Why are some exchange rates more volatile than others? Evidence from Transition Economies

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Abstract

To better understand why some currencies are more volatile than others, this paper considers the cross-country determinants of exchange rate volatility for a set of middle-income countries. Overall, the paper finds that higher levels of reserves reduce volatility, and it is estimated that an appropriate level of reserves is approximately 4 $\frac{1}{2}$ months of imports. Volatility is increased by increased uncertainty and loose fiscal policy. In addition, a volatile terms of trade spills over into a volatile currency. From a policy perspective, whilst it is clear that prudent macroeconomic policy is the best course of action to reduce exchange rate volatility, the influence of external volatility on the exchange rate (over which the authorities have no control) should not be underestimated.

Key words: macroeconomic policy, volatility, real exchange rate

JEL Codes: F31, C23

1 Introduction

The characteristics that define an economy as a transition economy are numerous. In general, a transition economy is considered to be in a transitional phase between developing and developed status. These economies are characterized by the changing and creating of institutions and fundamental changes in the role of the state. According to Havrylyshn and Wolf (1999), transition economies, in a broad sense, implement market reforms along with the reallocation of resources to their

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most efficient use, engage in macroeconomic stabilization policies, fiscal prudence, enforce rule of law and property rights.

While cyclical behaviour of GDP growth does not veer these economy off its long run growth path, exchange rate volatility may have adverse consequences on the long-term growth prospects of these economy.[1] Exchange rate volatility is an indication of the degree of uncertainty prevalent within an economy. Greater volatility of a country's currency implies that agents are unable to adequately plan ahead.[2] Moreover, increased uncertainty increases the threshold at which investment will occur.[3] Two examples of this are: Firstly, insufficient savings in some transition economies lead to borrowing from international markets for investment and consumption. Excessive movements in their exchange rate may not only affect the ability of these economies to repay their debt, but may also affect their ability to plan adequately consequently creating an unfavourable investment climate. Secondly, uncertainty created by exchange rate volatility also generates volatile terms of trade and consequently increased uncertainty for exporters and importers. This reduces investment and consequently depresses international trade.[4]

Given the above, Eichengreen and Hausmann (1999) stress that many emerging market economies may have little ability to tolerate a high degree of exchange rate volatility against their major creditors.[5] Despite this, Hausmann et al (2006) note that transition economies tend to have higher levels of real exchange rate volatility vis-à-vis developed economies with volatility swings being more persistent in transition economies.

Given the adverse impact of currency volatility on transition economies , this paper considers the possible determinants of exchange rate volatility in these economies. The study gauges the effect on currency volatility of a set of macroeconomic fundamentals. In particular, the analysis tests if there exists a consistent response in the volatility of the real exchange rate, in the long run, to changes to a variety of macroeconomic fundamentals.

We begin by providing some observations on the behaviour of ex-

[1] This fact is true for all econnomies including transition economies.

[2] See for example statement by the New Zealand Reserve Bank Governor Alan Bollard of March 11, 2004 and a press statement by the Minister of Finance Trevor Manuel of December, 21, 2001.

[3] See Fedderke (2004) and Bleaney and Greenaway (2001).

[4] See Sauer and Bohara (2001), Dell'Ariccia (1999) and Chowdhury (1993).

[5] Notwithstanding the strong theoretical case for fully floating exchange rates, Calvo and Reinhart (2002) still find a pervasive "fear of floating" – many countries are reluctant to allow their exchange rates to freely float, due in no small part to the fact that floating exchange rates can be extremely volatile.

change rate volatility in transition economies in the recent past. Although previous studies analyze the behaviour of exchange rate volatility in developing, transition and developed economies using varying econometric techniques, to our knowledge, the literature does not specifically test whether the underlying structure of the performance of exchange rate volatility in transition economies is consistent across theses economies when faced with similar changes to their macroeconomic fundamentals. The paper concludes by providing some scenarios on possible exchange rate volatility in these economies in response to changes to a set of macroeconomic fundamentals and external shocks.

1.1 Motivation

The "tequilla crisis"[6] of 1995 through to the Asian/Russian/Brazilian financial crises of 1997-98 adversely affected exchange rates in transition economies more than developed or developing countries. This is perhaps because these financial crises emanated in transition economies. However, these crises also highlighted the sensitivity of exchange rates in these economies to shocks.

The question that arises is: Does excessive exchange rate volatility occur in transition economies only during periods of crises?

From a set of 51 developing, developed and transition economies, Figure 1 illustrates that exchange rates were, on average, most volatile[7] in transition economies from 1980−2000 and not only in the crisis years.[8]

The higher volatility in the exchange rate is associated with three stylized facts. Firstly, transition economies are increasingly drawn into the integrated world economy with respect to both their trade in goods and services and in financial assets.[9] Moreover, the bulk of their international commerce and finance is in terms of monies of major industrial countries, usually the US dollar. Thus private capital inflows have come to play a dominant role in transition economies' financing and adjustment. The downside is the increased exposure of these economies to abrupt reversals in capital flows and exposure to exchange rate risk. The instability associated with short-term capital flows is reflected in the countries' exchange rate gyrations. These fluctuations in the exchange rate are accelerated if the country has debt denominated in terms of monies of major industrial countries. Secondly, most of these economies

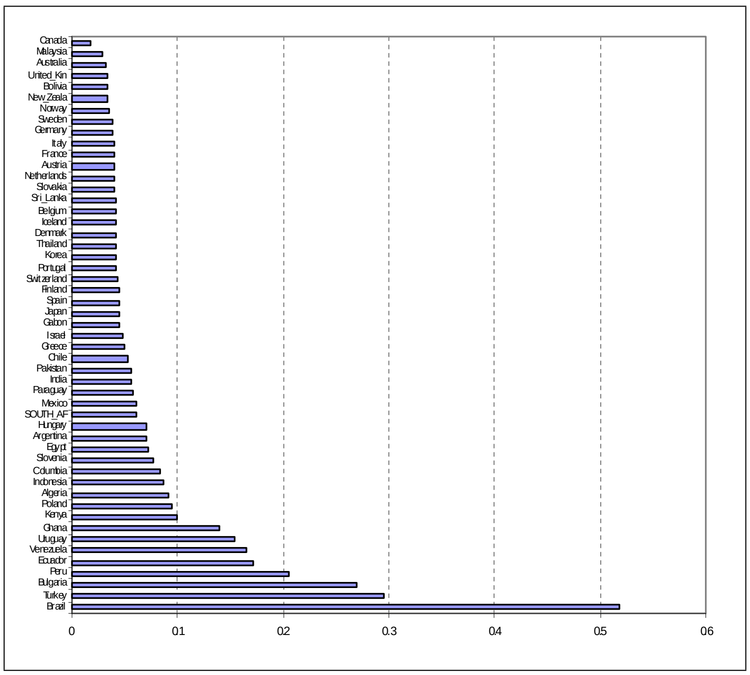
[6]This is the financial crisis that adversely affected transition economies following the December 1994 devaluation of the Mexican peso.

[7]We discuss in detail in Section 4 the calculation of real exchange rate volatility.

[8]Hausmann et al (2006) finds a similar result for a set of 74 developed, developing and emerging economies over the 1980-2000 period.

[9]Ricci et al (2008) state that the share of world trade for emerging countries rose by 27 percent in 1990 to 37 percent in 2004.

have moved towards manufactured exports from primary commodity exports. This move has made their terms of trade more stable while making them more sensitive to exchange rate movements.[10] Lastly, transition economies are subject to large nominal shocks because they have non-credible monetary institutions and weak fiscal position.[11] These nominal shocks are reflected in excessive exchange rate variability.



