

Real appreciation and exchange rate predictability in a sample of developing countries

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Abstract

We argue that real exchange rate appreciations can be costly because they raise uncertainty about the future path of the real exchange rate. The result is driven by the existence of multiple types of policymakers with differing costs of exchange rate intervention and by uncertainty about the type of next period's policymaker. We illustrate the result in a simple model with two types of policymakers who rotate in office stochastically: one who follows an S_s rule and the other an automaton who never intervenes. We then empirically test whether higher real exchange rates are less predictable using a dynamic panel model that allows for cross-sectional dependence and conditional heteroskedasticity and data from 14 developing countries from 1979 - 2002. We find strong evidence that real appreciation raises the conditional variance of the real exchange rate.

I. Introduction

Exchange rate management is one of the major challenges facing developing countries and is the subject of a large amount of research attention. The issue is complicated in that successful control of the nominal exchange rate is not always sufficient to control the real exchange rate, which more directly impacts economic activity and welfare. We know that developing countries are loath to float (Calvo & Reinhart (2002)), that pegging countries frequently experience real appreciations (Flood & Marion (1997)) and that real appreciations are generally reversed by nominal devaluations (Goldfajn & Valdés (1999)). In this paper, we argue that, in addition to the traditional costs of real exchange rate appreciation, such as the erosion of export competitiveness or increased unemployment, appreciation can also be costly because it raises uncertainty about the future path of the real exchange rate, which may itself adversely affect economic growth.¹

While our primary aim in this paper is empirical, in order to better illustrate our argument, we also present a model based on Ball (1992) and Flood & Marion (1997) that predicts a positive relationship between real appreciation and uncertainty about the future path of the real exchange rate. The intuition is straightforward. Consider a polity where, in the absence of policymaker intervention, the real exchange rate evolves stochastically and can potentially create economic costs. If there are at least two types of policymakers who face different costs of intervening, then uncertainty about the type of the policymaker can affect uncertainty about the future course of the real exchange rate. In particular, when the real exchange rate is not generating significant economic costs, no type of policymaker would have an incentive to intervene. Thus there would be no uncertainty about next period's real exchange rate arising from uncertainty about the type of next period's policymaker. However, as the real exchange rate appreciates and generates greater costs, some types of

policymakers will have an incentive to intervene and reset the real exchange rate, while other types will not. In this case, uncertainty over the type of next period's policymaker will generate increased uncertainty about next period's real exchange rate.

We test the hypothesis that real appreciations raise uncertainty about subsequent values of the real exchange rate in a panel of 14 emerging economies (Argentina, Brazil, Chile, Colombia, Hong Kong, Indonesia, Korea, Malaysia, Mexico, Peru, Singapore, Taiwan, Thailand, and Venezuela) from 1979 to 2002. Our econometric model is based on Goldfajn & Valdés (1999) model of the RER, but is implemented with Cermeño & Grier's (2006) panel estimator. We find that higher real exchange rates are associated with significantly greater uncertainty, which means that, this is an important new channel through for the RER to have real effects.

The paper is organized as follows. Section II presents our illustrative model of how higher real exchange rates may be less predictable. Section III describes our empirical method and presents the results. Section IV concludes.

II. A simple model of real exchange rate appreciation and uncertainty

In this section we present a simple formalization of our argument that real appreciation can raise uncertainty about future values of the exchange rate. We generate the result in a model with two types of policymakers: a pragmatic policymaker, who has a loss function which contains costs from being away from the ideal real exchange rate as well as costs of devaluing, and an ideological policymaker, in whose loss function the cost of devaluing is infinite.² When the real exchange rate is at a level where the pragmatic type would not intervene and devalue, then uncertainty about the type of the policymaker will not

affect the conditional variance of the exchange rate. However, when the exchange rate is such that the pragmatic type would intervene, then uncertainty about the policymakers type increases the forecast error variance of the exchange rate.

