Exchange Rates Predictability in Developing Countries

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Abstract

The main objective of this study is to re-investigates the exchange rates predictability puzzle using monetary model. It is hypothesised that the performance of exchange rate predictability is better off in countries with monetary instability. We employ bootstrap technique as proposed by Kilian (1999) to alleviate statistical inference intricacies inherit in the long horizon forecasting for three different monetary models (flexible price, sticky price and relative price) for selected developing economies. The empirical result shows the superiority of sticky price model along with the evidence of exchange rate predictability for high inflation economies.

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1 INTRODUCTION

The aim of this paper is to investigate the exchange rate forecastability puzzle that suggests that macroeconomic fundamentals contain negligible predictive content about the movements of nominal exchange rates. Since the seminal papers by Meese and Rogoff (1983a, 1983b), a lot of resources has been channelled into the refinement of theoretical models and advancement of estimation techniques to explain better the puzzle. However, the empirical evidence from mature economies has consistently failed to overturn this paradox. Consequently, clarifying the puzzle remains a challenging area for the researchers.

In this paper we give monetary models another chance and investigate whether by using dataset from developing economies can improve their forecasting performance. Our expectation is to find significant exchange rate predictability for countries with unstable macroeconomic fundamentals (see for example McNown and Wallace, 1994; Rogoff, 1996 and 1999a; and Moosa, 2000). The reason underlying this hypothesis is that countries with greater monetary instability are expected to show a stronger correlation between exchange rates and monetary fundamentals. Rogoff (1999a) argues that economically stable countries like United States, Germany and Japan generally experience very modest inflation rates. In such circumstances, it is difficult to identify the effect of monetary shocks on exchange rates. On the other hand, developing economies experience high inflation rates, trade balance deficit, budget deficit and excess money supply.[2] These relatively weak economic fundamentals, in addition to the poor management of the economy, are postulated to be crucial in predicting exchange rates under the monetary approach. Furthermore, most of the literature in the area of exchange rate predictability deals with developed and industrialised economies. Until now not much work has been done to investigate the forecastability of exchange rates in developing economies despite their increasingly liberalised financial markets and their growing importance in the global financial system.[3]

This study differs from most previous studies in few ways. First, our sample is limited to developing countries that satisfy two important assumptions of the exchange rate determination model: relatively floating exchange rate and considerably open economy for a long period to allow meaningful time series analysis. It does not mean that the developing countries that we choose are fully liberalised, rather that the markets are satisfactorily open with little market frictions and government interventions. The countries we consider are Chile, Uruguay, Philippines, Thailand, Israel, Morocco, South Africa and Tunisia. According to Levy-Yeyati and Sturzeneggar (2003) these are countries that are adopting relatively floating exchange rate regime and on the process of liberalizing their capital account.

Second, motivated by Chinn and Meese (1995), we calculate the deviation from monetary fundamentals that suitable for the developing economies. In particular, we consider sticky price and relative price Balassa-Samuelson monetary models to account for developing country characteristics, as suggested by

[2] Refer to Table 1 for comparison between income volatility and inflation rate between developing countries and the US. Countries Chile, Israel and Uruguay are categorised as high inflation countries.

[3] Bulks of related works in the developing countries are more concern on the subject other than forecasting exchange rate movements using monetary model. Among other issues of interest are optimal exchange rate regime, (Hochreiter and Tavlas, 2004; Alfaro, 2005), exchange markets integration, (Francis et al. 2002; Cheung et al. 2006; Rogers, 2006; Tai, 2007), exchange markets and financial crisis, (Phengpis, 2006; Kan and Andreosso-O'Callaghan, 2007), and exchange rate determinants, (Civcir, 2004; Candelon et al. 2006).

MacDonald and Ricci (2001). These models are expected to be superior to the standard flexible monetary model especially for countries which are still in the process of liberalization period (see Crespo-Cuaresma *et al.* (2005); Candelon et al. 2007).

Third, we use an error-correction framework to investigate both in-sample predictive content and out-of-sample point forecast accuracy of the fundamental-based models by employing the bootstrap technique proposed by Kilian (1999). The technique is able to account for small sample biases and size distortion that arise in the inferences procedure. Furthermore, the methodology is designed to differentiate whether forecastability power (if any) is due to the contribution of the explanatory variables or simply due to the drift term in the model.

