note

(continued)

advantages to focusing on the domestically determined component of the monetary base (δ) much like the traditional monetary approach.[19] A more formal modeling strategy that includes both interest rates and δ is presented in Part III. As an intuitive justification for using δ, note that even if the central bank targets an interest rate *ex-ante*, domestic credit adjusts *ex-post* in order that money markets to clear at that interest rate. So, while interest rates may reflect the *intentions* of the policy makers, domestic credit indicates *ex-post* whether monetary policy is tight or loose.[20] Thus, according to equation (2), EMP increases when real money demand (m) decreases, when the domestic component of the money supply (δ) increases, when the real exchange rate depreciates and/or foreign inflation falls (λ).[21]

One might also ask about the relative importance of the elements in the right hand side of equation (2). Are movements in EMP primarily due to changes in money demand, money supply, or other factors contained in λ? To address this question, consider next this expression for the *variance* of EMP:

$$\text{var(EMP)} = \text{var}(\delta)+\text{var(m)}+\text{var}(\lambda)+2[-\text{cov}(\delta, \text{m})+\text{cov}(\delta,\lambda)+\text{cov}(\text{m},\lambda)] \tag{3}$$

also that in some other papers in the currency crisis literature (for example Kaminsky and Reinhart (1999)) broader measures of money and/or credit are used. However, these broader measures are to a large extent market determined. By contrast, the narrower measure used here more accurately reflects policy decisions.

[19] Importantly, if sterilized intervention occurs, central bank domestic credit may have an endogenous component, as noted by Darby (1980) and more recently by Zettlemeyer (2000). The model presented in Part III of this paper addresses this issue.

[20] This argument also holds if domestic and U.S. dollar assets are imperfect substitutes. In this case, domestic interest rates reflect perceived risk and expected exchange depreciation. With more risk or higher expected devaluation, the marginal depositor must be compensated by higher domestic interest rates keep her funds onshore. To maintain the *ex-ante* interest rate target, the central bank adjusts domestic credit according to the demands of the banking system. Faced with external pressures, the interest rate targeted by the central bank may not be sufficiently high *ex-post* to prevent a capital outflow and a corresponding drain on the banking system's liquid reserves. These points are formalized in Part III.

[21] 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. In Part III, EMP and interest differential are modeled jointly.

Table 2 presents the means of EMP, δ, m, and λ, the variance of EMP, and the elements on the right hand side of equation (3) *as a fraction of var(EMP)*, for the 32 emerging market countries. For WH, calculations are presented both for a longer data sample and recent, lower inflation periods. Unsurprisingly, EMP is higher and more variable in the WH and Europe than in Asia. However, much EMP in the WH reflects the high inflation periods in certain countries (notably Brazil). When high inflation periods for WH are excluded EMP falls and becomes less variable.

An important message of Table 2 is that for most countries and time periods, money supply factors are an important element of EMP. Among WH and Asian countries, var(δ) as a fraction of var (EMP) generally exceeds either var(m) or var(λ). In these regions, in most cases, var(δ)/var(EMP) is close to (if not greater than) unity. In Europe, however, relative to other regions, var(δ)/var(EMP) is somewhat lower while var(m) and especially var(λ) are considerably greater.

The data suggest that periods of increased exchange market pressure are accompanied by expansions of domestic credit by the central bank, reductions in real money demand, and real depreciations. In Table 3, simple bivariate regression coefficients of EMP on δ, m, and λ, estimated country-by-country, are presented. These regressions are intended to summarize the data, not to imply causality. The estimated coefficients $\partial EMP/\partial \delta$ are positive and almost always significant; those for $\partial EMP/\partial m$ are less than zero and in most cases significant; and those for $\partial EMP/\partial \lambda$ are almost always positive and significant.

Focusing specifically on the common shock periods, casual inspection also suggests that currency crises tended to be more severe in those countries where monetary policy was looser, especially during the TS and Asian periods (but less so for the Russian and Brazilian episodes). Figures 1–4 show present average monthly EMP and δ – for those specific months when EMP peaked – for selected countries in each region.[22] For the TS and Asian crisis periods the charts convey a positive cross-country relationship between EMP and δ.[23]

[22] The precise months plotted may vary between countries, since related crises may occur in succession, as happened in Asia.

[23] This appears to be true for example, during the TS period. At this time, WH countries with negative EMP (reserve inflows and/or exchange rate appreciation) like Colombia and Chile had tighter monetary policy, while monetary policy was looser in countries with higher EMP like Venezuela, and Bolivia. Note also that Argentina, while subject to a currency board, has a margin of discretion in monetary policy so long as the monetary base is fully backed by international reserves (that is, net domestic credit of the central bank is not positive).

Table 2. Exchange Market Pressure and its Components: Means and Variances

	Means				var (EMP)	As a Fraction of var(EMP)					
	EMP	δ	m	λ		var(δ)	var(m)	var(λ)	2cov(δ,m)	2cov(δ,λ)	2cov(λ,m)
Argentina	-1.36	0.19	0.79	-0.76	255.7	0.48	0.18	0.19	0.06	0.16	-0.05
Low Inflation	-2.10	-0.72	0.68	-0.70	101.7	0.94	0.41	0.06	0.25	-0.15	0.01
Tequila	4.52	3.23	-1.58	-0.28	78.1	0.49	0.75	0.00	0.25	0.02	0.01
Asia	-1.74	-0.90	0.77	-0.06	64.2	0.46	0.32	0.00	-0.20	0.01	0.00
Russia/Brazil	-1.37	-1.37	0.09	0.09	81.7	0.75	0.34	0.00	0.10	0.02	0.00
Bolivia	-0.65	-0.01	0.53	-0.12	43.5	1.03	0.75	0.02	0.81	0.03	0.02
Low Inflation	-0.65	-0.01	0.53	-0.12	43.5	1.03	0.75	0.02	0.81	0.03	0.02
Tequila	1.71	2.59	0.28	-0.60	29.8	0.48	1.43	0.01	0.76	0.00	0.15
Asia	-1.43	-0.26	0.82	-0.35	48.5	0.87	0.82	0.02	0.74	0.08	0.04
Russia/Brazil	0.83	-0.71	-1.23	0.32	36.8	0.46	0.97	0.00	0.43	0.02	0.02
Brazil	40.94	42.20	0.92	-0.37	5610.9	1.13	0.03	0.01	0.12	-0.07	-0.02
Low Inflation	-0.28	1.35	1.75	0.13	102.7	2.07	1.19	0.69	2.52	-0.79	-0.36
Tequila	-1.81	4.00	3.98	-1.84	69.5	0.84	1.45	0.11	1.62	-0.16	-0.38
Asia	-1.57	0.58	2.38	0.22	85.2	2.36	0.72	0.00	2.08	-0.03	-0.03
Russia/Brazil	8.72	2.96	-1.48	4.27	263.8	0.63	0.37	1.31	0.38	-0.77	0.16
Chile	0.42	1.64	1.09	-0.14	44.7	1.07	0.75	0.53	1.36	0.23	0.22
Low Inflation	-0.58	0.31	0.52	-0.37	6.3	0.49	0.69	0.53	0.64	0.11	0.17
Tequila	-2.73	0.38	1.38	-1.72	10.4	0.21	0.22	0.39	0.17	0.35	0.00
Asia	-1.57	0.14	-0.06	0.25	85.2	0.13	0.53	0.21	0.12	0.11	-0.15
Russia/Brazil	0.48	0.04	0.09	0.53	10.0	0.27	1.10	0.54	0.83	0.07	0.15
Colombia	-1.43	-0.93	0.20	-0.29	35.9	2.32	1.33	0.16	-0.42	-0.42	-0.01
Low Inflation	-1.70	-1.51	-0.09	-0.36	21.0	3.29	1.95	0.33	-0.83	-0.83	0.00
Tequila	-1.56	-0.20	-0.13	-1.08	2.1	17.74	14.51	1.90	-4.67	-7.10	0.75
Asia	-0.50	-1.73	-1.32	0.26	8.5	8.29	4.09	0.76	-1.43	-3.43	0.80
Russia/Brazil	-0.49	-2.55	-0.71	1.60	9.4	8.03	2.10	1.39	0.59	-5.39	-0.89

Notes: EMP = exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP – δ_t + m_t = residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/Brazil windows, and calculation of weighted averages, see Table 1.

Table 2 (continued). Exchange Market Pressure and its Components: Means and Variances

	Means				var(EMP)	As a fraction of var(EMP)					
	EMP	δ	m	λ		var(δ)	var(m)	var(λ)	2cov(δ,m)	2cov(δ,λ)	2cov(λ,m)
Costa Rica	1.10	1.82	0.64	-0.08	34.6	1.20	1.53	1.08	0.67	0.01	2.15
Low Inflation	0.39	0.74	0.38	0.04	29.5	1.10	2.32	1.87	0.53	0.04	3.79
Tequila	1.23	3.49	1.70	-0.57	12.8	1.60	1.43	0.13	1.67	-0.39	0.10
Asia	-2.17	-1.60	0.54	-0.03	62.0	0.79	0.16	0.01	-0.06	0.00	0.02
Russia/Brazil	-1.01	-1.55	-0.42	0.12	33.2	1.27	0.23	0.02	0.42	-0.04	0.06
Dominican Republic	2.89	3.43	0.53	0.00	849.9	0.34	0.04	0.17	-0.03	0.39	-0.02
Low Inflation	-0.47	0.43	0.61	-0.29	21.7	0.69	0.35	0.14	0.12	-0.05	0.02
Tequila	-0.49	0.71	0.56	-0.64	6.3	0.26	0.28	0.85	0.38	-0.65	-0.65
Asia	0.72	1.33	1.47	0.86	14.7	0.14	0.80	0.41	0.42	0.08	0.00
Russia/Brazil	-1.15	0.53	1.50	-0.18	10.3	0.56	1.05	0.14	0.92	-0.22	-0.39
Ecuador	4.39	4.88	0.54	0.04	1855.5	0.91	0.03	0.02	0.06	0.11	0.01
Low Inflation	0.25	0.69	0.66	0.22	1466.4	1.02	0.04	0.02	0.08	0.02	0.01
Tequila	-37.25	-36.62	-0.26	-0.89	13608.3	0.99	0.00	0.00	0.00	0.01	0.00
Asia	-2.49	-2.43	-0.07	-0.13	81.2	0.78	0.53	0.04	0.38	0.04	0.02
Russia/Brazil	9.06	7.05	1.09	3.09	256.8	0.83	0.27	0.44	0.45	-0.12	-0.04
El Salvador	0.78	1.99	0.68	-0.54	167.8	1.16	0.59	0.20	1.11	0.14	-0.03
Low Inflation	-1.43	-0.20	0.68	-0.56	21.2	1.90	1.31	0.06	2.20	-0.03	0.05
Tequila	1.56	2.56	0.40	-0.59	12.3	1.66	2.32	0.03	2.84	-0.15	0.01
Asia	-3.75	-1.19	2.34	-0.21	47.8	2.44	1.63	0.01	3.05	-0.02	0.00
Russia/Brazil	-0.97	-0.42	0.59	0.04	16.5	1.50	0.23	0.05	0.52	-0.29	-0.05
Guatemala	0.38	0.57	0.48	0.29	177.7	0.25	0.34	0.74	0.28	-0.08	-0.04
Low Inflation	-1.26	-0.21	0.70	-0.34	78.1	0.65	1.00	0.03	0.69	-0.02	-0.03
Tequila	0.21	0.77	-0.17	-0.73	2.4	24.25	28.06	0.91	51.80	0.61	1.01
Asia	-6.20	-2.15	3.92	-0.14	545.9	0.20	0.80	0.00	0.03	0.01	-0.02
Russia/Brazil	-1.15	-1.57	0.45	0.88	94.1	1.26	0.44	0.04	0.73	-0.06	-0.06

Notes: EMP= exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP − δ_t + m_t= residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/Brazil windows, and calculation of weighted averages, see Table 1.

Table 2 (continued). Exchange Market Pressure and its Components: Means and Variances

	Means				var(EMP)	As a fraction of var(EMP)					
	EMP	δ	m	λ		var(δ)	var(m)	var(λ)	2cov(δ,m)	2cov(δ,λ)	2cov(λ,m)
Honduras	1.99	2.60	0.78	0.17	386.3	0.48	0.16	0.64	0.19	-0.11	-0.02
Low Inflation	-1.48	0.16	1.20	-0.44	174.0	0.71	0.40	0.02	0.18	0.04	-0.01
Tequila	-3.90	0.07	2.05	-1.91	177.8	0.53	0.72	0.03	0.27	0.07	0.08
Asia	-8.53	-6.29	1.48	-0.75	206.4	0.56	0.13	0.00	-0.34	-0.04	0.00
Russia/Brazil	-4.52	-4.06	0.13	-0.34	96.1	0.38	0.45	0.00	-0.18	0.01	0.02
Mexico	0.71	1.40	0.47	-0.22	164.3	0.85	0.32	0.35	0.63	0.12	0.01
Low Inflation	-1.15	-0.22	0.60	-0.32	278.4	0.93	0.22	0.12	0.45	0.23	0.05
Tequila	19.64	13.81	-0.60	5.22	1491.4	0.57	0.05	0.27	0.26	0.54	0.18
Asia	-5.52	-4.32	0.60	-0.60	49.1	1.49	1.11	0.06	1.68	-0.35	-0.36
Russia/Brazil	-1.81	1.29	2.14	-0.96	20.9	2.63	1.59	0.89	3.05	-1.43	-0.37
Paraguay	-0.70	-0.51	0.48	0.30	70.7	1.12	0.61	0.76	0.65	-0.47	0.37
Low Inflation	-0.78	-0.05	0.41	-0.32	66.2	1.11	0.62	0.07	0.82	0.07	0.05
Tequila	-3.05	-0.44	1.83	-0.79	17.5	2.24	3.35	0.02	4.67	0.02	-0.05
Asia	1.53	0.96	0.74	1.31	30.2	0.90	1.34	0.16	1.19	-0.24	-0.04
Russia/Brazil	-2.14	-2.60	0.40	0.85	228.3	0.90	0.19	0.03	0.15	0.05	0.02
Peru	6.43	5.15	0.40	1.68	2699.7	0.12	0.02	0.50	-0.02	0.29	-0.05
Low Inflation	-2.75	-1.34	1.30	-0.12	78.6	1.07	0.34	0.03	0.35	-0.04	0.05
Tequila	-1.37	1.83	2.38	-0.81	324.1	1.08	0.06	0.01	0.03	-0.11	0.01
Asia	-1.81	-1.16	0.50	-0.14	5.2	2.08	1.83	0.20	2.11	-0.63	0.37
Russia/Brazil	1.25	1.16	0.72	0.80	10.9	0.92	2.89	0.48	1.47	-0.25	1.56
Uruguay	6.43	5.47	0.41	-0.42	2699.7	0.96	0.17	0.07	0.28	0.17	0.09
Low Inflation	-2.75	0.72	0.16	-0.50	78.6	1.50	1.08	0.09	1.56	-0.05	0.06
Tequila	-0.31	1.62	0.50	-1.43	22.9	0.74	0.79	0.22	1.06	0.38	0.08
Asia	-1.39	-0.15	1.25	0.02	17.6	2.14	0.39	0.02	1.50	-0.10	-0.05
Russia/Brazil	-0.49	-0.92	-0.18	0.25	11.1	1.43	1.87	0.06	2.16	-0.07	0.13

Notes: EMP= exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP – δ_t + m_t= residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/Brazil windows, and calculation of weighted averages, see Table 1.