Consistent with the time series properties of the data we use in the empirical section below, we assume that the real exchange rate has a stochastic trend. In this way, as emphasized by Drazen & Masson (1994) and Velasco (1997), the costs of a sub-optimal real exchange rate are persistent and cumulative. That is to say, if real exchange rate appreciation is causing costly unemployment, the dynamic costs of not resetting the real exchange rate now must be factored into the policymaker's decision rule. A simple way to incorporate this phenomenon is to have the pragmatic policymaker follow an Ss pricing rule, as discussed by Barro (1972) and Sheshinski & Weiss (1977, 1983). In these models, the policymaker balances the accumulated flow of the cost of being away from the ideal value of a variable against the fixed costs of changing the value of the variable in order to determine the limits of deviations that are acceptable and the size of interventions that will be undertaken.³

Specifically, we assume that the exchange rate follows a random walk with drift, subject to interventions by the policymaker.

$$R_t = \delta + R_{t-1} + V_t + \varepsilon_t \quad [\varepsilon_t \sim \text{IID}(0, \sigma^2)] \quad (1)$$

Here δ measures trend appreciation, and V the intervention, if any, undertaken by the policymaker.⁴ Given the stochastic trend, we assume that the pragmatic policymaker follows a one-sided Ss rule.⁵ In implementing this type of rule, the pragmatic policymaker chooses a band for the real exchange rate. When the exchange rate hits the upper bound (S^*), the policymaker intervenes with a nominal devaluation to reset the real rate to the lower bound (s^*). The size of the band (S^*-s^*) depends on δ , σ^2 , the loss function of the policymaker and

the probability that future policymakers will be of the same type. For our purposes, it is not necessary to explicitly define the policymaker's target real exchange rate or her loss function. Given that one type follows (any) one sided Ss rule and the other is an automaton, there will be situations where uncertainty about the identity of the policymaker does not affect the accuracy of the public's forecast and other situations where such uncertainty is economically relevant.

We assume that the two types of policymakers rotate stochastically in office with a new policymaker selected in each period. This policymaker will be ideological with probability p and pragmatic with probability $1-p$. We also assume the following sequence of events: (1) Given an information set that includes R_t , S^* , s^* , and p , the public forms their expectations of the next period's real exchange rate, $E_t[R_{t+1}]$; (2) The policymaker for period t is determined by a draw from our stochastic process; (3) The policymaker decides whether or not to intervene. Specifically, If $R_t > S^*$, the Pragmatic policymaker will devalue, choosing a nominal rate that, in the absence of the macro shock (ϵ_{t+1}) would reset the real rate to s^* . The Ideological policymaker will always do nothing; (4) Finally, after the policymaker has taken action, the macro shock (ϵ_{t+1}) occurs and R_{t+1} is realized. This sequence of events is then repeated.

We are now in a position to demonstrate our result of interest. The rational expectation of next period's real exchange rate is the mathematical expectation under each type of policymaker weighted by the probability that the type will be in office. That is to say,

$$E_t[R_{t+1}] = p E_t[R_{t+1} | \text{Ideologue}] + (1-p)E_t[R_{t+1} | \text{Pragmatic}] \quad (2)$$

The variance of the forecast error will be given by,

$$E_t[(R_{t+1} - E_t[R_{t+1}])^2] \quad (3)$$

Let us consider the two relevant cases, first when $R_t < S^*$ (and neither type of policymaker will devalue) and second when $R_t > S^*$ (and the Pragmatic policymaker will devalue, lowering the real exchange rate by $S^* - s^*$). In the first case, the expected real exchange rate is given by,

$$E_t[R_{t+1}] = p(\delta + R_t) + 1-p(\delta + R_t) = \delta + R_t \quad (4)$$

and the forecast error variance is

$$E_t[(R_{t+1} - \delta - R_t)^2] = E_t(\varepsilon_{t+1}^2) = \sigma^2 \quad (5)$$

In the second case, the expected real exchange rate is given by

$$E_t[R_{t+1}] = p(\delta + R_t) + 1-p(s^*) \quad (6)$$

and the forecast error variance is,

$$E_t[(R_{t+1} - E_t[R_{t+1}])^2] = pE_t[(\delta + R_t + \varepsilon_{t+1} - p(\delta + R_t) - (1-p)s^*)^2] + (1-p)E_t[(s^* + \varepsilon_{t+1} - p(\delta + R_t) - (1-p)s^*)^2] \quad (7)$$

With some algebra, (7) can be simplified to:

$$E_t[(R_{t+1} - E_t[R_{t+1}])^2] = \sigma^2 + p(1-p)(s^* - R_t)^2 \quad (7^*)$$

Equation (7) is unambiguously greater than σ^2 , the forecast error variance in case one, meaning that uncertainty about the type of the future policymaker creates a positive link between real appreciation and increased uncertainty about future exchange rates. The link is not simply due to the existence of a policymaker who is not fully committed to the peg. In fact, in a world with only pragmatic policymakers, there would be no increased uncertainty at higher real exchange rates because the public would know exactly when the devaluation will come, as in Flood & Marion (1997).