Sample: 1980-2000

Figure 1: Average Real Exchange Rate Volatility against US Dollar

Analyzing the worst performing currencies for the first half of 2006,[12] Figure 2 confirms that eight of the ten worst performing currencies for this period belong to transition economies. In the first half of 2006, the South African Rand recorded the biggest depreciation (14,8 percent) against the dollar. Figure 2 also highlights that, except for Chile, all of these countries experienced acute current account deficits for the first half of 2006. One of the factors behind rand depreciation was concern about the widening current account deficit (1,2 percent of GDP in 2005 and 6,1 per cent in the first half of 2006).

[10] See Mussa et al (2000).

[11] See, for example, Hausmann et al (2006).

[12] The data was obtained from International Financial Statistics of the International Monetary Fund.

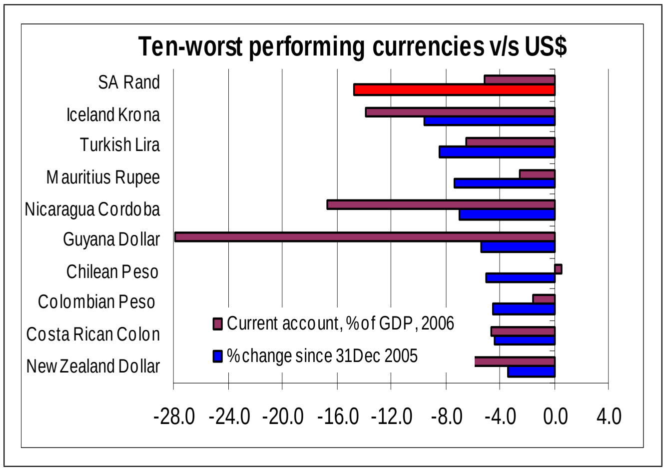


Figure 2: Ten worst-performing currencies in the first-half of 2006

Current account deficits indicate the inability of savings, both private and public, to meet private and public investment needs. Insufficient savings are indicative of budget deficits and/or high debt to GDP ratios. Thus the current account deficits are a symptom of macroeconomic imbalances. This finding supports the argument that macroeconomic fundamentals do affect exchange rate behaviour.[13] Moreover, these imbalances not only affect the trend in the real exchange rate but also its volatility.[14] This corroborates the finding of Hausmann et al (2006) that the substantial persistent difference in long term real exchange rate volatilities between developed and transition economies indicate that there exist differences in the underlying economic fundamentals between these two sets of countries.

We allude to the possibility that current account imbalances adversely affect exchange rate volatility. Moreover, given that exchange rate volatility has adverse consequences on economies, understanding the drivers of exchange rate volatility is therefore crucial for economies. There exist two types of theoretical models in the literature that investigate the impact of a variety of shocks on exchange rate volatility

[13] MacDonald (1999) claims that macroeconomic fundamentals have role to play in explaining exchange rate volatility. The paper argues for the use of error correction models in determining exchange rates in the long run. Stockman (1988, 1995) also advocate the use of macroeconomic fundamentals in determining real exchange rate variability.

[14] Canales-Kriljenko and Harbermeier (2004) state that variables that determine the level of the exchange rate affect exchange rate volatility as well.

- the *liquidity model* and the *sticky price model*.[15] The former states that unanticipated liquidity shocks lead to fluctuations in interest rates, causing real exchange rates to deviate from their 'apparent' fundamentals.[16] Thus only in an expected sense is the real exchange rate constant. There are two drawbacks to the liquidity approach. First, the magnitude of the real exchange rate variations is consistently below that observed in the data.[17] Second, the absence of persistence in the effect of monetary shocks due to the assumption of perfect price flexibility. Even when these models include costs to portfolio adjustment when shocks occur,[18] the length of delay required to generate persistence in the model as observed in the data is unrealistic.

Sticky price models of exchange rate volatility extend the Mundell-Fleming-Dornbusch framework to incorporate optimizing behaviour of agents faced with an intertemporal budget constraint.[19] These models are significantly restrictive for the following reasons. Firstly, the implications for real exchange rate volatility in these models are based on the currency (domestic or foreign) a firm sets its price at and whether the firm is import or export oriented;[20] Secondly, even when the models endogenize price stickiness[21] there may exist multiple equilibria with significantly different implications for the real exchange rates.

The above indicates that theoretical models are unable to adequately explain the persistence of exchange rate volatility due to shocks. Therefore considering empirical models of exchange rate volatility, Hausmann et al (2006) test for the impact and significance of shocks on exchange rate volatility for a group of developed, developing and transition economies. The shocks they consider are terms of trade shocks, output shocks and nominal shocks. They find terms of trade shocks are positively and

[15] Devereux (1997) provides an extensive analysis of theoretical models attempting to characterize exchange rate volatility. The paper highlights the flaws associated with each model and their inability to satisfactorily account for exchange rate volatility.

[16] See Lucas (1990), Grilli & Roubini (1992), Ho (1993), and Sclagenhauf and Wrase (1992,1995)

[17] Backus, Kehoe and Kydland (1995) emphasize that these models are only able to generate results similar to observed data if extremely low marginal rates of substitution between goods is assumed.

[18] Alvarez and Atkeson (1997) and Alvarez, Atkeson and Kehoe (2002), and Stockman (1995) develop such models.

[19] See for instance Mankiw (1985) on the incorporation of menu costs in order to generate a persistent response of macroeconomic variables to shocks in a business cycle model.

[20] Giovannini (1988) discusses currency price setting and argues that the critical issue is the degree of concavity or convexity of the exporter's demand schedule.

[21] See Obstfeld and Rogoff (1995), Benhabib and Farmer (2000) and Beaudry and Devereux (1995) for examples of models that endogenize price stickiness.

significantly correlated with variability in the real exchange rate such that a positive terms of trade shocks should lead to an appreciation of the real exchange. However, Hausmann et al (2006) do discover that terms of trade shocks do have a smaller effect on exchange rate volatility during periods of high GDP growth. An output shock, as measured by the GDP growth, is found to have a positive and statistically significant effect on exchange rate volatility indicating that rising GDP growth may adversely affect exchange rate volatility. This result is amplified for rapidly growing transition economies catching up with the developed world. With rising growth rates and nominal rigidity present in these economies, exchange rate volatility is the outcome. The paper also finds nominal shocks, as measured by a change in the inflation rate, while having an insignificant effect on exchange rate volatility,[22] is able only to account for a small, statistically significant, difference in exchange rate volatility between developed and transition economies.

Given the persistence of exchange rate variations and the inability of shocks to adequately explain away the difference between volatility between developed and transition economies,[23] Engel, Mark, and West (2007) assert that real exchange rate behavior at medium to long horizons can be at least partly explained by fundamentals.

To this end, a number of empirical studies have analyzed the link between exchange rate volatility and a set of variables (including macroeconomic fundamentals) for developing, developed and transition economies using a variety of econometric techniques. The impact of policy on exchange rate volatility through its effect on macroeconomic fundamentals have also been studied by a number of papers. For example, Chan and Ngiam (1998), on Singapore's experience during the Asian financial crisis of 1997, state the following: "The Singapore dollar has withstood the currency storm lashing the region because of its extremely strong economic fundamentals...(including) low foreign debt, huge foreign exchange reserves, large current account surpluses, substantial budget surpluses, high savings rates, strong inflow of foreign direct investment, a sound financial system and prudent government policies". This highlights the importance of sound macroeconomic fundamentals in affecting real exchange rate variability.

For much of the empirical literature on exchange rate volatility influenced by macroeconomic fundamentals, a frequent point of departure has been the Mundell (1961) model for assessing the Optimal Currency

[22] Note that with the inclusion of the change in the inflation rate results in a loss of a significant number of observations. Therefore, Hausmann et al (2006) states that this result may not be robust.

[23] Stockman (1995) and Hausmann et al (2006).