Table 2 (continued) Exchange Market Pressure and its Components: Means and Variances

	Means				var(EMP)	As a fraction of var(EMP)					
	EMP	δ	m	λ		var(δ)	var(m)	var(λ)	2cov(δ,m)	2cov(δ,λ)	2cov(λ,m)
Venezuela	-2.68	-2.05	0.62	-0.01	182.3	1.26	0.45	0.66	0.41	-1.10	-0.14
Low Inflation	-4.07	-2.97	0.59	-0.51	173.3	1.61	0.64	0.46	0.73	-1.10	-0.12
Tequila	-2.44	0.37	-0.95	-3.76	54.0	2.49	1.07	0.01	2.66	0.08	-0.02
Asia	-4.10	0.25	2.39	-1.97	248.5	0.08	0.98	0.01	0.17	0.00	-0.10
Russia/Brazil	-0.39	-0.41	-0.88	-0.86	139.3	1.02	0.33	0.01	0.44	0.01	-0.06
Jamaica	3.99	5.03	0.79	-0.25	691.9	0.88	0.12	0.05	0.27	0.23	0.01
Low Inflation	0.80	1.38	0.34	-0.24	128.3	0.83	0.49	0.20	0.83	0.29	-0.02
Tequila	-2.34	1.10	2.49	-0.95	20.0	1.41	1.43	0.13	2.07	-0.03	-0.13
Asia	0.76	5.75	4.61	-0.38	23.8	9.43	8.15	0.02	16.60	0.19	0.19
Russia/Brazil	1.13	0.87	-0.05	0.21	7.9	2.77	2.17	0.11	4.03	-0.12	-0.10
Weighted Avg.	17.57	18.54	0.73	-0.28	2632.5	0.99	0.25	0.20	0.24	-0.03	0.00
Low Inflation	-1.11	0.19	1.08	-0.19	139.6	1.58	0.84	0.40	1.27	-0.41	-0.11
Tequila	2.56	4.37	1.47	-0.31	463.8	1.97	1.93	0.23	1.18	-0.35	-0.08
Asia	-2.39	-0.81	1.39	-0.09	78.1	1.98	0.98	0.07	1.26	-0.28	-0.03
Russia/Brazil	3.25	1.17	-0.28	1.82	142.5	1.46	0.82	0.84	0.91	-0.89	0.01
Excl. Argentina, Mexico, Brazil	0.86	1.19	0.55	0.13	708.1	1.19	0.62	0.42	0.30	-0.21	0.07
Low Inflation	-1.90	-0.96	0.51	-0.32	129.7	1.59	0.96	0.32	0.32	-0.39	0.12
Tequila	-3.18	-0.94	0.54	-1.61	669.5	5.87	4.86	0.58	1.67	-1.56	0.19
Asia	-2.01	-0.70	0.63	-0.27	95.4	2.62	1.76	0.26	0.44	-0.86	0.20
Russia/Brazil	0.26	-0.41	-0.12	0.61	55.8	2.52	1.36	0.51	0.83	-1.28	0.03

Notes: EMP= exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP – δ_t + m_t= residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/Brazil windows, and calculation of weighted averages, see Table 1.

Table 2 (continued). Exchange Market Pressure and its Components: Means and Variances

	Means				var(EMP)	As a fraction of var(EMP)					
	EMP	δ	M	λ		var(δ)	var(m)	Var(λ)	2cov(δ,m)	2cov(δ,l)	2cov(λ,m)
Bangladesh	0.62	0.95	0.51	0.08	17.2	0.77	0.85	0.79	1.31	-0.23	-0.13
Tequila	-1.20	-0.36	-0.31	-1.15	31.3	0.84	0.65	0.27	1.17	0.53	0.11
Asia	0.21	1.07	0.54	-0.32	17.7	0.70	0.93	0.64	1.28	-0.33	-0.35
Russia/Brazil	0.59	0.64	0.15	0.10	17.8	0.80	0.83	1.12	1.15	-0.20	0.39
Sri Lanka	-0.42	0.93	0.46	-0.88	40.2	0.93	0.40	0.86	0.52	-0.60	0.08
Tequila	-1.16	-0.97	-0.31	-0.50	6.3	1.49	4.02	2.35	2.19	-0.78	3.88
Asia	-1.34	-0.86	0.81	0.33	108.3	0.74	0.17	0.14	0.03	-0.02	0.06
Russia/Brazil	0.62	0.02	0.49	1.09	15.9	0.67	0.71	0.88	0.12	-0.21	0.92
India	0.06	0.82	0.52	-0.24	6.9	1.66	1.74	0.82	2.90	-0.23	0.09
Tequila	-0.67	1.03	1.09	-0.61	2.4	3.52	3.35	0.18	6.03	0.62	0.65
Asia	0.00	-0.22	-0.02	0.21	5.6	1.14	1.64	0.85	2.23	0.00	0.40
Russia/Brazil	-0.84	-0.18	0.40	-0.26	1.6	2.73	4.69	1.80	4.92	-0.85	2.45
Indonesia	-1.56	-0.25	0.94	-0.37	127.5	1.81	0.28	0.62	0.35	-1.36	0.00
Tequila	-0.66	0.75	0.85	-0.56	19.0	3.41	2.74	0.01	5.14	-0.14	-0.12
Asia	-1.49	-4.80	2.14	5.45	892.5	2.41	0.18	0.95	-0.25	-2.79	0.00
Russia/Brazil	3.60	-0.18	0.40	-0.26	485.7	1.80	0.03	0.63	-0.17	-1.42	0.21
Korea	-1.41	0.04	0.89	-0.56	65.9	2.04	0.99	0.24	2.02	-0.22	0.02
Tequila	-2.38	-0.53	0.95	-0.90	5.5	4.79	6.19	0.28	10.29	-0.81	-0.84
Asia	-6.02	-3.79	-1.04	-3.26	670.0	1.23	0.11	0.33	0.25	-0.32	0.10
Russia/Brazil	-8.55	-10.83	0.21	2.49	305.5	1.76	0.19	0.22	0.87	-0.42	-0.11

Notes: EMP= exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP – δ_t + m_t= residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/Brazil windows, and calculation of weighted averages, see Table 1.

Table 2 (continued). Exchange Market Pressure and its Components: Means and Variances

	Means				var(EMP)	As a fraction of var (EMP)					
	EMP	δ	m	λ		var(δ)	var(m)	var(λ)	2cov(δ,m)	2cov(δ,λ)	2cov(λ,m)
Malaysia	-1.82	-0.59	0.94	-0.28	54.6	1.13	0.34	0.12	0.59	0.07	0.07
Tequila	4.99	7.14	1.42	-0.73	61.4	1.49	0.52	0.01	1.09	0.06	-0.01
Asia	4.88	0.55	-1.13	3.20	93.7	0.70	0.74	0.85	1.33	1.24	1.20
Russia/Brazil	-8.95	-5.66	2.43	-0.85	194.2	1.23	0.33	0.04	0.87	0.39	0.11
Pakistan	0.48	1.15	0.41	-0.25	48.6	0.43	0.26	0.98	0.42	-0.11	0.13
Tequila	-0.52	0.74	0.90	-0.37	23.4	1.37	0.54	0.03	1.05	0.22	0.10
Asia	0.20	-0.11	0.04	0.36	6.2	2.99	1.33	0.82	3.01	-0.13	0.99
Russia/Brazil	0.21	0.66	0.35	-0.10	21.6	0.71	0.42	0.53	0.69	0.08	0.04
Philippines	-1.38	-0.74	0.51	-0.14	51.8	1.82	0.83	0.62	1.55	-0.73	-0.02
Tequila	1.37	3.55	1.86	-0.33	10.7	6.05	5.12	0.47	10.36	0.49	0.77
Asia	-0.53	-0.18	-0.52	-0.87	146.1	0.79	0.31	0.22	0.37	0.22	0.16
Russia/Brazil	-3.42	-1.10	0.23	-2.09	66.6	2.50	0.63	0.09	2.09	-0.18	-0.05
Singapore	-4.44	-3.39	0.64	-0.44	52.2	0.95	0.25	0.07	0.29	0.04	0.01
Tequila	-7.01	-5.31	0.70	-0.99	42.1	1.35	0.32	0.01	0.83	0.14	-0.01
Asia	-2.06	-2.91	-0.15	0.70	12.9	0.97	0.82	0.92	1.40	1.09	1.39
Russia/Brazil	-2.95	-3.51	-0.64	-0.08	62.4	0.85	0.47	0.09	0.55	0.17	0.04
Thailand	-1.60	-0.26	0.68	-0.66	53.7	1.21	0.38	0.11	0.57	-0.13	0.01
Tequila	-3.18	-0.92	1.68	-0.58	29.0	1.37	0.48	0.03	0.91	0.06	0.02
Asia	1.45	3.48	-0.50	-2.53	743.8	1.05	0.04	0.12	0.06	-0.21	-0.06
Russia/Brazil	-1.97	-0.07	0.08	-1.82	18.1	1.90	0.85	0.35	1.38	-0.67	0.05
Weighted Avg.	-1.17	-0.04	0.73	-0.41	55.4	1.61	0.88	0.45	1.55	-0.35	0.03
Tequila	-1.41	0.36	1.06	-0.71	15.8	3.39	3.44	0.18	6.00	-0.08	-0.06
Asia	-1.77	-1.60	-0.18	-0.36	420.4	1.33	0.60	0.58	0.86	-0.36	0.29
Russia/Brazil	-3.40	-3.98	0.35	0.35	179.5	1.88	1.31	0.65	1.72	-0.56	0.56

Notes: EMP= exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP – δ_t + m_t= residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/ Brazil windows, and calculation of weighted averages, see Table 1.

Table 2 (continued). Exchange Market Pressure and its Components: Means and Variances

	Means				var(EMP)	As a fraction of var (EMP)					
	EMP	δ	m	λ		var(δ)	var(m)	var(λ)	2cov(δ,m)	2cov(δ,λ)	2cov(λ,m)
Greece	-0.82	-0.02	0.56	-0.22	62.18	1.20	0.82	2.13	-0.31	-1.50	1.96
Tequila	-5.55	-0.12	3.97	-1.47	66.91	2.97	1.89	4.15	1.15	-2.67	4.19
Asia	1.16	0.96	1.02	1.23	139.55	0.80	0.47	0.82	-0.52	-0.75	0.86
Russia/Brazil	-1.06	1.21	3.07	0.81	51.67	1.57	1.42	4.56	-2.13	-4.28	4.41
Malta	-0.84	-0.21	0.34	-0.29	15.79	0.60	0.50	1.46	-0.08	-0.62	1.02
Tequila	-0.06	1.29	1.32	-0.04	9.95	2.03	1.78	3.59	-0.15	-3.52	3.03
Asia	0.21	-0.47	-0.39	0.29	46.29	0.17	0.03	1.70	-0.08	-0.69	0.29
Russia/Brazil	-1.21	-1.11	0.16	0.05	12.08	0.87	0.43	1.85	-0.86	-1.75	1.27
Turkey	3.28	3.71	0.37	-0.06	189.06	0.52	0.12	0.53	-0.05	0.07	0.29
Tequila	-2.17	-0.37	-0.26	-2.06	106.74	1.04	0.37	0.70	-0.38	-0.66	0.83
Asia	-6.96	-6.21	0.24	-0.52	198.38	0.85	0.07	0.19	-0.12	-0.05	0.18
Russia/Brazil	2.07	3.32	0.65	-0.60	158.43	1.19	0.19	0.53	-0.04	-0.45	0.50
Albania	-3.50	-2.92	0.77	0.19	404.32	1.02	0.10	0.32	-0.12	-0.22	0.33
Tequila	0.29	1.85	-1.10	-2.97	7.11	0.42	0.51	0.19	-0.92	-0.38	0.22
Asia	-0.10	0.46	-0.61	-1.17	31.64	1.00	1.33	4.31	0.04	-1.97	3.63
Russia/Brazil	-1.40	0.47	1.26	-0.60	7.36	1.14	0.86	2.47	-0.86	-2.73	1.61
Bulgaria	-1.50	-1.85	0.24	0.59	1290.46	0.54	0.11	0.40	0.26	0.43	0.23
Tequila	-3.76	-0.20	-0.73	-4.30	57.21	0.66	0.43	0.59	-0.68	-0.81	0.55
Asia	-14.21	-5.48	9.76	1.04	704.46	0.94	0.27	0.39	0.07	-0.11	0.42
Russia/Brazil	3.23	3.24	1.29	1.27	61.76	0.59	0.58	0.72	0.13	0.17	0.94

Notes: EMP= exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP – δ_t + m_t= residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/Brazil windows, and calculation of weighted averages, see Table 1.

Table 2 (continued). Exchange Market Pressure and its Components: Means and Variances

	Means				var(EMP)	As a fraction of var (EMP)					
	EMP	δ	m	λ		var(δ)	var(m)	var(λ)	2cov(δ,m)	2cov(δ,λ)	2cov(λ,m)
Czech Republic	-2.00	-0.29	1.36	-0.35	24.43	0.74	0.94	2.66	-0.37	-1.64	2.08
Tequila	-4.91	-2.55	0.34	-2.01	29.07	0.94	0.44	1.60	-0.90	-1.33	1.56
Asia	0.27	0.22	-0.23	-0.18	34.87	0.44	0.84	2.68	0.65	-0.55	1.76
Russia/Brazil	-0.55	-0.32	0.95	0.72	11.11	1.44	0.47	3.77	0.57	-4.06	0.04
Poland	-1.69	-0.69	-0.40	-0.99	26.34	2.10	1.48	2.87	-0.98	-3.31	2.29
Tequila	-4.81	-2.33	-0.60	-3.09	69.35	1.20	0.23	0.63	-0.56	-1.18	0.43
Asia	-4.04	-2.56	1.54	0.06	24.28	2.25	1.15	3.86	-2.02	-4.44	3.84
Russia/Brazil	-1.06	-0.47	0.72	0.13	16.62	7.95	2.21	10.59	-4.53	-16.27	8.02
Romania	1.88	2.39	0.45	-0.21	163.22	0.54	0.52	1.65	-0.23	-0.60	1.32
Tequila	3.30	5.93	1.88	-0.75	13.22	12.15	13.61	48.40	-18.99	-45.35	46.80
Asia	-7.29	-1.29	2.27	-3.73	226.39	0.46	0.50	1.04	0.45	0.64	1.19
Russia/Brazil	4.36	3.57	-0.96	-0.17	92.89	0.95	0.54	2.90	-0.98	-2.07	2.31
Weighted Average	0.37	1.13	0.33	-0.34	130.70	1.08	0.71	1.74	-0.37	-1.31	1.40
Tequila	-3.48	-0.55	0.81	-2.13	72.42	2.25	1.59	4.79	-1.40	-4.35	4.68
Asia	-3.84	-2.66	1.05	-0.13	139.78	1.11	0.54	1.56	-0.55	-1.28	1.46
Russia/Brazil	0.50	1.54	1.15	0.10	77.15	2.90	1.02	4.37	-1.60	-5.59	3.29

Notes: EMP= exchange market pressure, δ_t = change in domestic credit scaled by monetary base, m_t = percent growth in real money base (deflated by CPI), λ_t= EMP – δ_t + m_t= residual term (see text). All data are monthly. For time periods, including definitions of Tequila, Asia, and Russia/Brazil windows, and calculation of weighted averages, see Table 1.