In the next section, we test empirically whether higher real exchange rates are less predictable using a dynamic panel model, allowing for both cross-sectional dependence and conditional heteroskedasticity.

III. An Empirical Model of the RER

We investigate the relationship between real exchange rates and uncertainty in a model that measures uncertainty rather than simple volatility. The usual choices of experimental design are to average the data and estimate a cross-country or panel regression using the sample standard deviation as the uncertainty measure, or to estimate a GARCH model for one country at a time.⁶ Here we construct a model of the real exchange rate that controls for important economic factors and also allows the covariance matrix to vary over time.

To test the hypothesis that higher values of the real exchange rate (a more valuable local currency) create more uncertainty, we use monthly observations of J.P. Morgan's real exchange rate index.⁷ Higher values of the index imply a higher real value of the currency under study, meaning that real appreciations are denoted by increases in the index. We have complete time series for 14 developing countries.⁸ Figure 2 displays the real exchange rate data for each country in the sample. The 14 countries in our sample are not all officially classified as having fixed exchange rate regimes from 1979 - 2002. However, as noted in our introduction, Calvo & Reinhart (2002) show that most developing countries, regardless of their official regime have a strong "fear of floating" indicating that the nominal exchange rate is typically tightly controlled.⁹

We include lagged values of the RER to capture persistence in the series because any un-modelled serial correlation could cause us to spuriously find evidence of conditional heteroskedasticity. As for the other control variables discussed here, there is nothing in the theoretical literature which allows us to specify the timing of the relationship between them and the real exchange rate. For that reason, we also include several lags of these variables in the regression.

We also want to control for economic factors which may affect the evolution of the real exchange rate. To do that, we follow Goldfajn & Valdés (1999), who include a country's terms of trade, government expenditures, trade openness, and the international interest rate in a model of the determination of the real exchange rate.

The effect of the terms of trade variable on the real exchange rate can either be positive or negative. Diaz-Alejandro (1982) argues that decreases in a country's terms of trade negatively affects small, open economies because it reduces their permanent income. If the relative price of a country's exports falls, then citizens may reduce their overall demand for non-tradable goods, which would cause the real exchange rate to depreciate. Others, however, have argued that a possible substitution effect may swamp the income effect of a decrease in the terms of trade. Edwards (1989), for instance, shows that domestic production may switch out of producing non-tradables, which would increase the price of non-tradable goods and lead to an appreciation of the real exchange rate. Given the fact that a terms of trade adjustment can put both upward and downward pressure on the real exchange rate, the question of whether terms of trade is negatively or positively correlated with the real exchange rate is an empirical question. We include a terms of trade index that is taken from the World Bank's World Development Indicators, where 1995 is equal to 100. The numbers

are annual, so we divide them by 12 and interpolate to create a monthly data set.

The effect of government expenditures on the real exchange rate is also theoretically ambiguous. An increase in the amount of government spending will cause the real exchange rate to increase in value if the government raises the overall demand for non-tradables. However, if government expenditures is directed towards imported goods, then this rise in spending will actually cause a real exchange rate depreciation. We control for government spending by interpolating annual data from the World Bank's World Development Indicators on government consumption expenditures as a percentage of GDP.

The effect of trade openness has a more straight forward theoretical relationship with the real exchange rate. Goldfajn & Valdés make the argument that reducing the average import tariff will cause the prices of non-tradables to decrease in order to equilibrate labor markets. Using monthly data from the IMF IFS CD-ROM, we measure openness as the ratio of exports and imports to GDP.¹⁰ GDP figures are interpolated from annual data and are also from the IMF's IFS.

Goldfajn & Valdés argue that changes in the international interest rate can influence the real exchange rate in both the short and long run. They point out that if savings are inelastic in the short run, then any decrease in the interest rate will mean more money flowing to developing countries. In the longer term though, savings will be considerably more elastic and a drop in the international interest rate would also mean a decrease in the country's net foreign assets. To control for changes in the international interest rate, we include monthly data provided by the St. Louis Fed's FRED on the 3-month US Treasury bill rate in secondary markets.