Area (OCA) hypothesis. Specifically, Bayoumi and Eichengreen (1998) examine the empirical determinants of bilateral exchange rate volatility for a group of industrial countries, focusing on two OCA variables - namely, trade interdependence and the degree of commonality in economic shocks.[24] They show that the proxies for asymmetric shocks and trade linkages go some way toward explaining variations across countries in exchange market pressure. They claim that asymmetric shocks increase exchange rate volatility by intensifying exchange market pressure. Moreover, even if there is limited intervention by policy makers in response to asymmetric shocks, the real exchange rate remains a major conduit for the capturing this asymmetry since it reflects the price distortions emanating from the asymmetric shock.

Bangaké (2008) closely follow the Bayoumi and Eichengreen (1998) specification for a set of 21 African countries for the period 1990-2003. His results support the findings of Bayoumi and Eichengreen (1998) that greater bilateral trade reduces exchange rate volatility.

A robust theoretical prediction emphasized by Hau (2002a, 2002b) and Obstfeld and Rogoff (2000) is that more open economies exhibit less volatile real exchange rates. The argument is as follows. As an economy opens, the increase in the volume of imported goods provides a channel for a quick adjustment of the domestic aggregate price level. This decreases any short-run effect of monetary or real shocks on real household money balances and therefore reduces the scope of such a shock to develop real effects on either domestic consumption or the real exchange rate. Therefore, relatively closed economies,due to a lower import share, are deprived of aggregate price level flexibility transmitted through the exchange rate. These economies, in response to shocks, produce more pronounced effects on consumption and the real exchange rate, *ceteris paribus*.[25] Trade restrictions influence the level of the real exchange rate through its affect on domestic prices. Rising trade restrictions may lead to rising domestic prices and an appreciation of the currency. Devereux and Lane (2003) also find this result for developing and developed economies.[26]

[24] See Alesina and Barro (2002) for a discussion on the effects of asymmetric shocks.

[25] Incomplete exchange rate pass-through in the short run does not change the nature of the argument, but may just imply that the structural link between real exchange rate volatility and openness is more difficult to detect over short measurement periods.

[26] See also Edwards and Ostry (1990) and Goldfajn and Valdes (1999) and MacDonald and Ricci (2003). While Hau (2002b) cautions us to the existence of reverse causality from real exchange volatility to openness such that exchange rate risk is an impediment to trade. Thus highly volatile exchange rates may result in countries opting for restrictive trade practices.

The movements in capital flows is reflected in exchange rate movements. More variable are capital flows to and from a country, greater the likelihood of increased volatility in the real and nominal exchange rate. Capital flows are influenced by the country-specific internal socioeconomic position and the external environment in which the country operates.[27]

However, capital flows are also a function of information. That is, capital migrates according to beliefs held and information available on a particular country's internal socioeconomic position and the dictates of the external environment. Calvo, Leiderman and Reinhart (1993) state that rising volatility of capital flows is associated with asymmetric information. They depict a scenario where, in an environment characterized by asymmetric information, a sudden capital outflow may indicate to financial markets and lenders alike that the country has suffered a negative shock, even when no shock has occurred. This sudden capital flight may become self-perpetuating. This outflow of capital may have negative consequences for reserves, signalling possible existence of macroeconomic imbalances in the economy. Consequently, the expectations that gave rise to these detrimental capital outflows may become rational. All of these changes have adverse consequences for both the level and the variability of the real exchange rate. Policy makers can only counteract these irrational negative capital shocks by reducing the prevalence of asymmetric information. Policy makers can also increase the confidence in a country's economic position by eliminating restrictions on capital flows. Glick and Hutchinson (2005) argue that reducing capital flow restrictions may reduce the likelihood of currencies being prone to speculative attacks and currency crises by reducing foreign exchange market distortions.

Cady and Gonzalez-Garcia (2007) hypothesize that increasing transparency and providing markets with more complete information permits market participants to better assess a country's macroeconomic prospects. Providing up to date, complete information on a country's fiscal position reduces the level of uncertainty with regards to a country's prospects. Rising uncertainty increases the riskiness associated with a particular country. This is reflected in, among other things, a volatile exchange rate.

Macroeconomic fundamentals acts as a signalling device to markets

[27] Calvo, Leiderman and Reinhart (1993) argue that the renewal of capital flows to Latin America results from external factors and can be considered an external shock common to the region. The theory that economic reforms in some countries give rise to expectations of future reforms in others is discussed in Ghosh and Ostry (1992).

on the economic position of an economy.[28] An example of a signalling device is a country's reserve level. A low stock of reserves may reflect a history of populist monetary policy. While a high level of reserves reduces the likelihood of a currency crisis and lowers the external borrowing cost either through improved confidence in an economy and/or indirectly through improved credit ratings on foreign currency debt. That is, a country's default risk on debt is perceived to diminish with higher reserves.[29] All this translates to into improved market sentiment with rising reserve ratios reducing the uncertainty surrounding the country's fundamentals and its ability to withstand adverse shocks.

Hviding, Nowak and Ricci (2004) show that after controlling for macroeconomic conditions, increasing the level of reserves (relative to short-term debt) reduces the volatility of the real effective exchange rate. They argue that although theoretically freely-floating exchange rates do not require large reserve holdings, in practice the level of reserves may be an important signal for outside investors. Hviding et al (2004) also find non-linear relationship between real exchange rate volatility and reserves due to 'decreasing returns to reserves'.

A second signalling device is the government fiscal stance as measure by either the debt to GDP or budget balance to GDP ratios. The finding of Cady and Gonzalez-Garcia (2007) reveals that rising debt to GDP ratios may have adverse consequences on exchange rate volatility. Rising debt ratios signal to the market a decline in credibility and sustainability of the macroeconomic policy. They signal the inability of the government to meet its requirements through its revenue generating processes due to inept policies. Changes in the budget balance have two countervailing effects on the level of the real exchange rate.[30] On the one hand, an improvement in the budget balance will lead to an increase in private savings such that total spending falls and price of nontradables would fall, resulting in a depreciation of the real exchange rate.[31] On the other hand, the current account surplus generated by the initial real depreciation[32] would have to be wiped out in the long run by a real appreciation to ensure a trade deficit to offset the net inflow of foreign capital.

[28] Cady and Gonzalez-Garcia (2007) contend a country's foreign currency liquidity position acts as a signalling device for agents.

[29] See Mulder, Perrelli, and Rocha (2002) and Jonsson (2001).

[30] See for instance Ostry (1994), and De Gregorio, Giovannini and Wolf (1994).

[31] Note that overall savings would rise and total domestic demand fall in response to an improvement in the fiscal balance if Ricardian Equivalence does not hold perhaps due to uncertainty surrounding the duration of the improvement of the fiscal position.

[32] The real depreciation of the currency originates from a decline in the domestic price level due to a fall in demand.

Devereux and Lane (2003) include determinants measuring financial linkages between countries for a group of developing and developed economies.[33] The two sets of financial series they consider measure the degree of internal and external finance. The former captures the degree of financial depth within a country while the latter represents bilateral portfolio debt liabilities between countries. Devereux and Lane (2003) observe that both increased financial deepening and external financial linkages reduce nominal exchange rate volatility in developing countries. An increase in a country's financial depth provides more efficient financial markets by improving an economies ability to absorb shocks by facilitating intertemporal smoothing by households and firms or adding liquidity to financial markets (including the foreign exchange market).[34] This helps stabilize the exchange rate. The argument for a decline in exchange rate volatility with rising external financial linkages has to do with policy - developing countries will attempt to reduce exchange rate fluctuations, the greater the reliance on external finance.