The plan of the paper is as follows. Section 2 delves with literature reviews. In Section 3, we describe the process of constructing the fundamental variables, the dataset and the econometric procedure for testing predictability of exchange rate using the monetary models. Section 4 discusses the findings and the link between predictability and economic fundamentals of developing economies. Section 5 concludes.

2 LITERATURE REVIEW

The study of exchange rates predictability was pioneered by Meese and Rogoff (1983a, 1983b). Their results suggest that none of the structural exchange rate models were able to forecast out-of-sample better than a naïve random walk model. Subsequently, an extensive work has been carried out using various econometric techniques and different information sets to challenge the superiority of the random walk over monetary models of exchange rate determination. However, after more than two decades of efforts, none of the out-of-sample empirical work finds consistent evidence of superior forecastability of structural models compared to the random walk.

Mark (1995) has given a new hope for exchange rate predictability by exploiting the assumed long-run linkages between exchange rates and monetary fundamentals. He finds significant evidence of forecastability at longer horizons (12 and 16 quarter). The same conclusion can also be found in Chinn and Meese (1995) who investigate the same issue using a larger set of explanatory variables. Chinn and Meese (1995) find that fundamental-based error-correction models outperform the random walk model for long term prediction horizons. However, both the econometric techniques and the results of Mark (1995) and Chinn and Meese (1995) have not been free from criticism. Kilian (1999) finds that Mark's results suffer from inconsistencies in the testing procedure and small-sample bias. Correcting for these drawbacks, Kilian (1999) finds no support for long run predictability of exchange rate. Later, Berkowitz and Giorgianni (2001) argue that the results of Mark (1995) are not robust and heavily depend on the assumption of cointegration in the long run series. Berkowitz and Giorgianni (2001) show that using the same dataset as Mark (1995) but under the unrestricted VAR model has produced very little evidence of predictability. Therefore, unpredictability of exchange rates remains if no prior assumption is imposed.[4]

[4] Comprehensive debate on the reliability of long-term exchange rate forecast can be found in Berben and van Dijk (1998), Groen (1999) and Rossi (2005), among others.

Recent studies that use different information set and econometrics approaches (mostly depart from the traditional linear time series) to analyse the association of exchange rates and economic fundamentals do find encouraging support. For example, Kilian and Taylor (2003) use an Exponential Smoothing Threshold Autoregressive (ESTAR) model for seven OECD countries. They show the (in-sample) relevance of nonlinearities in exchange rate dynamics at the one- and two-year horizons. However, they still could not find support for out-of-sample predictability. Manzan and Westerhoff (2007) propose a chartist-fundamentalist model which allows for nonlinear time variation in chartists' extrapolation rate that provide support for the long-term predictability for five major currencies (German mark, Japanese yen, British pound, French franc and Canadian dollar) against the US dollar. Their study shows that the fundamentalist, together with the chartist, are correcting the deviation of exchange rate from its long run equilibrium path.

Faust et al. (2003) criticise the use of revised data for the fundamental variables and propose the use of real-time (unrevised) data. They argue that revised data can be used only if economic agents have the ability to predict future data (including the revision) correctly. However, this is not the case as Faust et al. (2005) among others, has shown that revisions to preliminary fundamental values are large and are unpredictable for some countries. Faust et al. (2003) empirically show that the exchange rate determination models that use real-time data are capable of explaining about 75% of the monthly directional changes of the US dollar-Euro exchange rate.

A comprehensive review of the empirical literature on the exchange rate unpredictability for industrialised nations over the last few decades can be found in Neely and Sarno (2002) and Cheung et al. (2005). The plausible explanations for the empirical failure of the exchange rate determination models include the instability of the parameters over the period, simultaneity problems, improper modelling of expectations formation and the failure of law of one price, among others. Following these dismal findings, exchange rate economists have drawn the conclusion that exchange rate movements cannot possibly be attributed to macroeconomic fundamentals, at least in the short term. However, they have a firm belief that exchange rates cannot move independently from macroeconomic fundamentals over long horizons.