IV. Results

We implement a version of Cermeño & Grier's (2006) model for the real exchange rate, allowing for both conditional and unconditional heteroskedasticity and conditional cross-sectional correlation of the error terms.¹¹ Equations 1-3 present the model:

$$\ln(R_{it}) = \alpha_i + \sum_{j=1}^{12} \alpha_j \ln(R_{it-j}) + \sum_{j=13}^{16} \alpha_j \ln(\text{terms of trade}_{it-j}) + \sum_{j=17}^{20} \alpha_j \ln(\text{open}_{it-j}) \quad (8)$$

$$+ \sum_{j=21}^{24} \alpha_j \ln(\text{gov. exp}_{it-j}) + \alpha_{25} \ln(\text{tbill}_t) + \varepsilon_{it}$$

$$h_{iit} = \phi_1 \varepsilon_{iit-1}^2 + \phi_2 h_{iit-1} + \phi_3 \text{Arg}_t + \phi_4 \text{Br}_t + \phi_5 \text{Ch}_t + \phi_6 \text{Col}_t + \phi_7 \text{Hkg}_t + \phi_8 \text{Ind}_t$$

$$+ \phi_9 \text{Kor}_t + \phi_{10} \text{Mal}_t + \phi_{11} \text{Mex}_t + \phi_{12} \text{Mex}_t + \phi_{13} \text{Per}_t + \phi_{14} \text{Sgp}_t + \phi_{15} \text{Twn}_t$$

$$+ \phi_{16} \text{Tha}_t + \phi_{17} \text{Ven}_t + \lambda \ln(R_{it}) \quad \text{For all } i = 1 - N \quad (9)$$

$$h_{ikt} = \rho_{ik} * h_{iit} * h_{kkt} \quad \text{For all } i \neq k \quad (10)$$

For our purposes, it will be convenient to difference equation 8, which serves to sweep away the individual effects and reduce the number of coefficients we have to estimate. That is, we will actually estimate

$$\Delta \ln(R_{it}) = \alpha_0 + \sum_{j=1}^{12} \alpha_j \Delta \ln(R_{it-j}) + \sum_{j=13}^{16} \alpha_j \ln(\text{terms of trade}_{it-j}) + \sum_{j=17}^{20} \alpha_j \ln(\text{open}_{it-j}) \quad (8^*)$$

$$+ \sum_{j=21}^{24} \alpha_j \ln(\text{gov. exp}_{it-j}) + \alpha_{25} \ln(\text{tbill}_t) + \varepsilon_{it}$$

Here R is the real exchange rate and the error terms are assumed to be distributed multivariate normal with mean zero and conditional variance H_t . The diagonal elements of H are given in (9) and the off-diagonal elements in (10). We allow for both conditional heteroskedasticity via the GARCH process and for unconditional heteroskedasticity via the lagged dependent

variable in (9). The model allows for individual effects in the mean equation but assumes the rest of the parameters are homogeneous. The key coefficient for testing our economic hypothesis is λ in (9). If appreciated real exchange rates significantly raise uncertainty, then this coefficient should be positive and significant.

Table 1 presents a preliminary result of estimating equation (8*) via Least Squares. The terms of trade variable is positive, which indicates that improvements in the terms of trade are associated with real exchange rate appreciations. The openness variable is negative and significant, indicating that greater levels of openness in our sample are correlated with depreciated real exchange rate values. Changes in the international interest rate are positively and significantly correlated with real exchange rate appreciations, while government spending is negatively correlated.

To test for conditional heteroskedasticity, we conduct tests using the estimated residuals of the OLS results. Table 2 presents a panel regression of the squared residuals on their first ten lags. The null hypothesis of no conditional heteroskedasticity can be tested by multiplying the R^2 of this equation times the number of observations. This statistic is asymptotically distributed χ^2 with 10 degrees of freedom in this case. The calculated statistic is 174.4, which is sufficient to reject the null at the 0.01 level. Inspection of the individual coefficients reveals that the first, second, fourth, and ninth lagged squared residuals are positive and significant. This degree of persistence indicates that a GARCH(1,1) specification would be an appropriate starting point.

We go on to estimate (8*), (9), & (10) simultaneously via direct numerical maximization of the likelihood function.¹² Table 3 presents the results. The data indeed display significant conditional heteroskedasticity, and show that as the real exchange rate

appreciates, it becomes less predictable. The conditional variance/covariance parameters are all positive and significant at the 0.01 level and there is no evidence that any patterns remain in the squared normalized residuals.