Attempts at controlling the fluctuations in the nominal exchange rate has consequences for domestic prices. Therefore, increasing reliance on external finance and attempts by countries to control changes to the nominal exchange rate due to this reliance affects domestic prices and consequently, leads to increased variation of the real exchange rate. However, since Devereux and Lane (2003) only consider nominal exchange rate volatility, they fail to factor in price movements.

We have argued that theoretical models are unable to adequately explain the persistence of exchange rate volatility due to shocks. Furthermore, shocks are unable to account for the difference in volatility between developed and transition economies. We therefore conduct an empirical investigation as to the determinants of exchange rate volatility in transition economies by identifying not only possible shocks but also macroeconomic fundamentals that may account for the persistence of exchange rate volatility in these economies. We would have preferred using a generally accepted model of exchange rates; however, in this field there is no consensus in the literature.[35] Thus, we draw on the empirical literature on exchange rate volatility literature to select possible explanatory variables.[36]

We consider a panel of transition economies to determine the macro-

[33] Fernandez-Arias et al (2001) and Poirson (2001) also consider financial factors (specifically, the ability to issue international debt in domestic currency)in a model of multivariate exchange rate volatility for a set of countries.

[34] See Kularatne (2002) and Levine (1997).

[35] See Sarno and Taylor (2002).

[36] See Devereux and Lane (2003), Hviding, Nowak, and Ricci (2004), and Hausmann et al (2006).

economic fundamentals and external variables that drive real exchange rate volatility in these economies. Some of the macroeconomic fundamentals investigated are: import cover, budget balance to GDP and debt to GDP ratios, GDP growth rate, openness of the economy, uncertainty, the current account balance, financial deepening and the inflation rate. In addition, we consider oil price volatility, dollar-euro volatility and capital flows.

The novelty of this analysis emanates from the explicitly testing of the existence of long run homogeneity of the coefficients across the countries. That is, if the test *fails to reject* (i.e., accept) long run homogenity of the regressors across the set of transition economies, we can claim that the impact is *not statistically different* across the set of transition economies.This result allows us to use these countries to form a panel. The inclusion of explanatory variables depends on if they meet this condition. The statistical test we use is the Hausman test statistic. This statistic is obtained from estimating real exchange rate volatility using Pool Mean Group Estimator. Another advantage of this approach is that the dynamics are explicitly modelled.

This paper proceeds as follows: Section 2 discusses the econometric methodology employed; Section 3 discusses the econometric specification of the model; Section 4 provides an analysis of the data; Section 5 discusses the results; Section 6 investigates possible scenarios; and lastly Section 7 concludes.

2 Econometric Methodology

2.1 Dynamic Heterogenous Panel Model

The natural advantage of using a panel data set and panel estimation is that the number of data points available becomes sufficiently large to draw meaningful results. Mark et al (2001) find evidence that with the increased efficiency from panel estimation, with the focus on longer horizons, implies that the macroeconomic models consistently provide forecasts of exchange rates that are superior to the "no change" forecast from the random walk model. Further, using dynamic heterogenous panel models, we allow for heterogeneity to exist in the short-run dynamics and test for homogeneity in the long-run, across the set of countries. This builds on the previous literature on exchange rate volatility amongst transition economies by testing the long-run homogeneity of currency volatility in response to macroeconomic fundamentals and external shocks across the set of transition economies.

Following Pesaran, Shin and Smith (1999), we base our panel analysis on the unrestricted error correction Autoregressive Distributed Lag

(ARDL) (p,q) representation:

$$\triangle y_{it} = \phi_i y_{i,t-1} + \beta_i' x_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \triangle y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}' \triangle x_{i,t-j} + \mu_i + \varepsilon_{it} \quad (1)$$

$i = 1, 2, ..N$, stand for the cross-section units (the countries that compose the middle-income countries) and $t = 1, 2, ...T$ denote time periods. Here y_t is a scalar dependent variable, $x_{it}\,(k \times 1)$ is the vector of (weakly exogenous) regressors for group i, μ_i represents the fixed effects, ϕ_i is a scalar coefficient on the lagged dependent variable, β_i's is the $k \times 1$ vector of coefficients on explanatory variables, λ_{ij}'s are scalar coefficients on lagged first-differences of dependent variables, and δ_{ij}'s are $k \times 1$ coefficient vectors on first-difference of explanatory variables, and their lagged values. We assume that the disturbances ε_{it}'s are independently distributed across i and t, with zero means and variances $\sigma_i^2 > 0$.

We also make the assumption that $\phi_i < 0$ for all i. This implies that there exists a long run relationship between y_{it} and x_{it}:

$$y_{it} = \theta_i' x_{it} + \eta_{it}, \qquad i = 1, 2, ..., N, \ t = 1, 2, ..., T \qquad (2)$$

where $\theta_i = -\beta_i'/\phi_i$ is the $k \times 1$ vector of the long-run coefficient, and η_{it}'s are stationary with possible non-zero means (including fixed effects). Then (1) can be written as

$$\triangle y_{it} = \phi_i \eta_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \triangle y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}' \triangle x_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (3)$$

where $\eta_{i,t-1}$ is the error correction term given by (2) and thus ϕ_i is the error coefficient measuring the speed of adjustment towards the long-run equilibrium.

Using the general framework described above,we consider the following approach:

Pool Mean Group Estimator (PMGE) The PMGE, advanced by Pesaran, Shin and Smith (1999), allows the intercepts, the short-run coefficients and error variances to differ freely across groups but the long-run coefficients are constrained to be the same. That is,

$$\theta_i = \theta, \quad i = 1, 2, ...N \qquad (4)$$

The common long-run coefficients and the group specific short-run coefficients and the group-specific short-run coefficients are computed by the pooled maximum likelihood (PML) estimation technique. These PML estimators are denoted by $\hat{\phi}_i$, $\hat{\boldsymbol{\beta}}_i$, $\hat{\lambda}_{ij}$ and $\hat{\boldsymbol{\delta}}_{ij}$and θ. We then obtain the PMGE as follows:

$$\begin{aligned}
\hat{\phi}_{PMG} &= \frac{\sum_{i=1}^{N}\hat{\phi}_i}{N}; \; \hat{\boldsymbol{\beta}}_{PMG} = \frac{\sum_{i=1}^{N}\hat{\boldsymbol{\beta}}_i}{N}; \\
\hat{\lambda}_{jPMG} &= \frac{\sum_{i=1}^{N}\hat{\lambda}_{ij}}{N}, \; j = 1, .., p-1; \hat{\boldsymbol{\delta}}_{jPMG} = \frac{\sum_{i=1}^{N}\hat{\boldsymbol{\delta}}_{ij}}{N}, \; j = 1, ..q-1 \\
\hat{\boldsymbol{\theta}}_{PMG} &= \hat{\boldsymbol{\theta}}
\end{aligned} \tag{5}$$

This depicts the pooling implied by the homogeneity restriction on the long-run coefficients and the averaging across groups used to obtain means of the estimated error-correction coefficients and other short-run parameters. Under long-run slope homogeneity, the PMGE are consistent and efficient. The Hausman (1978) test will be applied to examine the extent of the panel heterogeneity.

2.2 Threshold Autoregressive Estimation

Using the above estimation technique we can also test the Hviding, Nowak and Ricci (2004) finding of nonlinearity of reserves by employing the Threshold Autoregressive (TAR) estimation technique.[37] We now include an indicator term, which we use when testing for the existence of a non-linearity. This technique suggests the estimation of:

$$y_t = \beta_0 + (\beta_{11} + \beta_{12} I(P_{t-1} - \bar{P}))P_t \tag{6}$$

where y_t is a measure of currency volatility, P_t is the policy variable (reserve holdings) and $I(P_{t-1} - \bar{P})$ is an indicator variable.