3 EXCHANGE RATE PREDICTABILITY AND DEVELOPING COUNTRIES

3.1 Evidence

Investigating the predictability of exchange rate movements using exchange rate determination model in developing economies has not been an easy task. Empirical attempts are hampered by the difficulty to find an appropriate market that satisfies the assumption of free floating regime, free capital mobility and stable monetary regime.[5] Consequently, there is only relatively little empirical evidence of exchange rate forecastability in developing countries during post-liberalization eras. These very handful empirical works also produce inconsistent results and therefore no concrete conclusion can be drawn from these limited findings.

[5] Chinn (1998) stresses the importance of capital imperfect mobility and substitutability, and instability of money demand that are widespread in developing countries in monetary modelling in developing countries.

For instance, Ferreira (2006) extensively investigates the significance effect of monetary fundamentals on the exchange rates for Chile, South Korea, Malaysia, Mexico, South Africa, Thailand and Turkey from 1992 to 2002 using panel cointegration techniques. He considers the sticky price model to account for the price rigidities effect between developed and developing countries. The empirical evidence does not show any significant support to reject the hypothesis of no long run co-movement between exchange rates and monetary fundamentals across time and models.[6] Therefore the finding casts doubt on the validity of the hypothesis introduced by McNown and Wallace (1994) who find significant co-movement between exchange rate and monetary fundamentals in some developing countries (Argentina, Chile and Israel). On the other hand, Wang and Wong (1997) use Kalman filtering techniques and ARCH models to address the issues of parameter instability and conditional variances to predict Japanese yen, Singapore dollar and Malaysian ringgit from 1973 to 1995. They find that the predictive power improves over 6 to 12 months forecasting horizons. The out-of-sample forecast errors are significantly lower compared to the naïve random walk model. Baharumshah and Masih (2005) further confirm this finding using cointegration techniques. They find substantial evidence of strong predictive power of the monetary model, both for in-sample and out-of-sample forecast accuracy. Based on the standard root mean square error (RMSE) and the Theil's *U* statistics, their findings suggest that the structural model performs better than the random walk only when the current account is included into the VAR system. They also find the error-correction term in the exchange rate equation enters with a significantly negative coefficient. This could suggest that exchange rates converge to the equilibrium path over longer period.

3.2 Monetary Models and Estimation Procedure

Theoretically, economists strongly believe that the exchange rate cannot deviate significantly from its "fundamental value". In other words, the exchange rate and the fundamental value are supposed to be cointegrated and one of the two variables will pull the other toward the equilibrium path. Therefore current deviations of the exchange rate from its fundamental value should help predict future exchange rate movements. As such, they may be represented in a typical dynamic error-correction framework:

$$\Delta s_{t+k} = s_{t+k} - s_t = \alpha_k + \lambda_k (s_t - f_t) + \upsilon_{t+k} \quad k = 1, 8, 12 \text{ and } 16 \qquad \textbf{\textit{Equation 1}}$$

where s_t is logarithm of the nominal domestic-currency price of one unit of foreign exchange at time *t*. f_t represents the fundamental value of the exchange rate. α_k is a constant and λ_k is the predictability parameter to be estimated. *k* is the forecast horizon (3 months or quarter of a year) and υ_t is an *iid* disturbance term. If λ_k is smaller than 0, Equation 1 predict that the exchange rate should depreciate when $s_t > f_t$ in order to revert toward the equilibrium path. A statistical test of predictability of exchange rate at horizon *k* is thus carried out based on the null hypothesis of no predictability, $H_0 : \lambda_k = 0$, against the alternative hypothesis of predictability,

[6] Panel cointegration techniques have been employed in order to mitigate the problem of small sample bias and to increase the power of the statistical test. However, Neely and Sarno (2002) cast doubt on the validity of across countries estimation since currency values in different countries may be driven by very different forces such as monetary policy and exchange rate regime.

$H_1 : \lambda_k < 0$. There are at least two econometric procedures often used to estimate exchange rate predictability namely, traditional linear and non-linear time series techniques. In this study we only consider the conventional linear time series methodology.