Most important for our purposes, the coefficient on the lagged real exchange rate in the conditional variance equation (i.e. λ) is positive (8.9) and significant at the 0.01 level (asymptotic t-statistic of 3.7). We thus find strong empirical support for the proposition that appreciated real exchange rates are less predictable.

The rest of the model coefficients show that a decrease in the terms of trade is significantly associated with faster RER growth, while increased government spending has a significant negative net partial correlation with RER growth. The openness coefficients, while jointly significant, essentially sum to zero. Increases in the US t-bill rate significantly raise the RER in these countries as well.

To investigate the robustness of these results we perform a jackknife experiment. We re-estimate our system 14 times each time with one country excluded from the sample. In this way we can determine whether the results are sensitive to what countries are included in the sample. Table 4 presents the results for the Garch(1,1) coefficients and the lagged RER term in the conditional variance. The lagged RER term has an average value of 7.34 (slightly smaller than the value (8.9) reported in Table 3), a standard deviation of 1.6, and ranges between 3 and 10. The average values for the Garch coefficients are basically identical to those reported in Table 3. In short, our results do not depend on any one particular country's presence in the sample.

V. Conclusions

We demonstrate the existence of a strong positive and significant link between appreciation of the real exchange rate and its future predictability in a sample of 14 developing countries.

We present an illustrative model which demonstrates such a positive relationship, assuming stochastic turnover between two types of policymakers. In our model, when the real exchange rate is not overvalued, neither type of policymaker will devalue. When the real exchange rate becomes overvalued, one type of policymaker will devalue and the other will not. Thus, as the real exchange rate appreciates there is increased uncertainty over the future value of the real exchange rate.

Our results show that real appreciations can be costly in polities where there is uncertainty about the goals of future policymakers, in the sense that exchange rate uncertainty frequently associated with negative effects on trade or growth. Our results also show that models with multiple types of policymakers have a potentially important role to play in explaining real world behavior.

Table 1. A Least Squares Model of the Real Exchange Rate for 14 Latin American & East Asian Countries

$$\begin{aligned}
 \Delta \ln(R_{it}) = & -0.09 + .10 \Delta \ln(R_{it-1}) - .14 \Delta \ln(R_{it-2}) - .05 \Delta \ln(R_{it-3}) - .08 \Delta \ln(R_{it-4}) \\
 & (0.1) \quad (6.1) \quad (8.7) \quad (3.1) \quad (4.7) \\
 & + .03 \Delta \ln(R_{it-5}) - .04 \Delta \ln(R_{it-6}) - .07 \Delta \ln(R_{it-7}) - .03 \Delta \ln(R_{it-8}) \\
 & (1.9) \quad (2.6) \quad (4.4) \quad (1.6) \\
 & + .02 \Delta \ln(R_{it-9}) + .02 \Delta \ln(R_{it-10}) - .07 \Delta \ln(R_{it-11}) + .034 \Delta \ln(R_{it-12}) \\
 & (1.1) \quad (0.9) \quad (4.2) \quad (2.1) \\
 & + .07 \Delta \ln(\text{tot}_{t-1}) + - .87 \Delta \ln(\text{tot}_{t-2}) + 1.00 \Delta \ln(\text{tot}_{t-3}) - .07 \Delta \ln(\text{tot}_{t-4}) \\
 & (0.3) \quad (2.9) \quad (3.4) \quad (0.3) \\
 & - 0.15 \Delta \ln(\text{gov}_{t-1}) - 0.06 \Delta \ln(\text{gov}_{t-2}) + 0.08 \Delta \ln(\text{gov}_{t-3}) + 0.06 \Delta \ln(\text{gov}_{t-4}) \\
 & (0.4) \quad (0.1) \quad (0.2) \quad (0.2) \\
 & - 0.67 \Delta \ln(\text{open}_{t-1}) - .43 \Delta \ln(\text{open}_{t-2}) + .67 \Delta \ln(\text{open}_{t-3}) + 0.11 \Delta \ln(\text{open}_{t-4}) \\
 & (4.0) \quad (1.9) \quad (2.97) \quad (.63) \\
 & + 0.05 \Delta \ln(\text{tbill}) \\
 & (5.0)
 \end{aligned}$$

LLF = -21108; N=14, T=281. Numbers in parentheses are the absolute values of the asymptotic t-statistics.