Table 3. Bivariate Regressions of EMP with δ, m, λ

Explanatory Variable:	Supply (δ)		Demand (m)		Real Exchange Rate (λ)	
	Estimate	T-stat	Estimate	T-stat	Estimate	T-stat
Western Hemisphere						
Argentina	1.11	13.18	-0.98	-4.95	1.57	10.03
Bolivia	0.62	9.41	-0.45	-4.91	1.27	1.90
Brazil	0.92	68.03	0.69	1.84	-1.34	-2.23
Chile	0.47	8.93	0.05	0.71	1.01	17.43
Colombia	0.36	8.22	-0.08	-1.12	0.04	0.20
Costa Rica	0.73	17.91	-0.08	-1.29	0.01	0.14
Dominican Republic	1.63	57.77	-1.58	-6.64	2.20	41.01
Ecuador	0.58	15.13	-0.09	-1.27	1.42	15.40
El Salvador	0.26	1.72	-0.65	-5.48	0.97	20.13
Honduras	0.68	10.15	-0.47	-3.69	0.93	21.18
Mexico	0.70	16.05	0.00	-0.04	1.16	17.76
Paraguay	0.50	7.12	-0.17	-1.53	0.45	4.86
Peru	2.33	25.46	-2.98	-8.42	1.35	58.33
Uruguay	0.94	34.72	0.09	0.55	1.62	6.55
Venezuela	0.40	9.50	-0.70	-10.13	0.28	4.42
Jamaica	0.98	44.67	0.19	1.22	3.35	19.91
Asia						
Bangladesh	0.01	0.05	-0.30	-1.79	0.93	9.06
Sri Lanka	0.40	7.90	-0.26	-3.21	0.61	12.86
India	0.06	1.44	-0.14	-3.63	0.80	19.99
Indonesia	0.53	18.97	-0.38	-3.94	-0.09	-1.42
Korea	0.45	15.94	0.04	0.67	0.48	4.61
Malaysia	0.77	26.79	-0.05	-0.50	0.97	6.83
Pakistan	0.38	4.94	0.07	0.70	0.87	32.48
Philippines	0.37	7.28	-0.07	-0.81	0.43	4.46
Singapore	0.87	29.74	-0.39	-3.69	1.22	6.40
Thailand	0.71	24.02	-0.24	-2.90	0.38	2.42
Europe						
Greece	0.51	8.31	0.01	0.07	0.19	3.51
Malta	0.55	8.88	-0.06	-0.78	0.44	11.79
Turkey	1.11	25.51	0.02	0.15	0.79	13.38
Albania	0.95	15.00	0.07	0.10	0.14	0.37
Bulgaria	1.16	13.78	1.20	3.66	1.26	11.08
Czech Republic	0.15	1.15	-0.09	-0.82	0.30	5.12
Poland	0.35	6.55	-0.16	-2.13	0.02	0.42
Romania	0.63	4.56	0.04	0.24	0.42	5.48

Regression is: $EMP_t = a_0 + a_1 Z_t + error_t$, $Z_t = (\delta_t, m_t, \lambda_t)$. EMP= exchange market pressure, δ = change in domestic credit scaled by monetary base, m = percent growth in real money base (deflated by CPI), λ = EMP – δ – m = residual term (see text). All data are monthly.

Figure 1. Tequila Crisis Window
Exchange Market Pressure (EMP) and Domestic Credit Growth (δ)

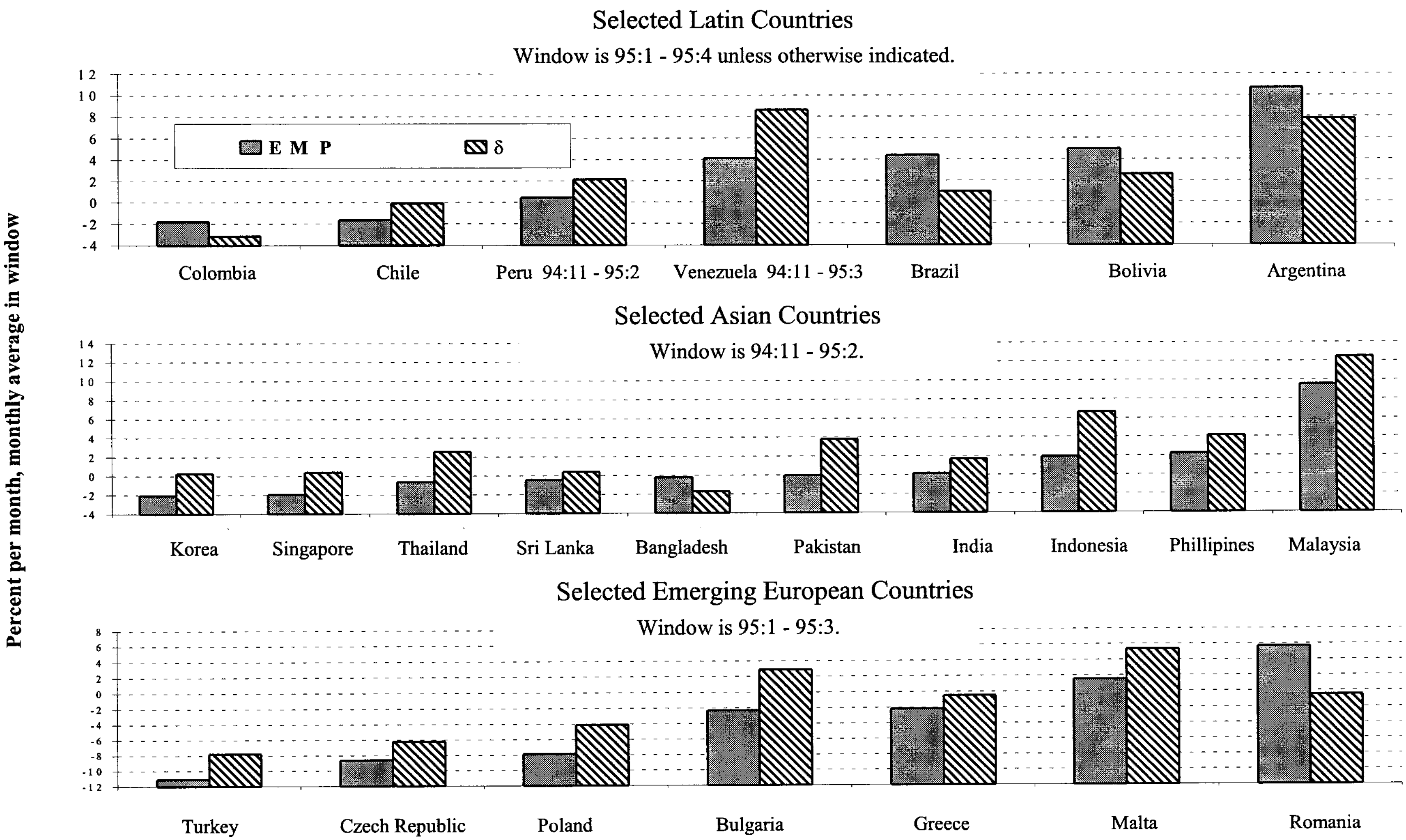


Figure 2. Asia Crisis Window
Exchange Market Pressure (EMP) and Domestic Credit Growth (δ)

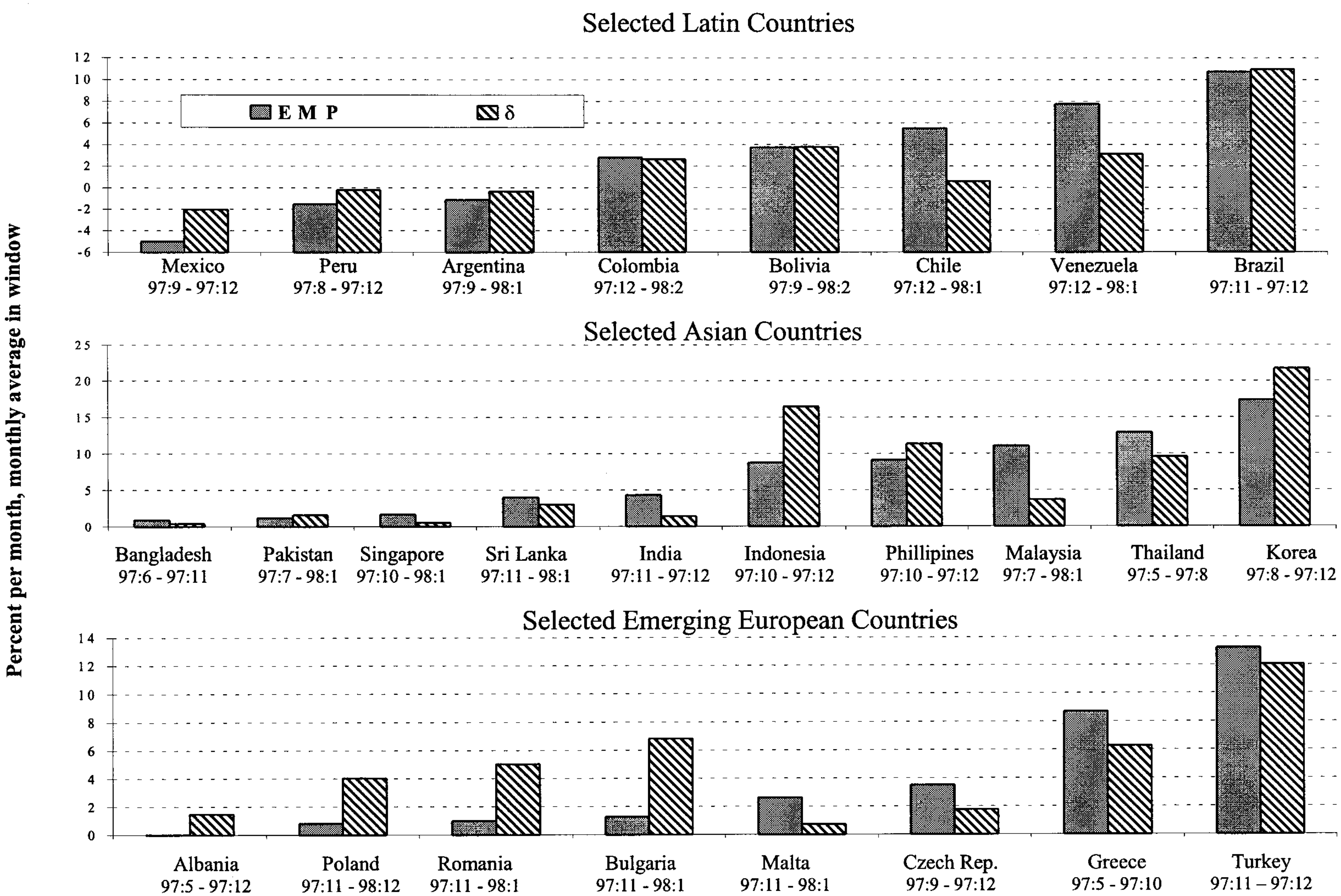


Figure 3. Russia Crisis Window
Exchange Market Pressure (EMP) and Domestic Credit Growth (δ)