The estimation of Equation 1 is implemented in 2 steps. First step consists of obtaining the fundamental value f_t and the second is to estimate the forecasting regression. Specifically, first, we use Mark (1995) methodology to construct the fundamental value but with few alteration to suite developing market characteristics. Instead of imposing theoretical value to the elasticity of money stock and income elasticity of money demand to [1, -1] respectively, the fundamental value f_t will be constructed using the estimated elasticity of money stock and income elasticity of money demand from the estimated cointegrating coefficient of the Dynamic Ordinary Least Squares (DOLS) method. After constructing the fundamental values then the forecasting estimation will be carried out employing bootstrap procedure proposed by Mark (1995) and improved by Kilian (1999) under a constrained error-correction specification.

3.2.1 Construction of the Fundamental Values

The fundamental values f_t is constructed using cointegrating coefficients estimated by DOLS regression using the following specification:[7]

$$s_t = \alpha + \beta f_t + \sum_{j=-q}^{q} \delta_j \Delta f_{t-j} + \varepsilon_t \qquad \textbf{\textit{Equation 2}}$$

where f_t is a vector of fundamental variables obtained from either one of the following three monetary models;

flexible price model

$$f_t = [(m_t - m_t^*),\ (y_t - y_t^*)] \qquad \textbf{\textit{Equation 3}}$$

sticky price model

$$f_t = [(m_t - m_t^*),\ (y_t - y_t^*),\ (i_t - i_t^*),\ (\pi_t - \pi_t^*)] \qquad \textbf{\textit{Equation 4}}$$

and **relative price model**

$$f_t = [(m_t - m_t^*),(y_t - y_t^*),(i_t - i_t^*),(\pi_t - \pi_t^*),(p_t^T - p_t^N) - (p_t^{T*} - p_t^{N*})] \qquad \textbf{\textit{Equation 5}}$$

where *m, y, i, π* and *p* in Equation 3 , 4 and 5 represent the logarithm of money stock, the logarithm of real income, nominal interest rate, the CPI inflation rate and overall prices which include *T*, tradable, and *N*, non-tradable goods, respectively. An asterisk indicates foreign markets. β in Equation 2 is a vector of parameters of the corresponding monetary models (flexible price, [β_m, β_y]; sticky price, [$\beta_m, \beta_y, \beta_i$,

[7] For *I(1)* series with one cointegration relation, the DOLS estimation procedure produces efficient estimates of the cointegrating vector.

β_π]; and relative price, [$\beta_m, \beta_y, \beta_i, \beta_\pi, \beta_p$]). The β_m represents the elasticity of money stock, β_y is the income elasticity of money demand, β_p is the relative price elasticity, β_i and β_π are the interest and inflation semi-elasticity, respectively. The anticipated sign for the estimated coefficients are β_m, β_p and $\beta_\pi > 0$, while β_y and $\beta_i < 0$. Δ is difference operator and following Stock and Watson (1993) we set the number of leads and lags of the regressor (q) in the DOLS estimator of Equation 2 equal to three ($q = 3$). We use Newey-West procedure to compute robust standard errors.

The estimated cointegrating coefficients, $\hat{\beta}$s in Equation 2 are then used to construct the fundamental values based on the following models;

flexible price,

$$\hat{f}_t = \hat{\beta}_m(m_t - m_t^*) - \hat{\beta}_y(y_t - y_t^*) \qquad \textit{\textbf{Equation 6}}$$

sticky price,

$$\hat{f}_t = \hat{\beta}_m(m_t - m_t^*) - \hat{\beta}_y(y_t - y_t^*) - \hat{\beta}_i(i_t - i_t^*) + \hat{\beta}_\pi(\pi_t - \pi_t^*) \qquad \textit{\textbf{Equation 7}}$$

and **relative price**,

$$\begin{aligned}\hat{f}_t = {} & \hat{\beta}_m(m_t - m_t^*) - \hat{\beta}_y(y_t - y_t^*) - \hat{\beta}_i(i_t - i_t^*) + \hat{\beta}_\pi(\pi_t - \pi_t^*) \\ & + \hat{\beta}_p[(p_t^T - p_t^N) - (p_t^{T*} - p_t^{N*})]\end{aligned} \qquad \textit{\textbf{Equation 8}}$$

Deriving fundamental values using the standard flexible price monetary model (Equation 6) is the most common procedure that has been extensively used by most of the researchers in the area, Mark (1995) and Kilian (1999) among others.[8] However, it is less appropriate in the case of developing countries since it requires domestic and foreign asset to be perfect substitutes and uncovered interest parity (UIP) condition to hold in the markets.