The indicator variable is created by selecting a potential optimal level of the policy variable denoted by $\bar{P}$. $\bar{P}$ is then subtracted from the original data series denoted P_{t-1}. All values of the new series that are greater than zero are set equal to one and all values less than zero are set equal to zero such that $I(P_{t-1} - \bar{P})$ is a dummy variable with values

[37] See Potter (1995) and Koop, Pesaran and Potter (1996). Since PMGE is essentially a vector error correction model for panel data, we are able to incorporate the TAR estimation technique into the PMGE framework.

of zero and one. In order to determine what the threshold level might be, we add the β_{11} and β_{12} coefficients.

Previous empirical and theoretical literature find reserves to have a negative effect on exchange rate volatility. This implies that $\beta_{11} < 0$. Thus the threshold level of reserves $\left(\bar{P} = P^*\right)$ after which any further increases in reserves will either have no effect on exchange rate volatility $(\beta_{11} + \beta_{12} = 0)$ or lead to an increase $(\beta_{11} + \beta_{12} > 0)$ in exchange rate volatility. We test if either of these cases occur.

3 Specification

Standard models of exchange rates, based on macroeconomic variables such as prices, interest rates and output, are thought by many researchers to have failed empirically. However, Mark et al (2001) provide evidence that exchange rates incorporate news about future macroeconomic fundamentals. These models examine the response of exchange rates to announcements of economic data. We assess the impact of a set of macroeconomic fundamentals on real exchange rate volatility for group of transition economies. However, in the empirical literature, there is no consensus in the literature on a generally accepted model of exchange rates.[38]

Therefore, we begin by extending the econometric framework of Canales-Kriljenko and Habermeier (2004) and Hviding, Nowak and Ricci (2004). Furthermore, since we are explicitly concerned with effect of changes to macroeconomic fundamentals on exchange rate volatility in transition economies, we shall test if the explanatory variables we include in this model display a homogenous long-run effect on exchange rate volatility for a set of transition economies. We also control for external factors that may account for exchange rate volatility in transition economies. We demonstrate that such models might well be able to account for observed real exchange rate volatility in transition economies.

The data set consists of an unbalanced panel of 12 macroeconomic indicators for 19 countries between 1981 and 2003.[39] The measure of real exchange rate volatility (REXVOL), measured as the log of the coefficient of variation for the real exchange rate vis-à-vis the US dollar. Given the international empirical literature discussed in Section 1.1, real exchange rate volatility is hypothesized to be related to the

[38] See, for example, Sarno and Taylor (2002).

[39] The set of countries are: Argentina, Bolivia, Chile, Columbia, Ecuador, Hungary, India, Indonesia, South Africa , Sri Lanka, Mexico, Malaysia, Pakistan, Peru, Paraguay, Thailand, Turkey, Uruguay and Venezuela. This set of transition economies is chosen from the International Finance Corporation Global Index of August 2003.

following variables: the fiscal stance, measured as the budget surplus to GDP ratio (DGBAL) or indebtedness (DBGDP), measured by the log of government debt to GDP ratio in US dollars PPP; reserve adequacy (RA), measured as the number of weeks of import cover; real GDP growth (DGDP), measured in US dollars PPP terms; the inflation rate (INF) and the change in the inflation rate (DINF), measured using the consumer price index (CPI); financial deepening, measured by the ratio of M3 to GDP (FINDEEP); net capital inflows to GDP ratio (CAPFLOW), measured in US dollars PPP terms; the current account balance to GDP ratio (CAB); a measure of the degree of openness of the economy (OPEN), measured as the log of the ratio of exports plus imports toGDP; and a measure uncertainty (INSTAB), measured by the log of the interest rate differential between the US and each country's interest rate as a proxy for uncertainty.

Due to data constraints, it was not possible to construct a direct measure of the terms of trade volatility as this data is not available for all countries at a high frequency. Second best is to proxy this volatility. This analysis selects oil price volatility (OILV), measured by the volatility of the US dollar price for oil, as the measure best suited to proxy terms of trade volatility. This is because the oil price is an important part of either the import or export basket for almost all the countries in the sample. It is also argued that commodity price volatility is a good proxy for terms of trade volatility.[40] Researchers also find that commodity prices are strongly cointegrated with the real exchange rate and may even be a better predictor of exchange rate fluctuations than terms of trade.[41] MacDonald and Ricci (2003) provide an explanation why this is the case. They assert that the relative accuracy of commodity price data as opposed to arbitrary, country-specific export and import deflators, together with the high frequency of commodity price data, allows for financial markets to anchor their decisions on exchange rate movements to the prices of these commodities.

Given the substantial literature on the link between commodity-exporting countries and the level of the exchange rate, so it would follow that volatility in commodity prices may also filter through to volatility in exchange rates. For example, for a commodity exporting country, a higher commodity price should appreciate the real exchange rate through income or wealth effects by inducing higher wages. This would induce

[40] See Havemann (2005) for a detailed explanation of the linkage between commodity prices, terms of trade and the real exchange rate.

[41] See, for example, Chen and Rogoff (2003), MacDonald and Ricci (2002), and Cashin, Cespedes and Sahay (2004).

higher domestic demand and increase the price of nontradables.[42] These effects should be captured in the country's terms of trade.[43] Figure 3 portrays commodity price volatility matches volatile periods in the world economy as well.

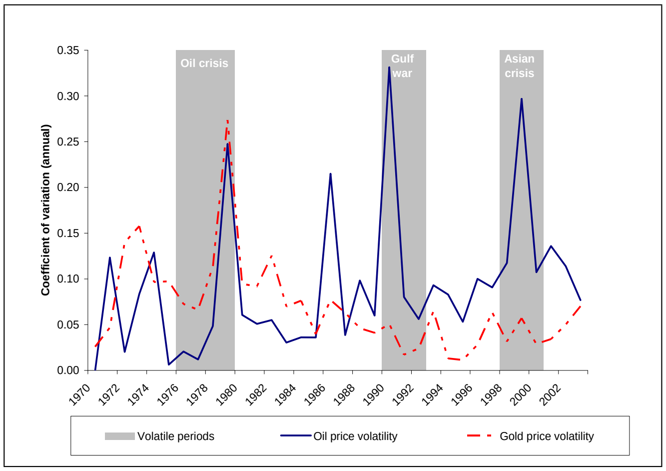


Figure 3: Oil and gold price volatility (1970-2002)

There is a strong argument that there are time-specific factors at play when considering exchange rate volatility. One example is the Asian crisis of 1997/8. Although the effects of the sudden devaluation of the Thai bhat during the 1997/8 Asian crisis were initially only felt in south-east Asia, financial contagion quickly spread throughout global financial markets. This is a good example of a case where the poor fundamentals of one country (in this case Thailand) led to exchange rate volatility in other (emerging) countries. There are a number of approaches that may be used to capture systemic volatility in the world economy. We use the volatility of the Dollar-Euro exchange rate (DEUROV) as proxy for world volatility.

Given the above, we estimate the following:

$$\Delta REXVOL_{it}=\phi_i REXVOL_{i,t-1}+\sum_{j=1}^{q-1}\lambda'_{i,j}\Delta REXVOL_{i,t-j}+\sum_{j=1}^{p-1}\boldsymbol{\gamma}'^{m}_{i,j}\Delta\mathbf{X}^{m}_{i,t-j}+ \sum_{j=1}^{p-1}\boldsymbol{\gamma}'^{TOT}_{i,j}\Delta\mathbf{X}^{TOT}_{i,t-j}+\sum_{j=1}^{p-1}\boldsymbol{\gamma}'^{W'}_{i,j}\Delta\mathbf{X}^{W}_{i,t-j}+\mu_{i,t} \quad (7)$$

where i and t are country and time indices, respectively. $\mathbf{X}^m_{i,t}$, $\mathbf{X}^{TOT}_{i,t}$ and $\mathbf{X}^W_{i,t}$ represent macroeconomic fundamentals, terms of trade volatility and world volatility, respectively. ϕ_i is the error correction coefficient.