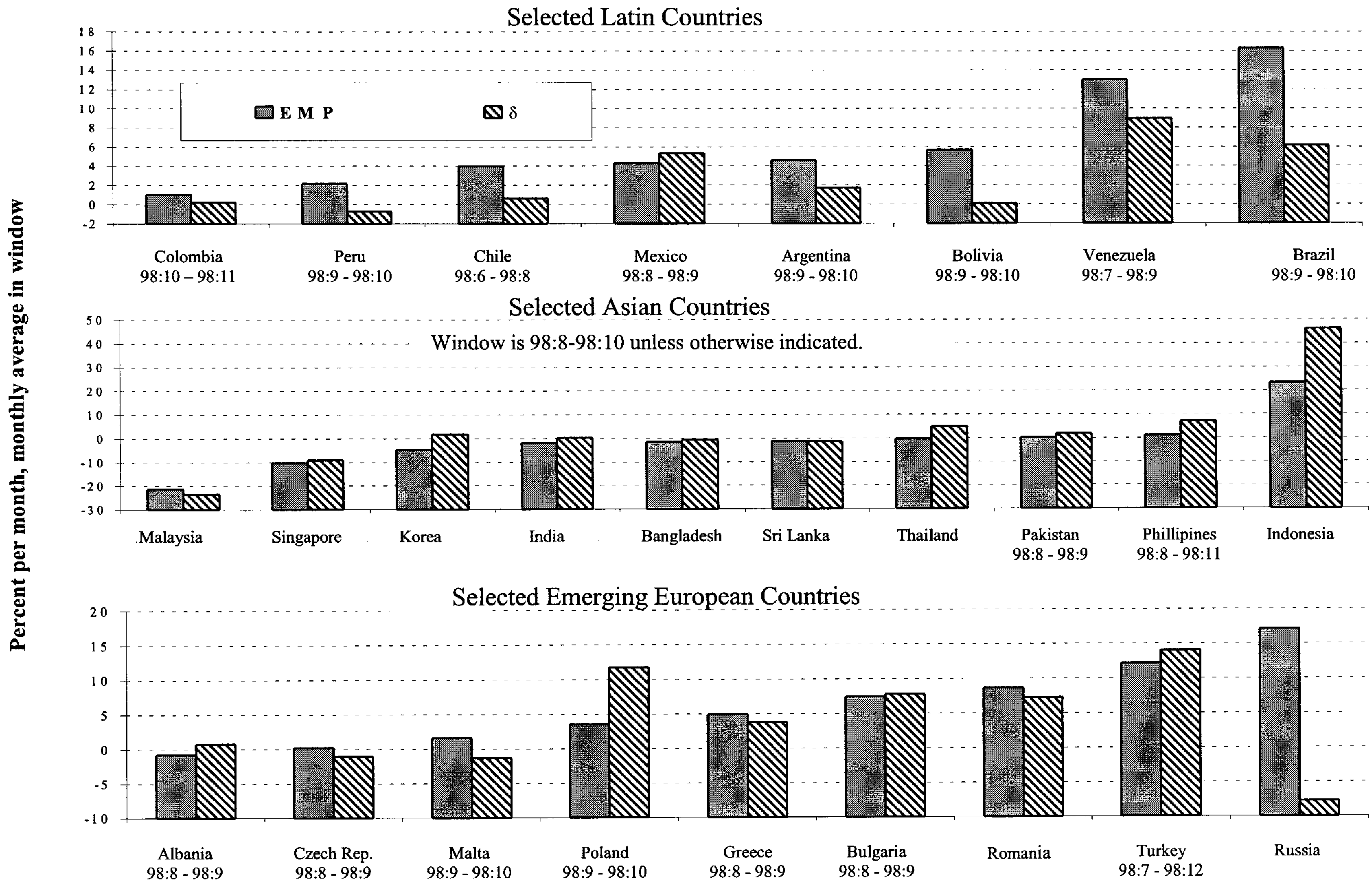
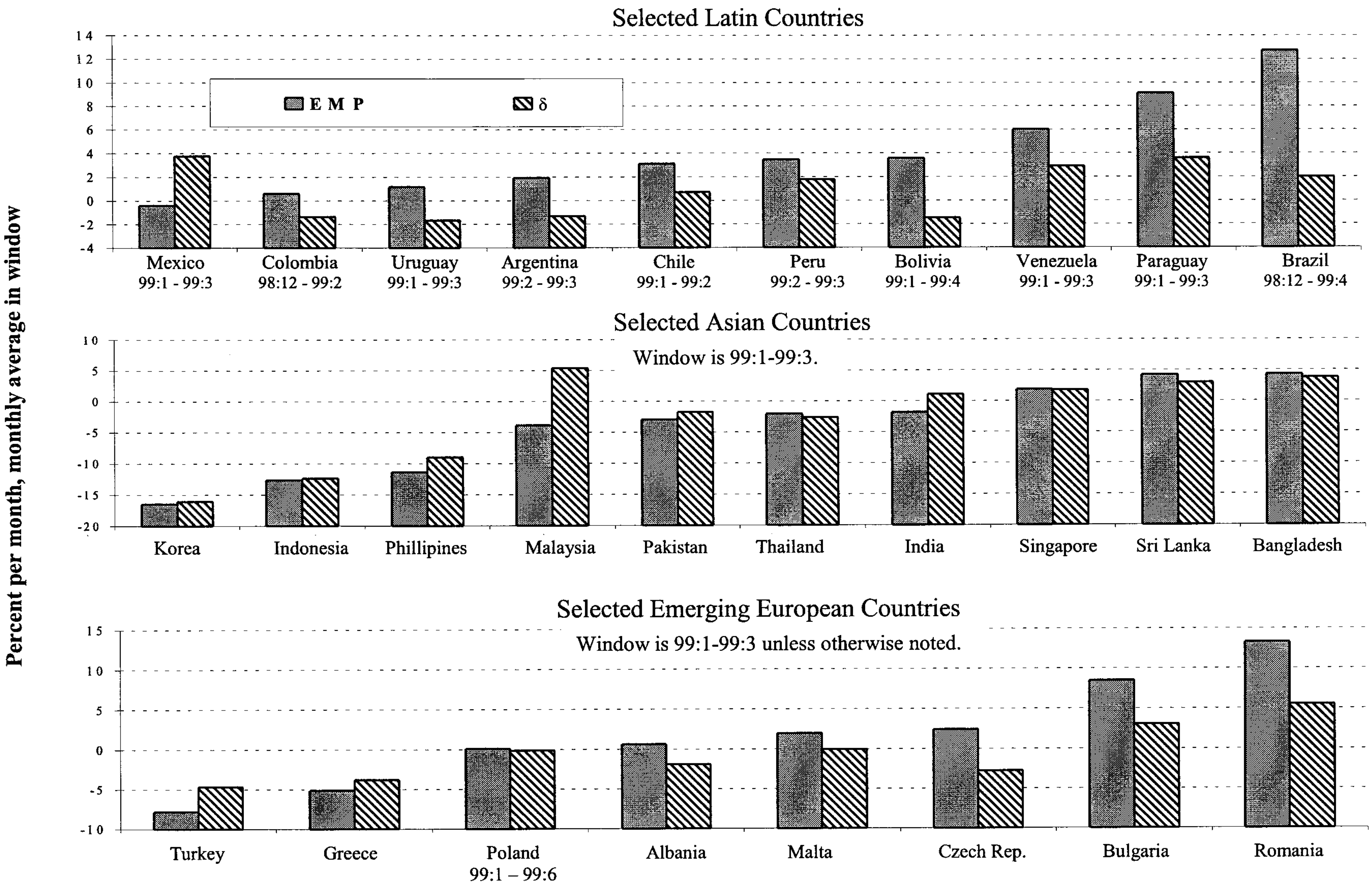


Figure 4. Brazil Crisis Window
Exchange Market Pressure (EMP) and Domestic Credit Growth (δ)



There are, however, some important cases where EMP appears somewhat higher or lower than the contemporaneous value of δ might otherwise indicate. For example, during the TS period, EMP was high in Romania despite a tight monetary policy. During the Asian window, in Chile, Venezuela, and Malaysia, EMP seems somewhat higher than (low) δ might otherwise suggest. To help explain Malaysia, controls on foreign capital and ceilings on domestic bank credit may play a role. [24] By contrast, EMP in Indonesia during this period is somewhat less than indicated by high δ during that period. And, three European countries, namely Poland, Romania, and Bulgaria substantially expanded domestic credit at this time while experiencing only modest EMP. Note also that, in Brazil, during the Russian window of late 1998 and the Brazilian window of early 1999, periods of loose fiscal policy, EMP is high despite low δ. Note however, that the central bank did not raise interest rates during this episode. Rather, money demand fell dramatically.

III. EMP and Monetary Policy: A Vector Autoregression (VAR) Analysis

The purpose of this section is to develop and test an empirical model that links EMP to monetary policy. Extending my previous work (Tanner (2001)), a vector autoregression (VAR) framework will be used.[25] The main question this model seeks to answer is whether monetary policy affects EMP in the "right" direction. That is, does tighter monetary policy reduces EMP? This question has recently received renewed theoretical attention. For example, several authors, including Flood and Jeanne (2000) and Lahiri and Végh (2000) suggest that defensive monetary policy may be ineffective or even counterproductive, since it implies a higher burden on the budget through higher interest payments.

An issue closely related to currency crises is sterilized intervention. As Flood and Marion (1998) note, within the context of a simple "modified first-generation model (of collapsing exchange rate regimes)...no fixed exchange rate regime can survive, even for a moment, if the monetary authority plans to sterilize an attack and those plans are understood by speculators." Accordingly, the model provides estimate the reaction of monetary policy to EMP shocks, including sterilization of reserve outflows by the central bank.

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[24] Malaysia placed limits on credits from the domestic banking system in mid-1997. However, external capital controls were imposed in September 1998 after most of the foreign capital had left. For details, see Boorman et. al. (2000).

[25] 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), and Bernanke and Mihov (1998).

A. Empirical Framework

To develop an empirical framework model, several preliminary issues must be addressed. One such issue is how to model monetary policy. Is the central bank's instrument an interest rate or a monetary aggregate? For the econometrician, which variable better captures the stance of monetary policy?

A compromise strategy that permits a role for both a monetary aggregate (δ) and the interest differential (ϕ) is developed below. Consider the vector autoregression (VAR) system:

$$X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2} + ... + v_t \tag{4}$$

where X = (δ, EMP, ϕ), is a vector of variables that includes scaled domestic credit growth (δ), exchange market pressure (EMP) and ϕ is the interest differential, a_i is a vector of coefficients, and $v_t = (v_\delta, v_E, v_\phi)$ is a vector of error terms.[26] A system like (4) permits testing for effects of past values of X on current values. Assumptions regarding the *contemporaneous* relationship between the variables in X, including the exogeneity of certain variables (like a policy variable), are easily incorporated into a system like (4). To do so, first note that each element of the error vector v_t is in turn composed of "own" error terms $w_t = (w_\delta, w_E, w_\phi)$ and contemporaneous correlations with "other" errors. That is:

$$v_\delta = w_\delta + \beta_{\delta E} w_E + \beta_{\delta\phi} w_\phi \tag{5a}$$

$$v_E = \beta_{E\delta} w_\delta + w_E + \beta_{E\phi} w_\phi \tag{5b}$$

$$v_\phi = \beta_{\phi\delta} w_\delta + \beta_{\phi E} w_E + w_\phi \tag{5c}$$

Thus, as mentioned above, contemporaneous relationships among variables in X are reflected in both the expected signs of and *a priori* (exogeneity) restrictions on the β coefficients.[27]

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[26] *Ceterus paribus*, the interest differential determines whether the marginal dollar is invested inside or outside the country. For those cases where ϕ is nonstationary in levels but stationary in first differences, it is entered instead as $\Delta\phi$.

[27] That is, the *ordering* of variables in a VAR is justified by certain assumptions. Also, the system will be just identified, thus permitting a simple Choleski decomposition to be used.

(continued)

As with any VAR system, exogeneity restrictions, an "ordering," must be chosen to reflect an underlying structural model. Of course, a common criticism of VAR's regards the choice of ordering. Orderings should not be chosen merely to obtain a desired result. Why is one ordering preferred to another? Such criticisms may confronted by clearly stating the assumptions behind the preferred ordering, but also providing results of alternative orderings.

Consider therefore the exogeneity restrictions for system (7a)–(7c) summarized by $\beta_{\delta E} = \beta_{\delta\phi} = \beta_{\delta\phi} = 0$, a Choleski ordering of δ, EMP, ϕ. This ordering permits a role for both monetary aggregate (δ) and an interest rate variable (ϕ) as the central bank's policy instrument, since the central banks' preferences regarding δ and ϕ in the current period are assumed to be contained in the shock terms w_δ and w_ϕ. This reflects a reality of policy in many central banks: both variables are instruments; even while a central bank sets an interest rate, it may also ration by quantity.

A feature of this ordering is that, while δ and ϕ are jointly determined, prices are assumed adjust to faster than quantities. Thus, current shocks to δ (w_δ) are assumed to affect ϕ immediately, but shocks to ϕ (w_ϕ) only affect δ with a lag. Likewise, current shocks to δ (w_δ) affect EMP immediately, but shocks to ϕ (w_ϕ) only affect EMP with a lag. Therefore, if monetary policy has a contemporaneous effect on EMP in the expected direction, $\beta_{E\delta} > 0$.

We may think of shocks to EMP (w_E) as exogenous changes in the willingness of international investors to keep their funds in the country. How might such a shock affect monetary policy and the interest differential? Consider first the demand for central bank lending by both the domestic banking system and the nonfinancial public sector, $w_\delta(d)$:

$$w_\delta(d)_t = (1\text{-}k)\, w_{Et} + a_1(v_{\phi t} - w_{\phi t}),\ a_1 < 0 \tag{6}$$

Demand is negatively related to the interest rate. Also, since current innovations in the interest rate w_ϕ are assumed to affect the quantity of credit only with a lag, the current demand for credit $w_\delta(d)_t$ depends on the noninnovation portion of interest rate movements, namely $v_{\phi t} - w_{\phi t}$.

In this context, a policy of central bank accommodation, or sterilized intervention, is easily analyzed. An external shock w_E causes a drain on banking system deposits. Under a fixed exchange rate regime, *with no change in the interest differential* ϕ, deposits likewise fall by w_E. The banking sector thus demands to borrow more. Assuming a required reserve ratio is

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Otherwise, a maximum-likelihood technique like that proposed by Bernanke (1986) would be required. And, alternative orderings, discussed below, yielded similar quantitative results.

k (0 < k < 1), no excess reserves prior to the shock, and ϕ constant, the central bank thus accommodates these additional demands (sterilizing outflows) with a liquidity injection of (1-k) w_E.[28]

Also, this framework permits an alternative interpretation of equation (5c): by inverting (6) and imposing equilibrium in credit markets ($w_{\delta t} = w_\delta(d)_t$), it is seen that current shocks to domestic credit (w_δ) and EMP (w_E) are assumed to affect the interest differential immediately.[29]

Interpreted thusly, the model has two additional implications. First, EMP shocks and the interest differential should be positively correlated, since $\beta_{\phi E} = -(1-k)/a_1 > 0$. This should not be surprising: higher exchange depreciation and/or lower reserves signals more risk for investors. Second, if the central bank loosens up credit, ϕ should fall: $\beta_{\phi\delta} = 1/a_1 < 0$.[30]

We may now summarize policy issues in terms of the parameters. First, does monetary policy positively affect EMP (tighter monetary policy reduces EMP) as expected? Regarding the monetary aggregate δ as the policy variable, for *contemporaneous* effects, if monetary policy works in the expected direction, $\beta_{E\delta}$ should be positive and significant.

Note also that lagged effects are contained in corresponding IRF's and F-tests (Granger causality) of δ on EMP in system (4). Regarding the interest differential ϕ, *lagged* effects are captured by corresponding IRF's and F-tests (Granger causality) of ϕ on EMP in system (6). If monetary policy works in the expected direction, these effects should be negative and significant. If by contrast an interest rate defense exacerbates financial fragilities or the quasi-

[28] A simple accounting example helps illustrate these points. Assume a fixed exchange rate and a legal minimum reserve requirement of 10 percent. Suppose further that deposits (and their cash counterpart) in the banking system drop by 100 units. Without any other change on the balance sheet, banks require a loan totaling 90 to maintain sufficient reserves. On the central banks balance sheet, the monetary base drops by 10 units. As a counterpart to the loan to banks, NDC increases by 90 units while NIR falls by 100 units.

[29] That is, as the interest rate rises, banks demand less funding from the central bank and the private sector is willing to hold more government paper. Note that domestic assets are assumed to be imperfect substitutes for U.S. dollar assets. Hence an increase in ϕ causes the marginal investor to keep her funds onshore.

[30] However, if a current expansion of credit signals a threat to the exchange rate regime *and this information is not captured entirely in v_E*,we would expect the opposite sign: $\beta_{\phi\delta} > 0$. Such an ambiguity about the sign of this coefficient reflects whether "liquidity effects" dominate "Fisher effects."

fiscal deficit (as mentioned by Flood and Jeanne (2000), Lahiri and Végh (2001), and others) the relationship between ϕ and EMP should be negative.[31]

Second, is monetary policy itself a function of EMP, as discussed above? Regarding the monetary aggregate δ, the reaction function is summarized by lagged IRF's and F-tests (Granger causality) of EMP on δ. Regarding the interest differential ϕ, the reaction function is summarized by lagged IRF's and F-tests (Granger causality) of EMP on ϕ.

B. Individual Country Estimates

VAR system (4) is estimated for 32 of the countries previously listed.[32] In Tables 4 and 5, results of exclusion tests (F-statistics) and impulse response functions (IRF's) are reported.[33] As a preview of results discussed in detail below, there is substantial evidence that changes in monetary policy have an impact on EMP. In most cases, the sign of the impact is consistent with traditional models: expansions of domestic credit (δ) increase EMP, while in most cases an increase in the interest differential (ϕ) reduces EMP. However, as noted below, there are a few cases in which ϕ and EMP are positively (rather than negatively) related to EMP. In any event, evidence regarding the relationship between δ and EMP is somewhat stronger than that relating ϕ and EMP. Regarding feedback mechanisms in the other direction (see Table 5), EMP helps explain δ and/or ϕ in about half the sample.