In this paper, we consider also two extension of the basic monetary model as suggested by Chinn (1998). First, following the work of Dornbusch (1976) and Frankel (1979), we consider a monetary model that incorporates short-term price rigidities (Equation 7). This model incorporates variables that allow for short run price stickiness that violates the Purchasing Power Parity (PPP) hypothesis. In addition, the relationship includes interest rates in order to capture the short term liquidity effect of the monetary policy. Second, we consider relative price movements by including the tradable and non-tradable goods within and across countries. Following Balassa (1964) and Samuelson (1964), the relative prices model is driven by relative differentials in productivity in the tradable and non-tradable sectors as presented in Equation 8. These two approaches, i.e. the sticky price monetary model and the relative price Balassa-Samuelson model, are expected to represent better the fundamental values of developing economies. Furthermore, the

[8] Mark (1995) and Kilian (1999) impose value of [1, -1] to β_m and β_y respectively.

inclusion of sticky prices and the Balassa-Samuelson effect in f_t could be crucial to find cointegration evidence in developing countries.

Equation 1, combined with the structural models discussed above, result in the following predictability equations:

Model 1:

$$\Delta s_{t+k} = \alpha + \lambda_k [s_t - (\hat{\beta}_m (m_t - m_t^*) - \hat{\beta}_y (y_t - y_t^*))] + \varepsilon_{t+k} \qquad \textbf{\textit{Equation 9}}$$

Model 2:

$$\begin{aligned} \Delta s_{t+k} &= \alpha + \lambda_k [s_t - (\hat{\beta}_m (m_t - m_t^*) - \hat{\beta}_y (y_t - y_t^*) - \hat{\beta}_i (i_t - i_t^*) \\ &\quad + \hat{\beta}_\pi (\pi_t - \pi_t^*))] + \varepsilon_{t+k} \end{aligned} \qquad \textbf{\textit{Equation 10}}$$

Model 3:

$$\begin{aligned} \Delta s_{t+k} &= \alpha + \lambda_k [s_t - (\hat{\beta}_m (m_t - m_t^*) - \hat{\beta}_y (y_t - y_t^*) - \hat{\beta}_i (i_t - i_t^*) \\ &\quad + \hat{\beta}_\pi (\pi_t - \pi_t^*) + \hat{\beta}_p ((p_t^T - p_t^N) - (p_t^{T*} - p_t^{N*})))] \qquad \textbf{\textit{Equation 11}} \\ &\quad + \varepsilon_{t+k} \end{aligned}$$

3.2.2 Forecasting Regression

We consider in-sample and out-of-sample forecast to evaluate the accuracy of monetary model in predicting exchange rate movements. Analysis of in-sample forecast (base on full sample from 1984Q1 to 2005Q4) of the monetary models (Model 1, 2 and 3) has been compared to random walk model of Equation 4.12 (as a benchmark)

$$s_{t+k} - s_t = d_k + \varepsilon_{t+k} \qquad k = 1, 8, 12 \text{ and } 16 \qquad \textbf{\textit{Equation 12}}$$

of the corresponding k and tested for $H_0 : \lambda_k = 0$ against $H_1 : \lambda_k < 0$ or based on joint test of all forecast horizon as $H_0 : \lambda_k = 0 \ \forall k$ against $H_1 : \lambda_k < 0$ for some k. On the other hand, for out-of-sample forecast, we use prediction mean-squared error of Equation 9, 10, 11 and 12 from the sequence of recursive forecasts to evaluate the Theil's *U*-statistic and DM statistic of Diebold and Mariano (1995) with and without drift. Specifically, the estimation starts from 1984Q1 to 1995Q4. To generate the next forecast k, the estimation sample is updated by one period 1996Q1 for $k = 1$, 1997Q4 for $k = 8$, 1998Q4 for $k = 12$ and 1999Q4 for $k = 16$. The procedure is repeated until we reach the end of the sample in 2005Q4.