Table 2. LM ARCH Test for 14 Country OLS Model's Residuals

$$(\epsilon_t^{\text{ols}})^2 = \alpha_0 + \sum \alpha_i (\epsilon_{t-i}^{\text{ols}})^2$$

<u>Variable</u>	<u>Coefficient</u>	<u>T-statistic</u>
$(\epsilon_{t-1}^{\text{ols}})^2$	0.13	8.20
$(\epsilon_{t-2}^{\text{ols}})^2$	0.089	5.47
$(\epsilon_{t-3}^{\text{ols}})^2$	-0.003	-0.17
$(\epsilon_{t-4}^{\text{ols}})^2$	0.051	3.12
$(\epsilon_{t-5}^{\text{ols}})^2$	0.024	1.47
$(\epsilon_{t-6}^{\text{ols}})^2$	0.005	0.29
$(\epsilon_{t-7}^{\text{ols}})^2$	0.009	0.58
$(\epsilon_{t-8}^{\text{ols}})^2$	0.022	1.38
$(\epsilon_{t-9}^{\text{ols}})^2$	0.057	3.49
$(\epsilon_{t-10}^{\text{ols}})^2$	0.016	0.99

N=3794, R²=.043892, $\chi^2_{(10)} = 174.4$

Table 3. A Model of the Real Exchange Rate, Controlling for Conditional Heterskedasticity & Cross-Sectional Dependence

$$\Delta \ln(R_{it}) = -0.99 + .18 \Delta \ln(R_{it-1}) - .03 \Delta \ln(R_{it-2}) - .003 \Delta \ln(R_{it-3}) - .01 \Delta \ln(R_{it-4})$$

(2.2) (7.8) (1.4) (0.1) (0.9)

$$+ 0.00 \Delta \ln(R_{it-5}) - .01 \Delta \ln(R_{it-6}) - .04 \Delta \ln(R_{it-7}) + .02 \Delta \ln(R_{it-8})$$

(0.0) (0.7) (3.0) (1.4)

$$- .02 \Delta \ln(R_{it-9}) + .01 \Delta \ln(R_{it-10}) - .04 \Delta \ln(R_{it-11}) + .07 \Delta \ln(R_{it-12})$$

(1.9) (0.6) (2.98) (5.6)

$$+ .18 \Delta \ln(\text{tot}_{t-1}) + - .48 \Delta \ln(\text{tot}_{t-2}) - 0.31 \Delta \ln(\text{tot}_{t-3}) + .03 \Delta \ln(\text{tot}_{t-4})$$

(1.5) (2.98) (2.0) (0.3)

$$- 0.21 \Delta \ln(\text{gov}_{t-1}) + 0.80 \Delta \ln(\text{gov}_{t-2}) - 0.84 \Delta \ln(\text{gov}_{t-3}) + 0.07 \Delta \ln(\text{gov}_{t-4})$$

(1.4) (3.8) (4.5) (0.5)

$$- 0.45 \Delta \ln(\text{open}_{t-1}) - .22 \Delta \ln(\text{open}_{t-2}) + .49 \Delta \ln(\text{open}_{t-3}) + 0.21 \Delta \ln(\text{open}_{t-4})$$

(4.1) (1.6) (3.1) (1.7)

$$. + 0.01 \Delta \ln(\text{tbill})$$

(2.3)

$$h_{iit} = .64 \varepsilon_{iit-1}^2 + .46 h_{iit-1} + 263.0 \text{ Arg} + 570.4 \text{ Br} + 124.5 \text{ Ch} + 90.9 \text{ Col} +$$

(13.4) (17.7) (4.2) (6.5) (3.9) (3.2)

$$38.9 \text{ Hkg} + 232.2 \text{ Ind} + 56.2 \text{ Kor} + 21.1 \text{ Mal} + 206.7 \text{ Mex} + 42.2 \text{ Per}$$

(2.3) (4.0) (2.8) (1.4) (5.7) (1.5)

$$+ 1.00 \text{ Sgp} + 2.48 \text{ Twn} + 136.8 \text{ Tha} + 403.0 \text{ Ven} + 8.9 R_{it-1}$$

(0.2) (0.2) (4.9) (3.8) (3.7)