In Table 4, the evidence suggests that shocks to δ have a positive impact on EMP. According to the F-tests, the null hypothesis that lagged δ does not help explain EMP is rejected at the 90 percent level or better in 10 of the 32 countries.

However, evidence from the IRF regarding the contemporaneous relationship of w_δ and EMP $\beta_{E\delta}$ is stronger, and remarkably uniform across countries (and hence are not shown graphically). In all countries except two (Czech Republic and India), estimates of the contemporaneous IRF, $\beta_{E\delta}$ are positive and significant. In most cases, the IRF falls after the first lag. This finding is consistent with the bivariate regression estimates of EMP on δ, presented

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[31] As an empirical matter, fiscal policy is explicitly introduced later in the paper. Note also that these models incorporate an interest rate "Laffer Curve:" after some point, higher interest rates are counterproductive for defending the exchange rate, since the fiscal effect of higher interest rates (one that discourages foreign investors) dominates the supportive effects of increased holdings of international reserves by the central bank.

[32] Malta and Romania were omitted since they lacked interest rate data.

[33] The estimations were performed in the Regression Analysis of Time Series (RATS) package. For impulse response functions, standard errors and T-Statistics were computed using the method due to Kloek and Van Djik (1978).

Table 4. Summary, Impacts of Monetary Policy on EMP, Individual Country Estimates

System (4): $X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2} + \ldots + v_t, \quad X = (\delta, EMP, \Delta\phi)$

Country	Time	Effect of δ on EMP: F-Test	Effect of δ on EMP: IRF $\beta_{E\delta}$	Effect of δ on EMP: IRF Higher order	Effect of ϕ on EMP: F-Test	Effect of ϕ on EMP: IRF 1 lag	Effect of ϕ on EMP: IRF Higher order
Albania	96:1-00:4	2.58^{*}	1.43*a*		1.04	-0.27	
Argentina	91:4 -00:5	2.05^{*}	2.07*a*		0.15	0.44	
Bangladesh	92:7-00:4	2.2^{*}	1.83*a*	+(1)	1.32	0.18	
Bolivia	87:1-00:5	0.51	4.06*a*	+(3)	2.8^{*}	-0.17	-(2,3)
Brazil	94:8-00:5	0.65	4.83*a*		0.57	-0.02	
Bulgaria	94:1-00:4	12.53^{**}	11.49*a*		33.47	3.34	+(3,4); -(5)
Chile	78:9-00:4	0.4	0.81*a*		0.63	0.02	
Colombia	87:7-00:5	0.93	3.2*a*		0.3	0.04	
Costa Rica	91:1-00:5	1.25	3.47*a*		2.67	0.07	-(3)
Czech Rep	93:2-00:3	0.92	0.63	+(3)	1.34	-1.05*a*	
Dom. Rep.	96:1-00:2	1.48	1.16*a*		2.48	1.12*a*	
Ecuador	86:11-99:12	0.68	31.83*a*		9.48	-17.84*a*	
El Salvador	91:5-00:4	0.19	2.36*a*		3.16	0.62	-(3)
Guatemala	91:1-00:4	0.92	3.39*a*		0.06	0.06	
Honduras	85:5-00:3	1.44	9.53*a*		0.67	0.23	
India	92:1-00:4	0.43	-0.39		0.47	0.23	
Indonesia	90:1-00:2	2.23^{*}	8.63*a*		3.32	0.75	-(4)
Jamaica	90:1-00:2	0.39	5.9*a*		1.29	0.34	
Korea	90:1-00:2	3.58^{**}	6.82*a*	+(3)	1.81	-1.42	-(3)
Malaysia	90:1-00:2	0.44	7.95*a*	+(1)	0.13	-0.5	
Mexico	90:1-00:4	2.19^{*}	12.8*a*		1.44	-2.98*a*	
Pakistan	90:1-00:3	1.73	1.85*a*		2.58^{**}	0.94*a*	
Paraguay	90:4-00:3	2.07^{*}	5.14*a*	+(1)	2.93^{**}	-0.6	+(2)
Peru	92:1-00:4	2.84^{**}	6.27*a*		0.81	0.17	
Philippines	90:1-00:4	0.78	3.78*a*		2.87^{**}	-1.11	-(3)
Poland	91:1-00:3	0.15	2.52*a*		1.47	-0.24	
Singapore	90:1-00:4	0.38	4.08*a*		1.44	-0.51	-(4)
Sri Lanka	90:1-99:12	1.56	2.49*a*		2.4^{*}	0.52	-(4)
Thailand	90:1-00:4	10.65^{**}	4.22*a*	+(3,6),-(1,4,7)	2.49^{**}	-0.06	
Turkey	90:1-99:12	1.66	9.34*a*	+(1)	5.92^{**}	4.31*a*	
Uruguay	90:1-00:4	0.14	3.24*a*		0.98	0.45	
Venezuela	90:1-00:5	1.83	6.65*a*	+(2,3)	0.83	0.39	

Notes: F-test: *,** indicates significant F-statistic at 90, 95 percent levels, respectively; "*a*" indicates positive T-statistic of IRF in excess of |2.0|; Higher order: "+" / "-": positive, negative IRFs with T-statistics in excess of 2.0, lag length in parentheses. Example: +(2,4) indicates positive shocks with T-statistic > 2.0 at lags 2 and 4. EMP = Exchange market pressure; δ = change in domestic credit relative to money base; ϕ = interest differential.

Table 5. Summary, Impacts of EMP on Domestic Credit Growth (δ) and Interest Differential (ϕ) Individual Country Estimates

VAR System (4): $X_t = a_0 + a_1X_{t-1} + a_2X_{t-2} + \ldots + v_t$, $X = (\delta, EMP, \Delta\phi)$

Country	Time	Effect of EMP on δ		Effect of EMP on ϕ	
		F-Test	IRF	F-Test	IRF
Albania	96:1-00:4	1.03		4.73**	+(3)
Argentina	91:4 -00:5	1.02	+(2)	2.78**	-(2)
Bangladesh	92:7-00:4	3.79 **	+(1)	5.95**	+(2,3)
Bolivia	87:1-00:5	1.86	+(1)	1.18	
Brazil.	94:8-00:5	1.87	+(2)	3.35*	+(0,2,3)
Bulgaria	94:1-00:4	22.79 **	-(1,2,3)	0.52	-(4)
Chile	78:9-00:4	1.67	+(3)	1.44	-(0),+(1)
Colombia	87:7-00:5	0.28		2.29*	+(2)
Costa Rica	91:1-00:5	0.63		0.48	+(0)
Czech Republic	93:2-00:3	0.75		0.10	+(0)
Dominican Republic	96:1-00:2	0.88		1.86	
Ecuador	86:11-99:12	1.18		2.19*	+(0)
El Salvador	91:5-00:4	1.19		1.71	
Guatemala	91:1-00:4	1.12		0.07	
Honduras	85:5-00:3	1.10		4.03**	-(2), +(3)
India	92:1-00:4	1.74	+(1)	2.06*	+(4)
Indonesia	90:1-00:2	8.28 **	-(3)	0.76	
Jamaica	90:1-00:2	4.06 **	+(1,3)	2.64**	+(2,3,5,6)
Korea	90:1-00:2	6.87 **	+(1,2)	8.25**	+(1,2,4)
Malaysia	90:1-00:2	0.68		0.72	
Mexico	90:1-00:4	5.19 **	+(2)	5.91**	+(1,3)
Pakistan	90:1-00:3	3.11 **	+(4)	1.21	-(0)
Paraguay	90:4-00:3	5.09 **	+(1,2)	1.59	
Peru	92:1-00:4	2.34 *	+(4)	1.36	
Philippines	90:1-00:4	1.91		1.17	
Poland	91:1-00:3	3.84 **		0.77	
Singapore	90:1-00:4	1.66		3.37**	+(1)
Sri Lanka	90:1-99:12	1.06		2.72**	+(1)
Thailand	90:1-00:4	7.96 **	+(1,4,7),-(2,5,8)	2.92**	+(2)
Turkey	90:1-99:12	1.93	+(1)	5.31**	+(2)
Uruguay	90:1-00:4	2.05 *	+(1,3)	0.79	+(2)
Venezuela	90:1-00:5	1.32		3.12*	+(1,2)

Notes: F-test: *,** indicates significant F-statistic at 90, 95 percent levels, respectively; "*a*" indicates positive T-statistic of IRF in excess of |2.0|; Higher order: "+"/ "-": positive, negative IRFs with T-statistics in excess of 2.0, lag length in parentheses. Example: +(2,4) indicates positive shocks with T-statistic > 2.0 at lags 2 and 4. EMP = Exchange market pressure; δ = change in domestic credit relative to money base; ϕ = interest differential.

earlier. Moreover, in 6 of 32 countries, (including the Czech Republic) there is a lagged positive IRF of δ on EMP with a T-statistic that equals or exceeds $|2.0|$.

Evidence also indicates that interest differential shocks (w_{ϕ}) affect EMP. According to the F-tests, the null hypothesis that lagged ϕ does not help explain EMP is rejected at the 90 percent level or better in 13 of the 32 countries. Also, in 16 countries, there are IRFs whose T-statistics equal or exceed $|2.0|$. In most cases, these IRF's occur between the first and fourth lag.

As Figure 5 shows, while there is considerable cross-country variety in the IRF patterns between ϕ and EMP, the evidence indicates that, in most cases, shocks to ϕ have a negative impact on EMP, confirming the traditional view that tighter monetary policy should reduce EMP.[34] Note, however the IRFs indicate an unambiguously positive relationship in four cases (Dominican Republic, Pakistan, Paraguay, and Turkey) and an ambiguous relationship in one case (Bulgaria).

Table 5 provides evidence that, in a number of countries, shocks to EMP help explain monetary policy, possibly indicating sterilized intervention. According to the F-tests, the null hypothesis that lagged EMP does not help explain δ is rejected at the 90 percent level or better in 12 of the 32 countries. Also, in 17 countries, there are IRFs whose T-statistics equal or exceed 2.0. In most cases, these IRF's occur between the first and fourth lag. As Figure 6 shows, there once again considerable cross-country variety in the IRF patterns between EMP and δ, the evidence indicates that, in 14 of the 17 cases, shocks to EMP have a positive impact on δ, indicating sterilized intervention. For two cases (Bulgaria and Thailand) there were negative impacts for at least one period, but on the whole the evidence suggests that there is a positive relationship between shocks to EMP (w_E) and δ in these countries as well. Note also that in one case, Indonesia, the relationship is negative.[35]

Finally, Table 5 provides evidence for a number of countries regarding effects of EMP on the interest differential ϕ. According to the F-tests, the null hypothesis that lagged EMP does not help explain ϕ is rejected at the 90 percent level or better in 17 of the 32 countries. Also, in 23 countries, there are IRFs whose T-statistics equal or exceed $|2.0|$. In most cases, these IRF's occur between the first and fourth lag. As Figure 7 shows, there once again considerable cross-country variety in the IRF patterns between EMP and ϕ, the evidence indicates that, in 20 of the 23 cases, shocks to EMP have a positive impact on ϕ. This possibly indicates that, despite sterilized intervention, domestic interest rates must nonetheless rise in relation to world interest rates, reflecting additional exchange depreciation and risk. For one case (Honduras) there was a

[34] To conserve space, only those cases whose IRF with T-statistics that equal or exceed $|2.0|$ are presented graphically.

[35] This result for Indonesia is reversed if a somewhat different definition for domestic credit δ (gross rather than net credit) is used; see Tanner (2001).

Figure 5. Impulse Response Functions (IRF): Impacts of a One-Standard Deviation Shock to Lagged Interest Differential (w_{ϕ}) on Exchange Market Pressure (EMP)

(Lags, in months, indicated on horizontal axis)

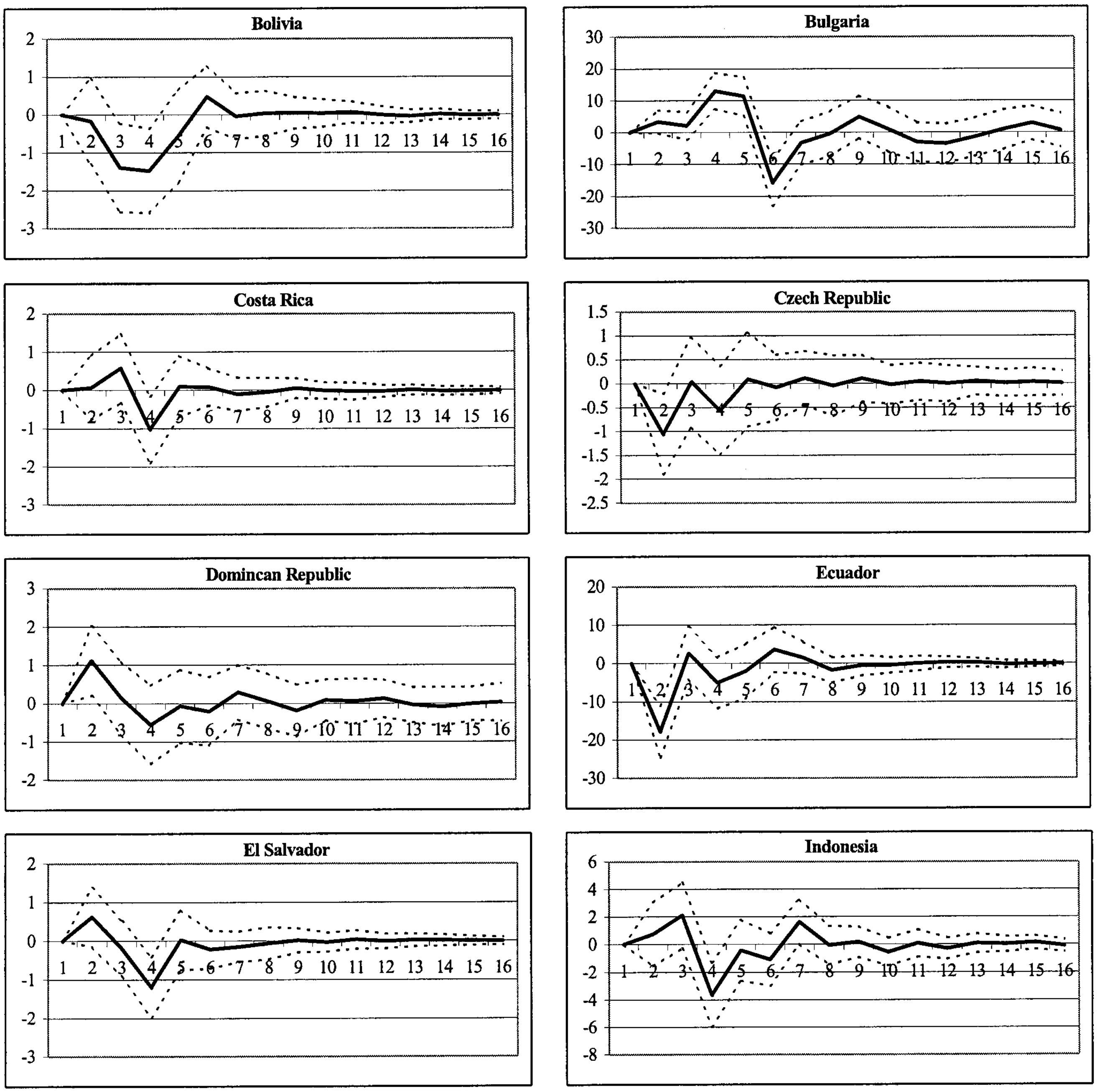


Figure 5 (continued). Impulse Response Functions (IRF): Impacts of a One-Standard Deviation Shock to Lagged Interest Differential (w_{ϕ}) on Exchange Market Pressure (EMP)