However, forecasting exercise based on Model 1, 2 and 3 involves some econometric difficulties. First, the error-correction representation is only appropriate under the assumption of stationarity of the error correction term $(s_t - f_t)$. This is because the asymptotic null distribution of test statistics for λ_k depends on whether the error-correction term is stationary or not, as discussed in Cavanagh et al (1995) and Valkanov (2003).

Another econometric problem is that forecasting involves future horizons k; when $k > 1$, the dependent variable $(s_{t+k} - s_t)$ represents overlapping sums of the original series that may result in high persistency of the error correction term. In this case, statistical inference should be handled with care since the in-sample R^2 and the *t*-statistics do not converge to a well-defined asymptotic distribution and the estimated coefficient, $\hat{\lambda}_k$, is biased away from zero due to size distortions. This bias is in favour of finding predictability as the forecast horizon (*k*) increases (see Mark and Sul, (2001), and Berkowitz and Giorgianni, (2001) among others, for detail discussions on the subject matter).

To mitigate the above discussed problems we consider bootstrap technique proposed by Kilian (1999) to approximate the finite sample distribution of the test statistic under the null hypothesis of no exchange rate predictability. This approach consist of first, estimating the Data-Generating Process (DGP) under the null of no predictability for the Constrained Vector Error Correction Model (VECM)

$$\Delta s_t = \alpha_s + u_{1,t} \qquad \textbf{\textit{Equation 13}}$$

and

$$\Delta f_t = \alpha_f - h_2(f_{t-1} - s_{t-1}) + \sum_{j=1}^{q-1} \xi_j^{21} \Delta s_{t-j} + \sum_{j=1}^{q-1} \zeta_j^{22} \Delta f_{t-j} + u_{2,t} \qquad \textbf{\textit{Equation 14}}$$

using constrained Estimated Generalised Least Squares (EGLS) technique with all coefficient but α_s set equal to zero. The system also requires the restriction of $h_2 < 0$ to be satisfied to ensure estimation stability. The lag order *q* has been determined under H_o using AIC criterion.[9]

Second, after estimating Equations 13 and 14, a sequence of $\left\{s_t^*, f_t^*\right\}$, pseudo observations can be generated under the assumption of i.i.d. innovations using cumulative sums of the realizations of the bootstrap data-generating process. The process has been initialized by specifying $\left(f_{t-1}^* - s_{t-1}^*\right) = 0$ and $\Delta s_{t-j}^* = 0$ and $\Delta f_{t-j}^* = 0$ for $j = q$-1, …, 1 and discard the first 500 observations. The pseudo innovation term $u_t^* = (u_{1t}^*, u_{2t}^*)'$ is random and drawn with replacement from the set of observed residuals $\hat{u}_t = (\hat{u}_{1t}, \hat{u}_{2t})'$. The process has been repeated for 2000 times. Third, use these $\left\{s_t^*, f_t^*\right\}$ of 2000 bootstrap replication to estimate the following long-horizon regression;

$$s_{t+k}^* - s_t^* = \alpha_k^* + \lambda_k^*(s_t^* - f_t^*) + \upsilon_{t+k}^* \quad k = 1, 4, 8, 12, 16 \qquad \textbf{\textit{Equation 15}}$$

Finally, use the empirical distribution of these 2000 replication of the bootstrap test statistics to determine the *p*-value of the *t*(20), *t*(A), *U*, *DM*(20), and *DM*(A) of Equation 9, 10 and 11.

Regarding the potential problem of the serial correlation of the error term due to $k > 1$, we adopt two approaches. First we use Newey-West corrected *t*-statistics by setting the truncation lags to 20 since the longest forecast horizon is 16. Second, we use a data-dependent formula provided by Andrews (1991) under a univariate AR(1) as an approximating model. As a result, the statistical inference is robust to highly persistent or near-spurious regression problems because it has the ability to automatically adjust the critical values to the increase in dispersion of the finite

[9] Further details explanation on the estimation procedures please refer to appendix in Kilian (1999).

sample distribution of the test statistic for different lag structures and estimation procedures.