[42] See Cashin, Cespedes and Sahay (2004) and Diaz-Alejandro (1982).

[43] Recall that a country's terms of trade is measured as the ratio of export prices to import prices.

4 Data

There are a number of measures of exchange rate volatility. We use the coefficient of variation (c_v) of the currency to capture exchange rate volatility.[44] It is calculated based on the monthly real exchange rate for each country in the sample. The coefficient of variation is a normalized measure of dispersion. This is a more appropriate measure of volatility since the average real exchange rate for each country per year is significantly different from one another. It is defined as the standard deviation (σ) divided by the mean (μ).

$$c_v = \frac{\sigma}{\mu} \tag{8}$$

Most countries do not publish monthly real exchange series, so this for this analysis we create a real exchange rate series in the standard way, by deflating the nominal exchange rate relative to the United States using that country's consumer price index relative to the US consumer price index.

We focus on real exchange rate volatility vis-à-vis the US dollar because certain countries (like Argentina) followed fixed nominal exchange rates for a considerable duration of the sample period.[45] We may argue that some of these countries had less flexible exchange rate regimes and therefore less volatile exchange rates. It is important to realize that all countries experience real exchange rate volatility, regardless of the exchange rate regime. Clark et al (2004) find that less flexible exchange rate regimes do not necessarily guarantee reduced real exchange rate volatility. This is because the real exchange rate measures both internal prices and external prices (tradables and non-tradables). Thus even when the nominal exchange rate is fixed, the real exchange rate is still volatile.[46] Calvo and Reinhart (2002) show that all real exchange rates, pegged or floating, are characterized by currency volatility.

Furthermore, pegged currencies have a greater likelihood of becoming 'freely falling', as speculators may force the central bank to abandon a peg when reserves dry up.[47] Indeed, a flexible exchange rate may bring about real exchange rate stability, by reducing the likelihood of speculative attacks against the currency.[48]

[44] The data on exchange rate volatility including the other variables included in this study is obtained from the International Financial Statistics of the International Monetary Fund.

[45] For example, Argentina had fixed exchange rate regime until the crisis of 1998.

[46] See for instance Giovannini (1998), Engel (1993), Engel & Rogers (1997).

[47] See, for example, Krugman (1996).

[48] The role of exchange controls is also an area of debate. Canales-Kriljenko and

In addition, sticky prices result in real exchange rate volatility.[49] Given that the real exchange rate is frequently never equal to one, even in the long run, this indicates a failure of the Purchasing Power Parity (PPP) in the data. An explanation for this is that changes to the macroeconomic environment generate deviations from PPP as trend movements in relative prices lead to persistent deviations from PPP. Moreover, the fixing of the nominal exchange rate implies that prices reflect shocks in the economy. This leads to volatility in the real exchange rate.[50]

Increasing exchange rate volatility may be reflecting rising uncertainty surrounding the socioeconomic factors in a particular country. Figure 4 depicts SA Rand volatility from 1981 to 2003. In SA Rand volatility rose, simultaneously with rising risk levels. For example, increased political uncertainty in 1985 and 1994 when the Rubicon Speech and first democratic elections occurred, respectively, the real exchange rate was relatively more volatile.

Constructing this measure of exchange rate volatility for a set of transition economies for the period 1982-2004, Figure 5 shows the South African Rand to be the fourteenth most volatile currency with Turkey being the most volatile currency.[51] Dissecting this sample into decades and ranking the currencies from the most to least volatile, Table 1 shows that Argentina and Turkey continue to have the most volatile currencies with the Bolivian pesos' volatility decreases and the South African Rand's volatility rising towards the 2000s.

5 Econometric Results and their Robustness

We now estimate Equation (7). We are unable to consider the full specification illustrated by Equation (7) due to limited time series data.[52] Therefore we estimate Equation (7) by considering the three groups of variables. The first group is the country's macroeconomic fundamentals,

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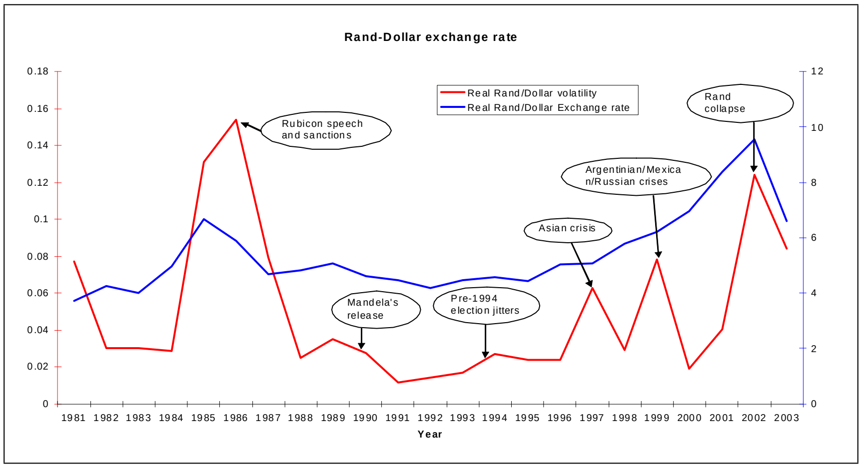
Harbermeir (2004) find that prudential limits on banks' foreign exchange position may reduce volatility by reducing speculative position taking. Such exchange controls may work to the detriment of the country if it creates an environment of overregulation.

[49] See, once again, Giovannini (1998), Engel (1993), and Engel and Rogers (1997).

[50] It may be better to use a trade-weighted measure of real eachange rate volatility. We argue that for a significant number of countries in the sample most trade and foreign debt is denominated in US dollars, suggesting this not a particularly important problem.

[51] We started out with an original sample of 23 transition economies. For reasons which we highlight in Section 5, we reduce the sample to 19 countries.

[52] We use a lag of 2.



Source: South African Reserve Bank

Figure 4: Rand-Dollar exchange rate from 1981-2003

i.e. variables that carry specific information about the country itself; the second group of variables – terms of trade volatility– captures the effect on real exchange rate volatility due to variability of a country's terms of trade; and the third group of variables - world volatility - reflects volatility of international markets.

Table 2 illustrates the estimations whose variables have a significant influence on real exchange rate volatility in the long-run.[53] Moreover, the Hausman test statistic reveals long-run homogeneity of currency volatility in response to macroeconomic fundamentals and external shocks across the set of transition economies.[54]

Using net capital flows and the measure of financial deepening we reject long-run homogeneity of regressors across the set of countries. This implies that real exchange rate volatility does not have a similar response to net capital flows and financial deepening across the set of 19 countries in the long run. The breakdown of homogeneity across the countries for the measure of financial deepening occurs because some countries have characteristics of developed-country financial markets while others have characteristics of developing-country financial markets.[55] Likewise, cap-

[53] Most of the coefficients of the explanatory variables are significant except for GDP growth in Regression [3].

[54] We fail to reject (i.e., accept) long-run homogeneity of the regressors across the set of countries, we claim that the impact is not statistically different across the set of transition economies in the long run.

[55] South Africa has highly developed financial markets similar to developed Anglo-Saxon economies. See Kularatne (2002).