(Lags, in months, indicated on horizontal axis)

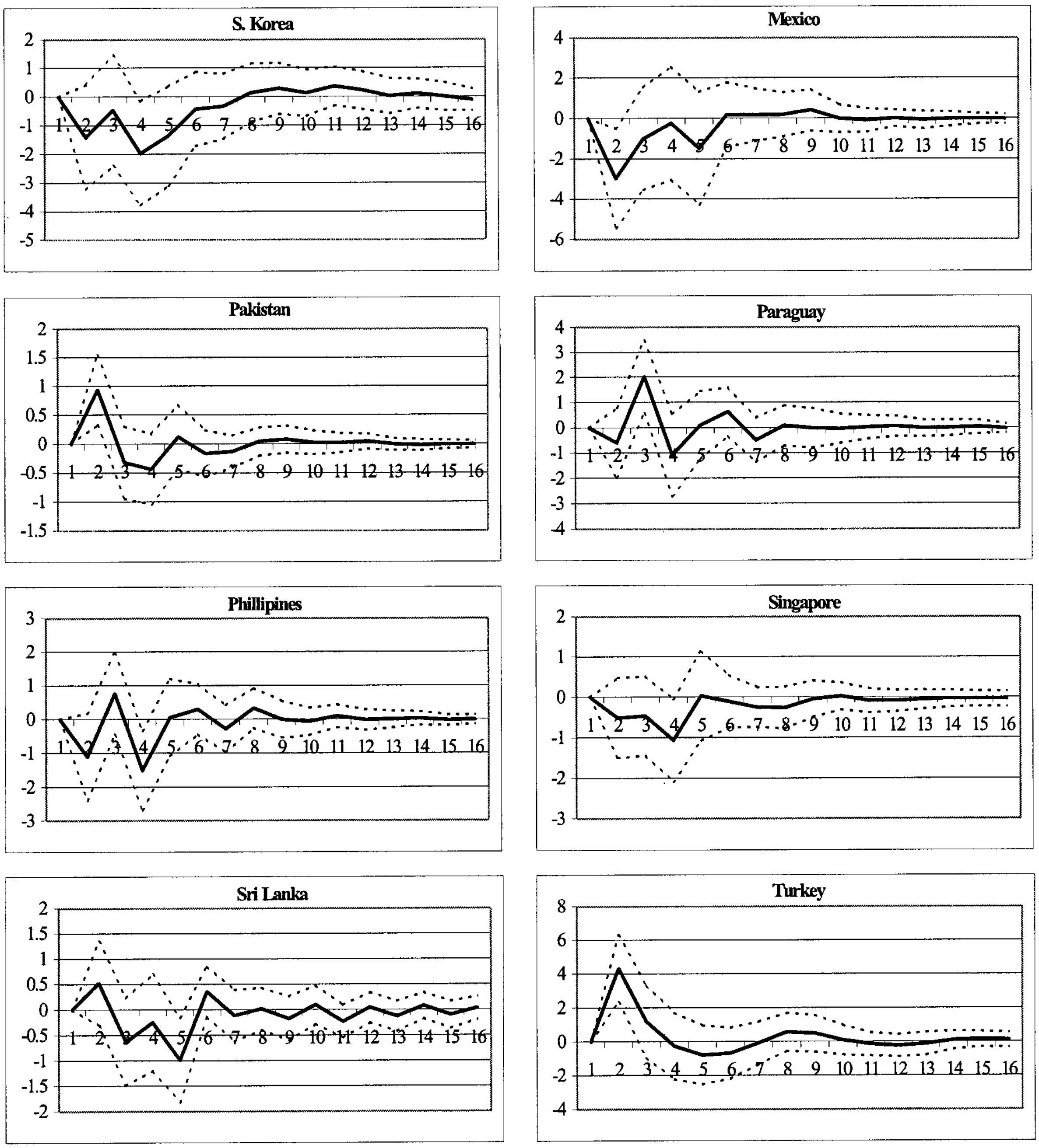


Figure 6. Impulse Response Functions (IRF): Impact of a One-Standard Deviation Shock to Lagged Shock to EMP (w_e) on Domestic Credit Creation (δ)

(Lags, in months, indicated on horizontal axis)

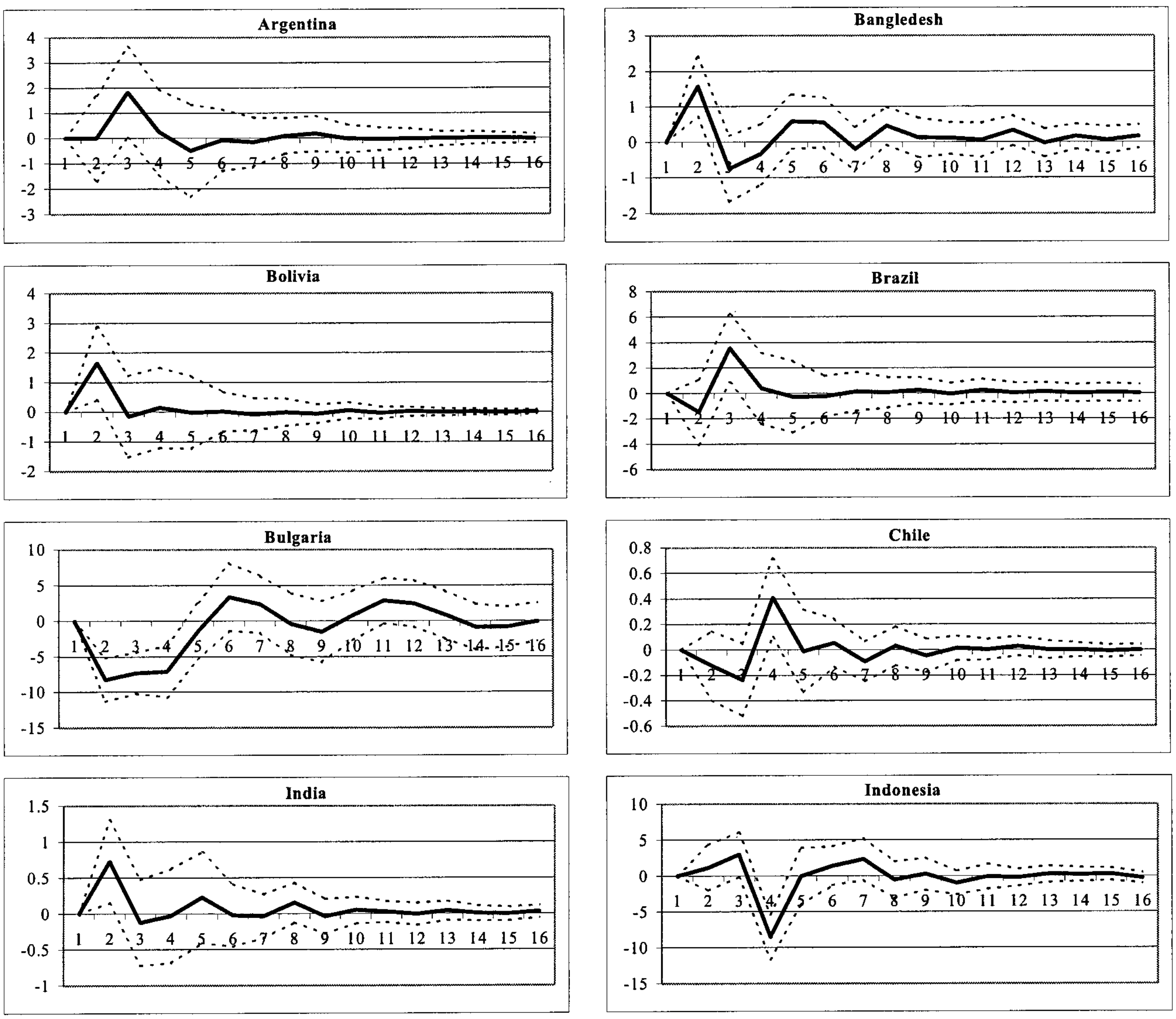


Figure 6 (continued). Impulse Response Functions (IRF): Impact of a One-Standard Deviation Shock to Lagged Shock to EMP (w_e) on Domestic Credit Creation (δ)

(Lags, in months, indicated on horizontal axis)

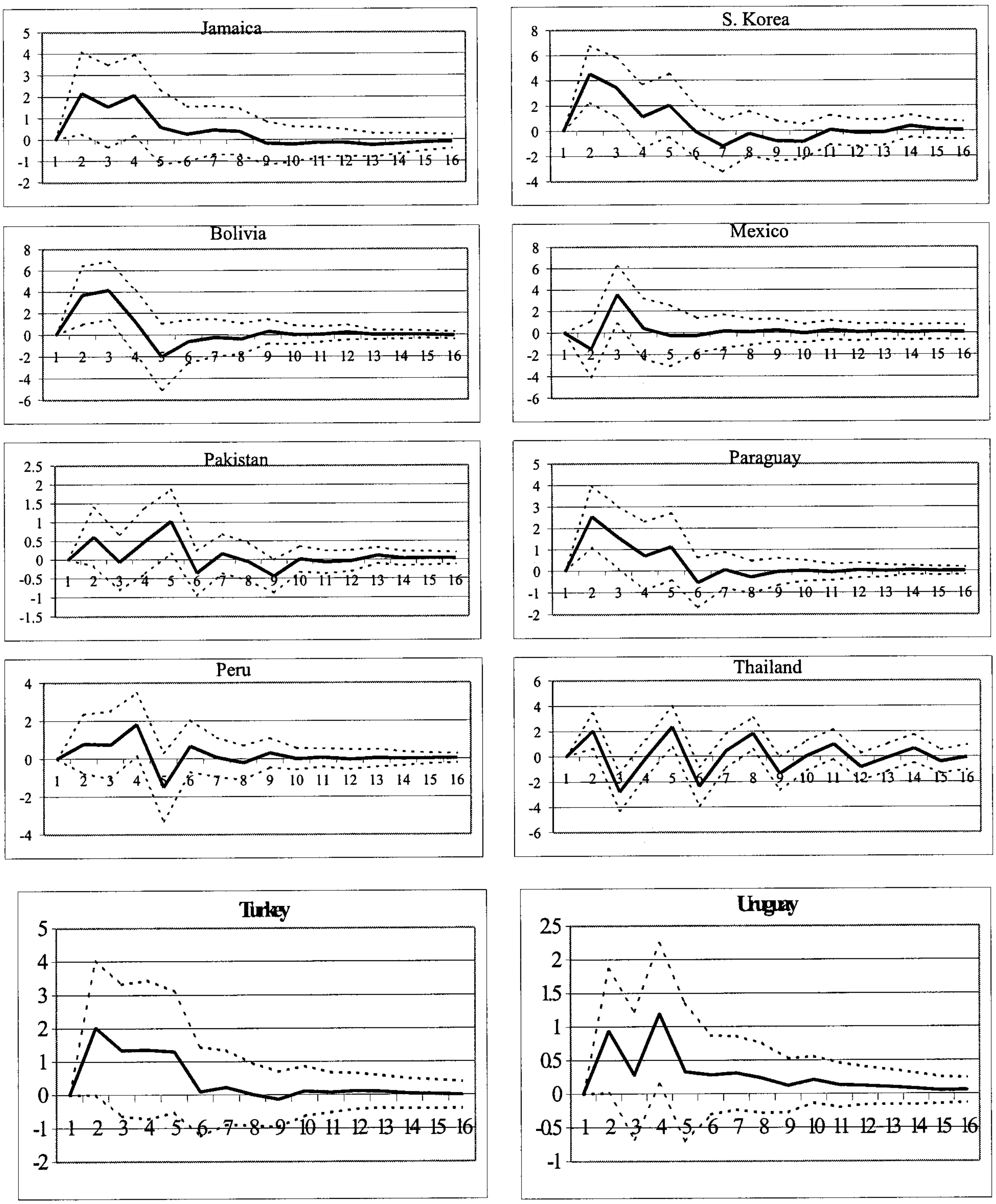


Figure 7. Impulse Response Functions (IRF): Impact of a One-Standard Deviation Shock to Lagged Shock to EMP (w_e) on the Interest Differential (ϕ)

(Lags, in months, indicated on horizontal axis)