Table 3 (continued)

$$h_{ikt} = \rho_{ik} * h_{iit} * h_{kkt}$$

Matrix of the estimated ρ_{ik}

	<i>Br</i>	<i>Ch</i>	<i>Col</i>	<i>Hkg</i>	<i>Ind</i>	<i>Kor</i>	<i>Mal</i>	<i>Mex</i>	<i>Per</i>	<i>Sgp</i>	<i>Twn</i>	<i>Tha</i>	<i>Ven</i>
<i>Arg</i>	-.07	.05	.06	.07	.07	.08	-.001	-.02	.06	.04	.15	.09	-.09
<i>Br</i>		.03	.18	.09	.11	.22	.12	.05	.05	.08	.21	.14	.03
<i>Ch</i>			.27	.32	.15	.28	.21	.21	.11	.21	.29	.11	.04
<i>Col</i>				.27	.20	.32	.09	.08	.10	.08	.25	.20	-.04
<i>Hkg</i>					.11	.23	.26	.16	.07	.15	.14	.12	.14
<i>Ind</i>						.21	.21	.08	.04	.21	.18	.24	.06
<i>Kor</i>							.14	.09	.09	.12	.28	.23	.04
<i>Mal</i>								.10	.07	.14	.18	.21	.06
<i>Mex</i>									.17	.16	.22	.003	.06
<i>Per</i>										.12	.27	-.01	-.00
<i>Sgp</i>											.20	.10	.13
<i>Twn</i>												.17	.13
<i>Tha</i>													.05

Maximized Log-Likelihood = - 18640 N=14 T=281

Numbers in parentheses are asymptotic t-statistics. Correlation coefficients in bold are significant at the .05 level or better

Table 4: Selected Jackknife Results

Coefficient	Average	Std Dev	Min	Max
Garch(1)	0.46	0.05	0.39	0.61
Arch (1)	0.64	0.09	0.37	0.75
RER(-1)	7.34	1.64	3.01	10.39

This table is produced by running the model in Table 3, 14 times, each time with one country dropped from the sample. The statistics presented are thus based on 14 estimated models with 13 countries each.

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Notes

1. Grier & Hernandez (2004), Arize (1993), Cottani et.al. (1990), Kroner & Lastrapes (1993), and Maloney & Azevedo (1995).
2. The assumption of an infinite cost of devaluing is extreme and not necessary to the argument. It is simply a convenient way to model a setting where the two policymakers have different costs of intervention.
3. Flood & Marion (1997) make a detailed set of assumptions and prove that a one-sided Ss rule is optimal in their set up. For a related contribution, see Ozkan & Sutherland (1998). In both of these cases, there is a single policymaker, so interventions are predictable by rational agents.
4. V will be equal to S^*-s^* whenever the pragmatic policymaker intervenes to reset the real exchange rate and otherwise equal to zero.
5. Ss pricing rules are not generally optimal policy rules, though Sheshenski & Weiss (1983) prove the optimality of the one sided Ss rule for a particular set of assumptions. However, Blanchard & Fischer (1989, p. 405) note that, “in many cases, a simple Ss rule may still be a good approximation to the optimal rule”. Since our main goal is empirical, choosing an explicit loss function and deriving the optimal Ss type rule is beyond the scope of this paper. All we really need is a world where heterogeneous policymakers sometimes will all undertake the same action and sometimes will not, along with uncertainty about the type of next period’s policymaker.
6. On the development of GARCH modelling, see Engle (1983) and Bollerslev (1990). Existing Multivariate GARCH models are limited in the number of series that can be considered because the number of coefficients to be estimated rises very rapidly with the number of series under consideration.
7. www.jpmorgan.com/MarketDataInd/Forex/currIndex.html. Data retrieved 4/02/07.
8. The 14 countries in the sample are: Argentina, Brazil, Chile, Colombia, Hong Kong, Indonesia, Malaysia, Mexico, Peru, Singapore, South Korea, Taiwan, Thailand and Venezuela.
9. In fact, in the large set of real appreciations studied by Goldfajn & Valdés (1999), between 38 - 40 percent of them occurred in countries that were not officially pegging their exchange rates (see their Table 3 on p. 243). They go on to show that only 8 percent of significant appreciations are reversed smoothly, which indicates that a large number of the non-pegged regime appreciations were reversed abruptly via nominal devaluations.
10. Malaysia only had quarterly data available so we interpolated in this case to construct a monthly series.
11. We conduct several tests to determine the appropriate number of lags for each variable. Specifically, we find that the best fitting lag structure includes 12 lags of the change in the real exchange rate, and 4 lags each of government spending, openness, and terms of trade. The US

t-bill rate is contemporaneously correlated to real exchange rate changes in these countries. The inclusion of the lags shortens the sample to 1979.8 - 2002.12.

12. This MATLAB code is available from the authors upon request.