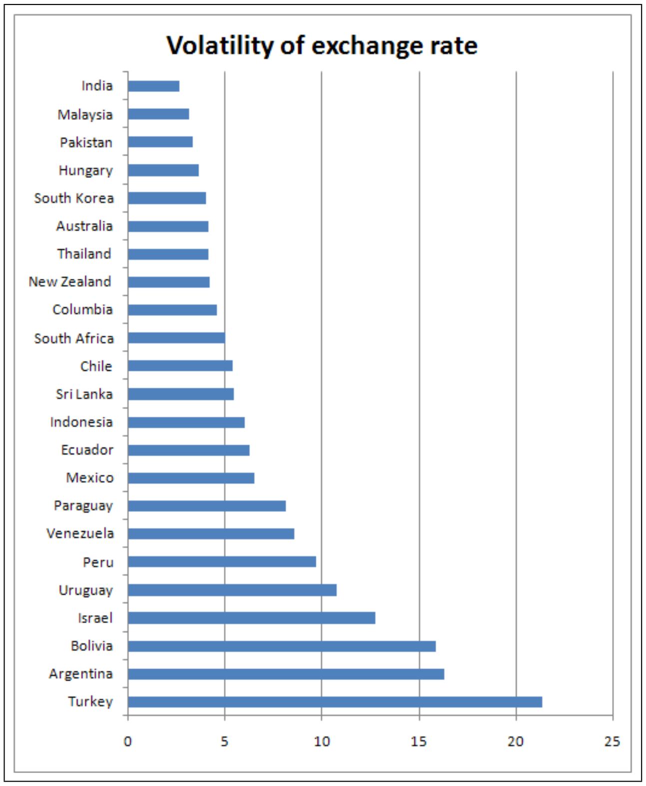


Figure 5: Real exchange rate volatility 1981-2004

ital flows to these economies have a diverse effects on real exchange rate volatility across the countries because the type of capital flows that affect each economy are different. For example, some economies may have an inordinate amount of short-term or 'hot money' capital flows whilst other economies have capital flows that reflect long-term investment opportunities in a country.[56]

From Table 2, we observe that the error correction term (ϕ) is between 0 and -1, indicating that a cointegrating relationship exists for all nine regressions. The results that are presented are shown to be robust to different specifications.

[56] A point to note is that we started the analysis with 23 transition economies and we present the analysis for a panel of 19 countries. The breakdown of the Hausman long-run homogeneity assumption for the entire panel is the reason for estimation across a smaller sample. The countries that we omitted are Australia, Israel, New Zealand and South Korea. We argue that the Hausman test fails because real exchange rate volatility in these countries are affected differently in the long run to the 19 countries in the subsample when changes occur to their macroeconomic fundamentals.

Country	1982-2004	80s	90s	2000s
Argentina	2	3	2	2
Australia	18	15	18	18
Bolivia	3	1	7	6
Chile	13	11	14	15
Columbia	15	17	15	11
Ecuador	10	10	19	5
Hungary	20	23	17	12
India	23	22	21	23
Indonesia	11	13	10	10
Israel	4	4	3	3
Malaysia	22	21	16	22
Mexico	9	8	12	14
New Zealand	16	14	20	16
Pakistan	21	19	23	17
Paraguay	8	7	8	9
Peru	6	5	5	13
South Africa	14	12	22	8
South Korea	19	18	13	19
Sri Lanka	12	16	9	20
Thailand	17	20	11	21
Turkey	1	2	1	1
Uruguay	5	6	4	4
Venezuela	7	9	6	7

Sample: 1982-2004

Table 1: Ranking of Real Exchange Rate Volatility against US Dollar

5.1 Macroeconomic variables ('fundamentals')

The results support the *a priori* expectation of the impact of changes to these macroeconomic fundamentals on real exchange rate volatility. Rising levels of reserves, an improved fiscal balance, rising GDP growth, increased openness, lower inflation and lower levels of risk or uncertainty reduces real exchange rate volatility. Detail results are given below.

1. Reserves

   From Regressions [1] – [4] and [7] in Table 2 reports that increasing the level of import cover, measured in number of weeks, reduces has a negative, significant impact on real exchange rate volatility. It is estimated that an increase in foreign reserves of 1 week reduces exchange rate volatility by between 2 to 4 percent. This result is robust across specifications. Using the methodology outlined in Section 2.2, the study tests for a nonlinear association between reserves and exchange rate volatility. We find that the optimal level of reserves is 4-and-half months of import cover, after which increasing the level of reserves has an insignificant impact on exchange rate volatility.[57] The result we find is similar to Hviding, Nowak and Ricci (2004).

2. Fiscal policy

   Improving the fiscal position decreases variability of the real exchange rate. Regressions [1] and [5] indicates a one percentage point improvement in the budget surplus to GDP ratio leads to a 0.8 percent or 1.3 percent decrease in real exchange rate volatility, respectively. Similarly a lower debt to GDP ratio is associated with lower real exchange rate volatility. As indicated in Regressions [2] and [9], a one percentage point increase in the debt to GDP ratio leads to a 0.27 or 0.40 percent decrease in exchange rate volatility, respectively. These results confirm the finding of Cady and Gonzalez-Garcia (2007).

3. Current account balance

   The research conducted found that the level of the current account balance did have a statistically significant effect on rand volatility.[58] A 1 percentage point improvement in the current account will lead to 4 percent decrease in rand volatility. In addition, improvements in the current account reduces rand volatility at an increasing rate, i.e., the more the current account improves, there are rising gains in terms of reduced rand volatility.

   The level of reserves, a country's fiscal position and her current account balance are macroeconomic fundamentals that signal to the markets the credibility and sustainability of the macroeconomic policy. Imbalances in the economy will filter into low levels of reserves, a deteriorating fiscus and/or pressure on the current account. A deteriorating current account balance increases currency volatility as the country's dependence on capital inflows (which are relatively mobile) increases. Fluid capital flows will adversely affect real exchange rate volatility.[59]

[57] For example, at the end of 2005, South Africa had approximately 3 months of import cover. The implication of this finding is that SA could reduce Rand volatility by increasing reserves to the optimal four-and-half months.

[58] See Regression [7].

[59] The deteriorating current account balance in some of the emerging-market

4. GDP growth

   GDP growth is only weakly significant and not robust to different specifications. One regression that did include this variable is reported – Regression [4]. It suggests that a one percentage point increase in growth leads to a 2.38 percent decrease in real exchange rate volatility. This finding is contrary to Hausmann et al (2006) finding of changes in output (measured by growth in GDP) having adverse consequences for growth. The implication is that rising growth rates in transition economies reduce currency volatility. Markets that observe growing economies are likely to have less uncertainty regarding the macroeconomic position of these economies resulting in reductions real exchange rate volatility. Moreover, a strongly growing economy may be at less risk of a currency crisis as it able to attract sufficient capital inflows.

5. Uncertainty

   From Regressions [1] – [7] we observe that rising levels of uncertainty increases real exchange rate volatility between 0.10-0.12 percent for a one percent increase in uncertainty. This finding is not surprising as we discussed in Section 1 that real exchange rate volatility could be a proxy for uncertainty surrounding the socioeconomic position of a country.

6. Inflation rate

   From Regressions [8] and [9], rising inflation rates are found to increase real exchange rate volatility at a decreasing rate. Hausmann et al (2006) emphasize that large nominal shocks, like an increase in the inflation rate adversely affects currency volatility in transition economies more than developed economies because transition economies are more likely to have non-credible monetary institutions and weak fiscal position.

7. Openness

   A one percent increase in openness results in a 0.12 to 0.22 percent decrease in real exchange rate volatility from Regressions [6]

economies has been mitigated by net equity portfolio inflows. For example, in South Africa's case, net non-resident equity portfolio inflows averaged US$ 0.7 billion per month in 2005, helping to fund an average monthly current account deficit of US$ 0.8 billion. However, the dependence of South Africa on non-resident portfolio inflows has raised a potential dilemma: if equity inflows suddenly stop or are reversed, the loss of this rand stability anchor could put downward pressure on the rand and upward pressure on inflation via the exchange rate pass-through to prices.

and [5], respectively. This result helps to confirm the theoretical prior that relatively closed economies with little aggregate price flexibility due to a lower import share are deprived of this aggregate price level flexibility transmitted through the exchange rate and therefore produce (*ceteris paribus*) more pronounced effects on consumption and the real exchange rate. Thus, as purported by Hau (2002b), opening the economy reduces currency volatility.