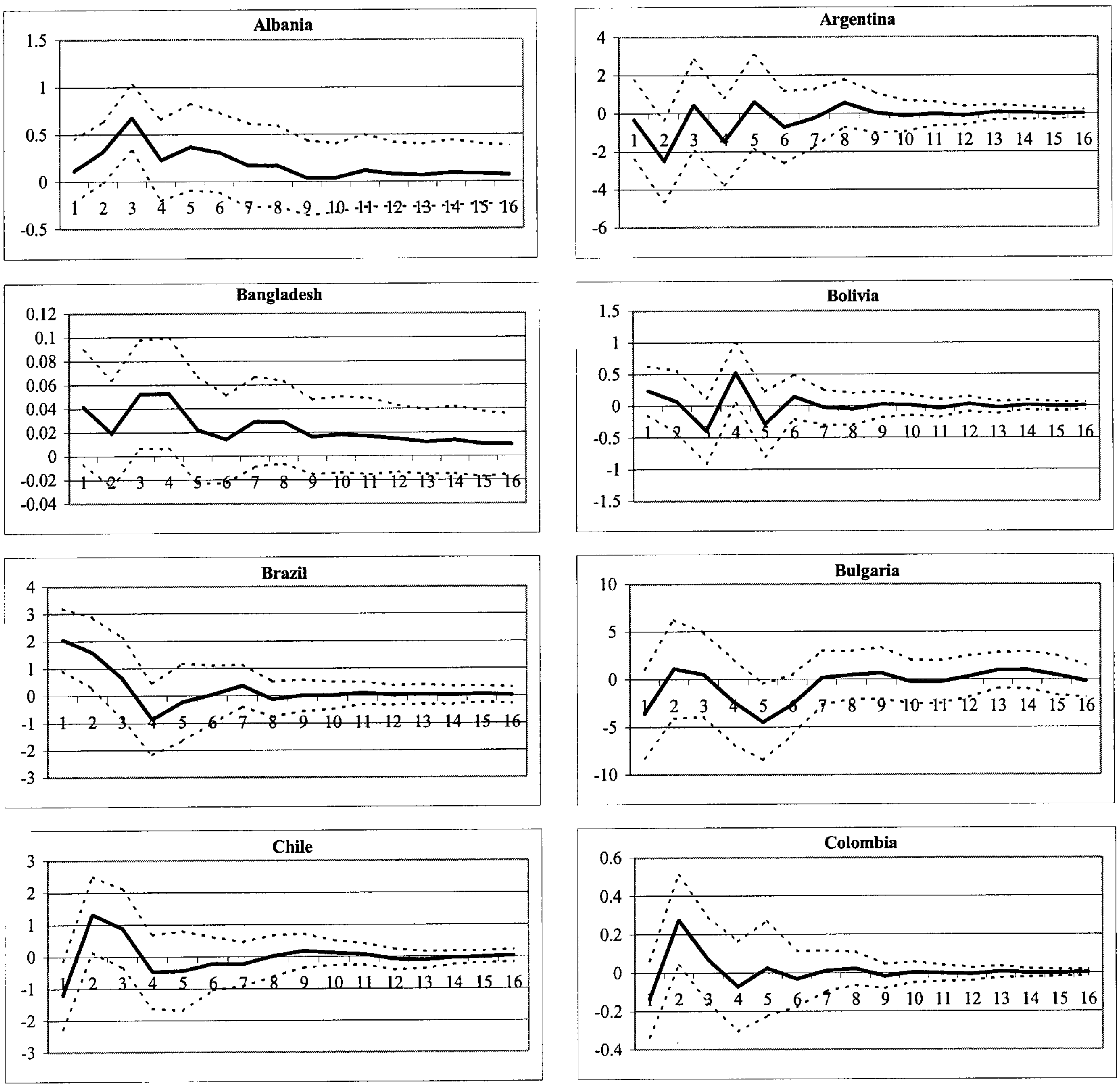


Figure 7 (continued). Impulse Response Functions (IRF): Impact of a One-Standard Deviation Shock to Lagged Shock to EMP (w_e) on the Interest Differential (ϕ)

(Lags, in months, indicated on horizontal axis)

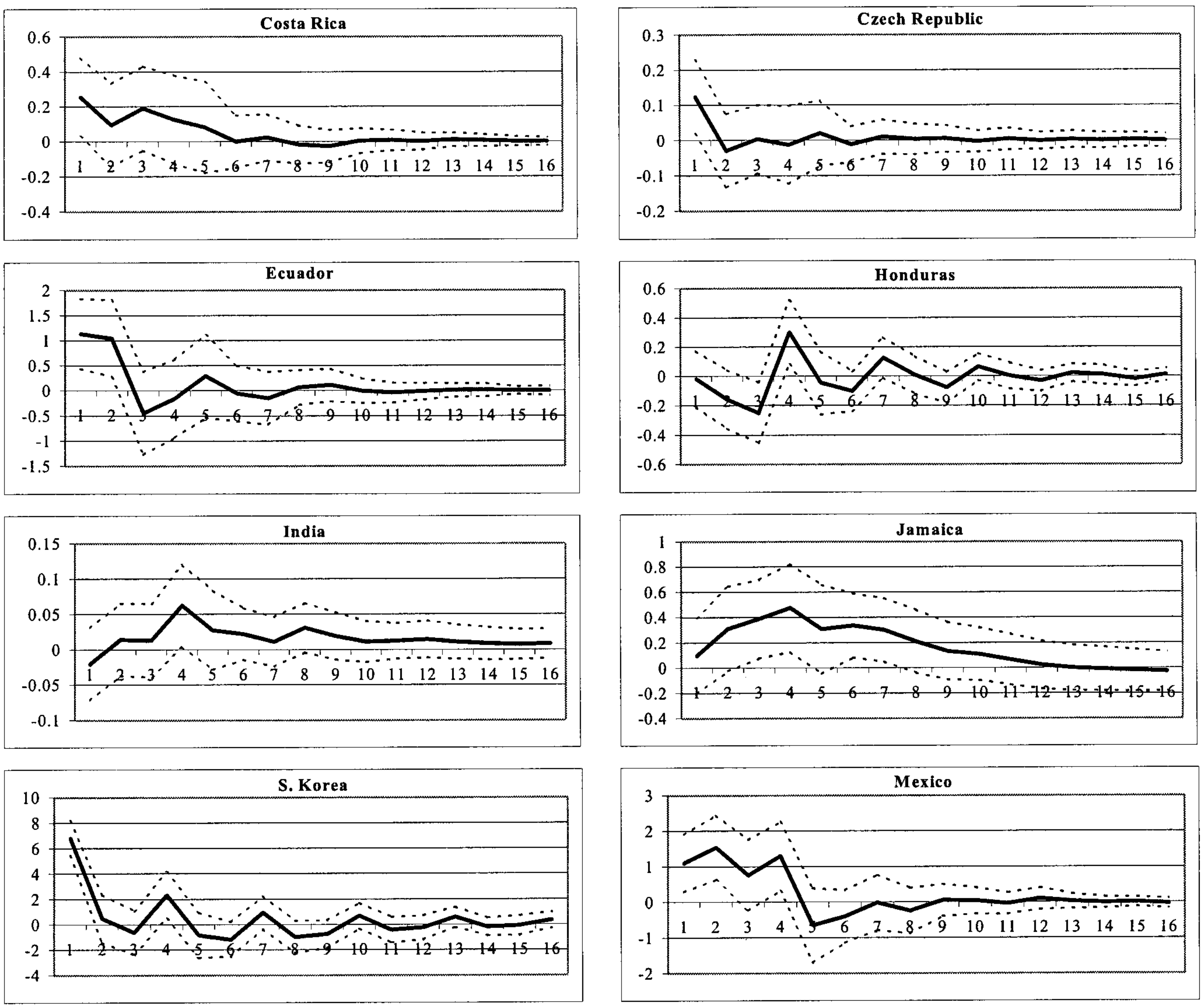
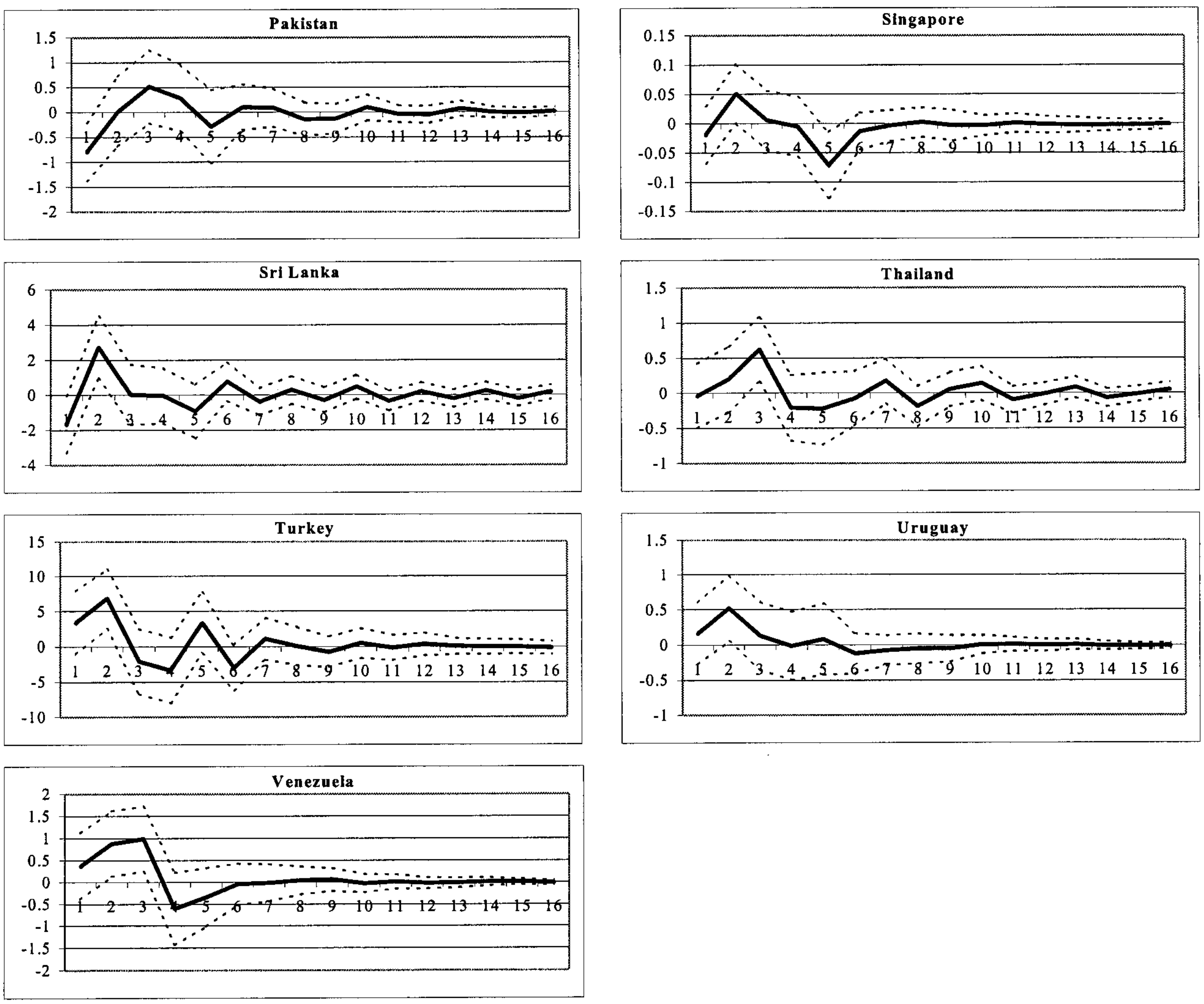


Figure 7 (continued). Impulse Response Functions (IRF): Impact of a One-Standard Deviation Shock to Lagged Shock to EMP (w_e) on the Interest Differential (ϕ)

(Lags, in months, indicated on horizontal axis)



negative impact for at least one period, but the impact was, on the whole, positive. Also, in two cases (Argentina and Bulgaria) the relationship is negative, suggesting that the central bank "smooths over" EMP shocks by reducing interest rates.

C. Pooled Estimates From a Recent Crisis Window

Structural parameters in (5a–5c) may vary over time. For example, as Flood and Garber (1984) note, parameters like these may differ between crisis and noncrisis periods.[36] One way to address such an estimation issue would be to use data only from certain crisis periods.[37] However, to obtain a sufficient number of data points, data from more than one country are generally required. The resulting *pooled* estimates, unlike individual country estimates, thus summarize the average relationships among the variables during crisis periods.

Table 6 presents pooled estimates using data from 1997:6 through 1998:5, a period that includes common shocks associated with the Asian, Russian, and Brazilian crises.[38] These results are broadly consistent with those from individual country estimates.[39] As before, monetary policy, when measured by δ, appears to impact EMP in the expected direction. The relevant F-statistic, 4.09, permits rejection of the null hypothesis that lagged δ does not help explain EMP. Moreover, T-statistics for the corresponding IRF exceed $|2.0|$ both contemporaneously and at higher orders. The estimate of $\beta_{E\delta}$ indicates that a one basis point increase in δ (w_d) boosts EMP by approximately eight basis points. However, evidence regarding the impact of ϕ on EMP is inconclusive. The relevant F-statistic, 0.26 does not permit rejection of the null hypothesis that lagged $\Delta\phi$ does not help explain EMP, and the T-statistic for the corresponding IRF never exceeds $|2.0|$.

Finally, despite cross-country heterogeneity in monetary policy reaction functions, evidence favors the proposition that, as a whole, countries engage in sterilized intervention. The relevant F-test, 5.38, indicates rejection of the null hypothesis that lagged EMP does not help explain δ,

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[36] Specifically, they show that *prior to* an exchange rate crisis, *but not after*, the forward premium (*FP*) is a linear function of domestic credit: $\partial FP/\partial\delta(D) > 0$ for $0 < D < D^*$, where D^* is the level of domestic credit that precipitates an exchange rate crisis. Note that in this context, the *implied* forward premium is $E\{[(1+i)/(1+i_{US}) - 1]$, where I and i_s are domestic and U.S. interest rates.Thus, for all D, $\partial\phi/\partial\delta = \partial FP/\partial\delta * (1+i_{US})/E$.

[37] And, some tests available from the authors reveal that, for some countries, parameter estimates do differ significantly differ between crisis and noncrisis periods.

[38] There are other potential ways to pool the data. For example, individual crises periods for all countries, in some cases reaching back to the 1970s, was also tried. Qualitatively, results (available from the author) were similar to those reported here.

[39] A similar result occurred in Tanner (2001), when data from six countries were pooled.

Table 6. Summary of Estimates, Vector Autoregression System (4)

$$(4)\quad X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2} + \ldots + v_t,\; X = (\delta, EMP, \Delta\phi)$$

Pooled Estimates, 1997:6–99:6 (*monthly data*)

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

Dependent Variable:	δ	*EMP*	$\Delta\phi$
F-Test, Exclusion of:			
Lagged δ	12.76	4.09	0.45
	(0.00)	(0.00)	(0.77)
Lagged *EMP*	5.38	1.86	1.96
	(0.00)	(0.12)	(0.10)
Lagged $\Delta\phi$	2.22	0.26	4.96
	(0.07)	(0.90)	(0.00)
R^2 Adjusted	0.07	0.02	0.01

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

	Responses of:					
	EMP		δ		$\Delta\phi$	
Shock to:	δ	$\Delta\phi$	*EMP*	$\Delta\phi$	*EMP*	δ
Period 0	8.12	-	-	-	0.31	0.38
	22.16	-	-	-	(2.79)	(3.28)
Period 1	-0.29	0.26	1.13	1.04	0.22	0.19
	(-0.71)	(0.52)	(2.29)	(2.07)	(2.07)	(1.81)
Period 2	-0.92	-0.31	1.81	0.83	0.18	0.12
	(-2.18)	(-0.68)	(3.92)	(1.67)	(1.68)	(1.05)
Period 3	0.65	-0.34	-1.36	-0.54	0.10	-0.02
	(1.59)	(-0.82)	(-2.76)	(-1.17)	(0.98)	(-0.15)
Period 4	-0.79	0.02	-0.11	-0.95	-0.25	-0.10
	(-1.98)	(0.04)	(-0.23)	(-1.88)	(-2.28)	(-0.84)
Period 5	-0.21	0.06	0.17	0.24	-0.03	0.02
	(-1.28)	(0.36)	(0.77)	(0.98)	(-0.57)	(0.45)
Period 6	0.31	-0.01	-0.26	0.23	0.03	-0.03
	(2.15)	(-0.06)	(-1.52)	(1.07)	(0.75)	(-0.86)

Notes: EMP = Exchange market pressure; δ = change in domestic credit relative to money base; ϕ = interest differential.

and the T-statistic for the corresponding IRF exceeds |2.0| both contemporaneously and at higher orders.

D. Sensitivity Analysis: Are Results Robust to Alternative Orderings?

In any VAR estimation, key results may depend on exogeneity assumptions (orderings). Thus, it is generally desirable to examine the robustness of the results to alternative orderings. Of course, theory may suggest that some orderings are less plausible than others. In the current context, the orderings that place EMP first ([EMP, δ, ϕ], [EMP,ϕ, δ]) are less plausible since they preclude the private sector from reacting to current information (unlike the public sector). Otherwise, orderings different from the preferred one are regarded as plausible. Table 7 summarizes results from all 6 orderings for 4 key issues: effects of δ on EMP, ϕ on EMP, EMP on δ and EMP on ϕ.

First, shocks to δ affect EMP positively in 30 countries, using either the preferred ordering or 2 of the 3 plausible alternative orderings. By contrast, under the remaining orderings (including the less plausible ones) δ affects EMP positively in 5–7 countries and negatively in 2–3 countries.

Second, results regarding the effect of shocks to ϕ on EMP are sensitive to the choice of ordering. As mentioned above, using the preferred ordering (δ, EMP, ϕ), as mentioned above, shocks to ϕ affected EMP negatively in 11 countries and positively in 5. However, under alternative orderings these numbers fluctuate, and under two orderings ([ϕ, EMP, δ], [ϕ, δ, EMP]) the effect of shocks to ϕ on EMP was positive in more cases than it was negative.

Fourth, the findings regarding the effect of EMP shocks on ϕ were robust. Under the preferred ordering (δ, EMP, ϕ) and the two orderings in which EMP occurs last ([δ, ϕ, EMP], [ϕ, δ, EMP]) shocks to EMP affected ϕ positively no less than 16 countries and negatively in no more than 3. For other orderings, including the implausible ones, these figures changed only slightly.

E. Sensitivity Analysis: Do Results Change When the Fiscal Balance is Included?

Another potential problem in the estimation and interpretation of (4) is the omission of a fiscal policy variable. As suggested above, expansionary monetary policy may reflect an underlying fiscal disequilibrium. Also, higher interest rates, by increasing the quasi-fiscal deficit, will increase total public liabilities. As several recent papers show, in certain cases contractionary monetary policy will increase EMP, rather than reduce it as the traditional analysis suggests.

Table 7. Sensitivity of Key Results to Alternative Orderings

	δ, EMP, ϕ	ϕ, EMP, δ	EMP, δ, ϕ	EMP, ϕ, δ	δ, ϕ, EMP	ϕ, δ, EMP
Impact of shocks to δ on EMP						
Positive	30	7	7	5	30	30
Negative	0	2	2	3	0	0
Impact of shocks to ϕ on EMP						
Positive/Ambiguous*	5	12	7	7	8	12
Negative	11	7	11	11	10	7
Impact of shocks to EMP on δ						
Positive	18	31	31	31	19	19
Negative	1	0	0	0	1	1
Impact of shocks to EMP on ϕ						
Positive	16	12	15	15	16	17
Negative	3	2	2	1	2	1

*As mentioned in the text, the case of Bulgaria exhibits a complex pattern.

A complete analysis of these and related issues is not possible in this paper. However, as a sensitivity analysis, a simple extension the work above is proposed. Where available, a fiscal surplus variable, SUR, is added to the vector X and system (4) is accordingly reestimated for a subset of 17 countries.[40] These estimates provide insights on two key questions.[41] First, are the previous results sensitive to the inclusion or exclusion of the fiscal surplus (SUR)? Might the previous conclusions change substantially if SUR is also included in the vector of variables? Second, what do these estimates reveal about the impact of SUR on EMP? Are impact estimates of the impact of SUR on EMP, β_{ES}, positive or negative? Note that such a relationship is theoretically ambiguous sign. On the one hand, according to simple Keynesian models, expansionary fiscal policy should place upward pressure on both the currency's value and domestic interest rates, while also stimulating capital inflows. In this case, we would expect a *positive* relationship between SUR and EMP. However, an increase in the deficit (that is, a reduction in SUR) may indicate additional risk and inflation. In this case, we would expect a *negative* relationship between SUR and EMP.

[40] To maintain cross-country comparability, these estimates include only those countries for which monthly estimates of the general government surplus SUR are available from the IFS database.

[41] Of course, system (4) may reveal other feedback relationships between fiscal policy, monetary policy, and interest rates. Such an analysis, however, is left for future research.

Thus, impacts of SUR, δ, and ϕ on EMP, from a modified version of system (4), are presented in Table 8. With some exceptions, estimates suggest that the previous conclusions relating monetary policy to EMP are largely unchanged when SUR is added to the vector. The sign and magnitude of the estimated relationship between the monetary variables (δ, ϕ) and EMP appear to be, on the whole, insensitive to the inclusion of SUR.

In no case did the addition of SUR yield a significant relationship between the monetary variables and EMP where none existed before. However, in several cases, the inclusion SUR does weaken previous conclusions. For Bolivia, Korea, and Mexico, the impact of $\Delta\phi$ on EMP, significant in the previous estimates, are no longer so.

In five cases there appears to be a significant relationship between SUR and EMP. In the case of Bolivia, Guatemala, and Honduras, his relationship is positive ($\beta_{ES} > 0$), suggesting that, in these countries, expansionary fiscal policy helped to both appreciate the country's currency and stimulate capital inflows. By contrast, for Peru and Singapore, this relationship is negative ($\beta_{ES} < 0$). In these countries, an increase in the deficit appears to signal additional risk and inflation to investors, thus boosting exchange depreciation and capital outflows.

IV. Summary, Conclusions, and Policy Implications

Recently, as less developed countries have participated more in world capital markets, they have also suffered currency crises more frequently. While currency crises are not new, they are more complex than before. Their changing nature is reflected in both theoretical and empirical work on the topic. On the theoretical front, the initial "first generation" of currency crisis models placed monetary policy at the center of the stage to explain currency crises (see Flood and Marion (1998)). Initially, most empirical work also emphasized the role of monetary policy at or around the time of the crisis.

However, currency crises of the mid- to late-1990's, specifically those in Mexico, Asia, and Russia, did not appear to conform to the previous paradigm. Instead, issues like financial system soundness and shocks from world capital markets became more important than previously. Monetary policy, often dictated by fiscal financing needs, was now also determined by these newer factors, as well as broader aspects of the domestic macroeconomic picture. In theoretical work, more recent generations of currency crisis models in many cases removed monetary policy from its central role. Empirical work on crises also de-emphasized the role of monetary policy at or around the crisis time, looking instead for a broader set of explanatory variables that might forecast crises over a medium term (from one to two years).

However, several factors have stimulated a renewed interest in the role of monetary policy at or around the time of the crisis. For example, there are differing views as to how much the recent crises actually differed from the traditional "first generation" crisis model. Regarding the Asian

Table 8. Summary, Impacts of Fiscal and Monetary Policy on EMP, Individual Country Estimates Modified System (4): $X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2} + ... + v_t$, $X = (SUR, \delta, EMP, \Delta\phi)$

Country	Time	Effect of SUR on EMP			Effect of δ on EMP			Effect of ϕ on EMP		
		F-Test	IRF		F-Test	IRF		F-Test	IRF	
			β_{ES}	*Higher order*		$\beta_{E\delta}$	*Higher order*		*1 lag*	*Higher order*
Bolivia	93:1-00:3	3.03**	1.71 *a*	-(1)	1.05	3.24*a*		0.40	0.22	
Brazil	94:8-00:5	0.86	-0.81		0.79	4.58*a*	+(1)	0.61	-0.02	
Colombia	87:7-00:5	1.15	-0.40		1.05	3.56*a*		0.44	0.12	
Costa Rica	91:1-00:5	0.47	-0.15		1.02	3.36*a*		2.51**	0.13	-(3)
Czech Rep.	93:2-00:3	1.73	-0.11		1.64	0.83	+(3)	0.85	-0.81	
Ecuador	90:1-99:12	0.96	-1.59		0.83	31.50*a*		9.74**	-17.55*a*	
El Salvador	91:5-00:4	0.11	0.03		0.12	2.45*a*		0.59**	0.59	-(4)
Guatemala	91:1-00:4	0.62	5.25*a*		0.94	2.80*a*		0.05	0.01	
Honduras	90:1-99:11	0.13	4.09*a*		1.48	9.47*a*		0.73	0.09	
Korea	90:1-00:2	2.13*	0.66	+(3)	4.91**	6.52*a*	+(3)	1.72	-1.075	
Mexico	90:1-99:9	0.24	-0.42		2.05*	13.88*a*		1.12	-2.68	
Peru	92:1-00:4	2.27**	-3.53*b*		2.90**	4.83*a*		0.54	0.21	
Philippines	90:1-00:4	0.99	0.60		0.73	3.70*a*		2.55**	-1.15	-(3)
Singapore	90:1-00:4	4.55**	-1.37*b*		0.58	3.32*a*		0.41	-0.34	
Thailand	90:1-00:4	2.12**	-0.61	+(2),-(4)	9.39**	4.14*a*	-(1),+(2,3),-(4)	3.32**	0.17	-(1)
Uruguay	90:1-00:3	0.35	0.32		0.13	3.51*a*		0.82	0.51	
Venezuela	90:1-00:5	1.04	0.82	-(4)	1.55	6.61*a*		0.83	0.23	

Notes: F-test: *,** indicates significant F-statistic at 90, 95 percent levels, respectively; Lowest order IRF: "*a*" indicates positive T-statistic of IRF in excess of |2.0|; "*b*" indicates negative T-statistic of IRF in excess of |2.0|; Higher order: "+"/"-": positive, negative IRFs with T-statistics in excess of |2.0|, lag length in parentheses. Example: +(2,4) indicates positive shocks with T-statistic > 2.0 at lags 2 and 4. SUR = real budget surplus; EMP = Exchange market pressure; δ = change in domestic credit relative to money base; ϕ = interest differential.

countries, there was also a debate as to whether the stance of monetary policy was "too tight" or "too loose." Some observers questioned whether tight monetary policy was effective in achieving one of its stated, narrow goals, namely to defend the currency. Several authors have suggested that monetary policy might be ineffective in this regard, overshadowed by issues of intertemporal public sector solvency.

As an extension of a previous paper by myself (Tanner (2001)), this one has attempted to reexamine currency crises in emerging markets, including some recent episodes, in a more traditional way, by emphasizing the role of monetary policy at or around the time of the crisis. Did monetary policy, however measured, play an important role? Did a tightening or loosening of monetary policy have the expected effect on exchange markets?

To address such questions, some preliminary issues needed to be tackled first. To measure the severity of crises under different exchange rate regimes, the paper defined exchange market pressure (EMP) as the sum of reserve losses scaled by base money plus exchange rate depreciation (higher EMP implies a more severe crisis). The paper proposed tow two indicators of monetary policy stance. The change in domestic credit scaled by the monetary base (δ) is a traditional measure used in early literature on the monetary approach of the balance of payments, while the change in the interest differential ($\Delta\phi$) is the relevant decision variable for the marginal investor in an open economy.

The paper has several messages. First, as the decompositions and figures in Part II show, while the factors causing currency crises have become ever more complex in recent years, monetary policy nonetheless remains important. In most countries, a substantially greater percentage of the variance of EMP typically corresponded to variance in δ than by the variances of either real money demand or real exchange rates. And, in virtually every country considered, there was a positive, significant, contemporaneous relationship between the domestic money supply variable (δ) and EMP.

Second, more often than not, monetary policy affects EMP in the direction predicted by traditional approaches. According to vector autoregression (VAR) estimates (a method commonly used to study the effects of monetary policy), both country-by-country and pooled, shocks to the domestic money supply variable money supply (δ) almost universally have a positive impact on EMP. That is, when the central bank chooses to reduce the domestic money supply, some combination of reserve inflows or currency appreciation occurs.

Evidence regarding the interest differential $\Delta\phi$ and EMP was more tentative (and more sensitive to ordering). Here, individual country estimates yielded stronger evidence than did the pooled estimates. There appears to be a relationship between $\Delta\phi$ and EMP in just under half of the 32 countries examined. Of these countries, shocks to $\Delta\phi$ had a negative impact to EMP in all but three. That is, tighter monetary policy, when measured in this way, also helped to strengthen the currency. Of course, these three countries (Dominican Republic, Paraguay, and Turkey) may provide the basis for further research on the topic. However, the pooled estimate presented in the paper did not yield a significant relationship.

Also, the paper provides evidence that feedback from EMP to monetary policy not uncommon. Specifically, evidence of sterilized intervention, characterized here as a positive impacts of EMP on δ, is present in over half of the individual country estimates and in the pooled estimates as well.

These results do *not* mean that "only monetary policy matters." We cannot forget other factors and focus exclusively on monetary policy. Rather, the approach in this paper should be regarded as a supplement to other, broader empirical work on currency crises. For example, while this paper has addressed the question of how monetary policy is determined, it has done so only in a very narrow way.

Much evidence suggests that many of the broader factors that explain currency crises—financial sector soundness, the fiscal balance, unemployment, the real exchange rate, and so on—also constrain monetary policy decisions. Here the Asian countries provided a good example: weaknesses in the banking sector prevented central banks from raising interest rates, thus leading to sterilized intervention and ultimately exchange rate crises.

Nor does this paper say that central banks should, at all costs, defend the exchange rate regime by tightening monetary policy. (On this point, see Lahiri and Végh (2001)). In some cases, an exchange rate peg should be abandoned, since doing so might be increase welfare for a country's residents.

Instead, this paper confirms an important, if simple and conventional message: monetary policy can be a powerful tool to defend a currency, provided that it is free to do so. However, when constrained by other factors, expansionary monetary policy has been the culprit behind many recent episodes of exchange market turbulence.

Decomposition of Exchange Market Pressure

In this appendix, EMP is shown to contain three elements, namely a money demand element, a money supply element, and a residual term that includes changes in both the bilateral real exchange rate and foreign (U.S.) inflation.[42] On the demand side, the growth of real base money (m_t) is:

$$m_t = \mu_t - \pi_t \tag{A.1}$$

where $\mu = \Delta M/M$ is the growth of nominal (base) money and π is the inflation rate ($\Delta P/P$, where P is the domestic price level).[18] The inflation rate is linked to world inflation π_t^* through the rate of nominal depreciation ε:

$$\varepsilon_t = \pi_t - \pi_t^* + z_t \tag{A.2}$$

where z_t is the deviation from (bilateral) purchasing power parity. On the money supply side, the two components of nominal base money are international reserves and net domestic credit. That is,

$$\mu_t = r_t + \delta_t \tag{A.3}$$

where δ_t is the change in net domestic credit scaled by the monetary base ($\Delta NDA/MB$). Combining (4), (5), and (6), and rearranging, EMP is expressed as:

$$EMP_t \equiv \delta_t - m_t + \lambda_t \tag{A.4}$$

where $\lambda_t = \pi_t^* + z_t$ may be thought of as a residual term that includes real exchange rate changes.

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[42] For simplicity, the model is expressed in continuous time. A discrete time formulation is somewhat more complicated. Also, the model may be easily expressed in terms of a trade-weighted or effective exchange rate.

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