5.2 Terms of trade shocks

As mentioned above, terms of trade volatility is proxied in this study by oil price volatility. Table 2 reports Regressions [1], [3], [5] and [8] which include oil price volatility. All four regressions indicate rising oil price volatility has adverse consequences for real exchange rate volatility. In particular, one percent increase in oil price volatility leads to a 0.06 to 0.07 percent increase in the volatility of the exchange rate depending on the specification. This finding is in keeping with Hausmann (2005).

5.3 World volatility

Our proxy for world volatility, the real exchange rate volatility of the Dollar-Euro increases real exchange rate volatility in transition economies. A one percent increase in Dollar-Euro volatility leads to a 2.31 percent increase in a country's real exchange rate volatility. The argument that systemic impact of global volatility affects individual currency volatility in transition economies is supported by this result.

6 Scenarios

The effects of the various explanatory variables on real exchange rate volatility in terms of actual currency is discussed below. Table 3 provides scenarios[60] based on the regression coefficients illustrated in Table 2. The scenario is simulated on South African data.[61]

From Table 3 we observe that changes to the debt to GDP ratio and the current account balance has the highest impact on exchange rate volatility. Worsening current account deficits and debt to GDP ratios increase the standard deviation of the real exchange rate by 30 cents. In

[60] Table 5.3 depicts standardised results.

[61] As we failed to reject long-run homogeneity of the regressors across the set of countries, we claim that the impact is not statistically different across the set of transition economies in the long run. However, for each country, the exact impact of each explanatory variable on exchange rate volatility depends on the initial value of each explanatory variable and the exchange rate which may vary from country to country.

fact, the impact on real exchange rate volatility due to a deterioration of the fiscal and the current account balance is larger than the impact of oil price or Dollar-Euro volatility.

The results imply that government policy may have a larger impact on real exchange rate volatility than factors outside the domestic economy. These results once again reinforce the importance of macroeconomic performance of the country in reducing exchange rate volatility. The signalling effect of government macroeconomic policy is crucial for real exchange rate variability.

Although the magnitude of the sensitivity of real exchange rate volatility to world volatility and oil price volatility is relatively low, the frequency of the change in these variables result in the daily movements in the exchange rate being affected primarily by these two variables. This is because information on the macroeconomic performance of the country is rather infrequent[62] while information on the Dollar-Euro exchange rate and the oil price is available instantaneously.

7 Conclusion

This paper concentrates on the cross-country determinants of exchange rate volatility for a panel of transition economies. The results indicate that the behaviour of real exchange rate volatility to macroeconomic fundamentals and external factors, across a set of transition economies, is similar to one another in the long run. The study suggests that prudent macroeconomic policy - a combination of low inflation and a healthy budget balance - lowers exchange rate volatility.[63] Particularly, results in other studies underscore the role of reserves in reducing volatility, even if this is merely as a signal to market participants. The findings of an optimal level of import cover is significant in that provides a mechanism for anchoring the accumulation of reserves at some level.

Terms of trade volatility, proxied by oil price volatility, increases exchange rate volatility for the countries in the sample. This is not surprising as many of the countries are either significant importers or exporters of oil. Furthermore, the scenarios displayed in this analysis provides a more concrete understanding as to the impact of these variables on exchange rate volatility in Rands and cents.

The governments of transition economies (if not all economies) should attempt to ensure good governance, efficient institutions and strive to

[62] Usually only quarterly data is available on a country's macroeconomic performance.

[63] See Hausmann (2008) report to the National Treasury of South Africa highlighting the importance of adhering to prudent macroeconomic policy objectives so as not to adversely affect currency volatility.

create an enabling environment in order to influence the risk-adjusted return on investment in order to reduce the volatility of capital flows and in turn, reduce currency volatility.

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	Regression (1)	Regression (2)	Regression (3)	Regression (4)	Regression (5)	Regression (6)	Regression (7)	Regression (8)	Regression (9)
Macroeconomic variables	Reserves, Budget surplus -to-GDP, uncertainty, oil volatility	Reserves, Debt-to-GDP, uncertainty	Reserves, GDP growth, uncertainty, oil volatility	Reserves, GDP growth, uncertainty dollar/euro volatility	Budget surplus -to-GDP, openness, uncertainty	Openness, uncertainty, oil volatility	Current account, change in current account, import cover, uncertainty	Inflation rate, change in the inflation rate, oil volatility	Debt-to-GDP, inflation rate, change in inflation rate
Import cover	-0.043** (-2.98)	-0.044** (-3.09)	-0.037** (-4.45)	-0.044** (-3.64)			-0.022** (-2.78)		
Budget surplus to GDP ratio	-0.008* (-1.89)				-0.013** (-2.36)				
Log debt-to GDP ratio		0.279** (2.90)							0.398** (4.04)
GDP growth			-0.574 (-1.50)	-2.378** (-4.33)					
Openness					-0.221* (-1.72)	-0.122** (-2.14)			
Inflation rate								0.178** (3.70)	0.32** (5.25)
Change in the inflation rate								-0.037** (2.77)	-0.032** (-1.99)
Log Uncertainty	0.103** (9.65)	0.100** (9.10)	0.117** (16.20)	0.132** (9.25)	0.105** (8.392)	0.096** (9.29)	0.100** (8.97)		
Terms of trade volatility									
Log Oil volatility	0.062** (2.44)		0.074** (3.94)			0.064** (2.79)		0.060** (2.20)	
Current account balance							-0.040** (-3.62)		
Change in current account balance							-0.068** (-3.95)		
World volatility									
Dollar/euro volatility				2.309** (2.82)					
Φ	-0.858** (-13.27)	-0.842** (-12.46)	-0.915** (-7.24)	-0.827 (-8.85)	-0.908** (-17.90)	-0.985** (-10.56)	-0.913** (-7.55)	-0.86** (12.90)	-0.79** (-12.87)
Joint Hausman test (p-value)	1.80 (0.77)	0.53 (0.91)	7.10 (0.13)	5.39 (0.25)	4.08 (0.25)	4.14 (0.25)	6.15 (0.10)	5.99 (0.11)	5.35 (0.15)

* denotes significance at the 10% level and **denotes significance at the 5% level.
Standard errors in parentheses.

Table 2: Estimation results

				Number of Rand cents above/below the average[1]		
Macroeconomic variables	**Current values**	**Scenario**	**Difference**	**First half of 2006**	**Scenario result**	**Difference[2]**
Import cover (months)	3*	2	1 month	29 cents	30 cents	1 cent
Budget surplus to GDP ratio (%)	-0.59*	-1.59	1 percentage point	29 cents	49 cents	20 cents
Debt-to GDP ratio (%)	35.8*	36.8	1 percentage point	29 cents	59 cents	30 cents
Uncertainty	Rise by 50 basis points			29 cents	31 cents	2 cents
Terms of trade						
Oil volatility	Standard deviation rises by US$ 1**			29 cents	30 cents	1 cent
Openness (%)	56	55	1 percentage point	29 cents	30 cents	1 cent
Current account balance	-4.10*	-5.1	1 percentage point	29 cents	59 cents	30 cents
World volatility						
Dollar/Euro volatility	Standard deviation rises by 1 US cent**			29 cents	34 cents	5 cents

1. Measures deviation of Rand-US$ exchange rate from its mean in Rand cents (standardized)

2. Measures increase in standard deviation of Rand US$ exchange rate (in cents)

* represents 2005 average; **average calculated for the first half of 2006

Table 3: Scenarios