3.3 Data

In the present case, which is limited by the availability of fully liberalized developing economies, we constrain ourselves to markets that satisfy the assumptions of the monetary model i.e. floating exchange rate regime and relatively open capital markets for long period. Based on Levy-Yeyati and Sturzeneggar (2003, 2005), and supplemented with ratios of total external trade to GDP (see Table 1), we choose the following 8 developing economies: Chile, Israel, Morocco, Philippines, South Africa, Thailand, Tunisia and Uruguay (along with the US economy as a base market).[10] Levy-Yeyati and Sturzeneggar (2003) classify 3 *de-facto* exchange rate regimes: float, intermediate and fixed. We choose only markets that are under float or intermediate regimes for the whole sample periods.[11] Float and intermediate regimes also indirectly indicate that the markets are not only open but characterised by little market frictions and government intervention. As defined by Levy-Yeyati and Sturzeneggar (2003), float and intermediate regimes are characterized by indices of low reserve volatility together with high exchange rate volatility. Low volatility of reserves is considered an indicator of less government intervention in the monetary policy. Therefore countries that have adopted a hard peg exchange regime, like China and Malaysia, or excessive capital control, like Korea, are excluded from the analysis.

[INSERT TABLE 1 ABOUT HERE]

The variables considered in our monetary model are end of period quarterly nominal exchange rates expressed as the US dollar per developing countries currency to proxy the nominal exchange rate (s_t), the money stock M2 to measure money supply (m_t), the Gross Domestic Product (GDP) is used to proxy real output (y_t), the Consumer Price Index (CPI) is used as broad deflator (π_t), short term interest rate is proxied by inter-bank deposit interest rates (i_t), and the relative price of tradable and non tradable price deflator (p_t) is proxied by the ratio of CPI and Producers Prices Index (PPI) or Wholesale Price Index (WPI). The sample period considered in the analysis is from 1984Q1 to 2005Q4 and retrieved from either Datastream® or the IMF's International Financial Statistics. All variables except interest rates are converted to natural logarithms.

4 RESULTS

Unlike to the earlier studies (for instance Mark 1995 and Kilian 1999), this paper does not impose theoretical value for the cointegrating coefficients in constructing

[10] The definition of developing market is based on the International Financial Cooperation (IFC). For more details explanation refer to Global Economic Prospects and the Developing Countries, *World Bank*, (2002), among others.

[11] We do include Philippines and South Africa into our sample though these two economies had fixed exchange rate regime on the following years, 1987, 1993, 1996 and 1990, 1993, 1995 respectively. Countries that experience more than three years of fixed exchange rates regime were excluded from the analysis. Full version of exchange rate regime classification can be access from http://200.32.4.58/~ely/index.html.

the fundamental values (f_t). Instead, we use the estimated parameters obtained from DOLS regressions of Equation 2. Table 2 shows the estimated cointegrating coefficients that are used in constructing the fundamental values for all models and markets.

[INSERT TABLE 2 ABOUT HERE]

We compute the Theil's *U*-statistics (the ratio of RMSE from two competing models-monetary versus random walk), the *t*-statistics and the Diebold-Mariano, (*DM*) statistics to assess the performance of exchange rate forecast using Model 1, 2, and 3.[12] The estimation results are presented in Table 3a and 3b for the drift-less random walk benchmark model while Table 3c and 3d for the random walk with a drift term. All the test results are presented in the form of bootstrap *p*-values based on 2000 replications. We are particularly interested in testing (in-sample) the hypothesis that $\lambda_k < 0$, and the out-of-sample performance based on one-step ahead the Diebold-Mariano *DM* test statistics and Theil's *U*-statistics. Long horizon predictability arises if the *p* values indicate increasing significance as the horizon *k* becomes larger. We are also interested in testing the joint significant of $\lambda_k = 0$ for all *k* at 10% level.

[INSERT TABLE 3a, 3b, 3c AND 3d ABOUT HERE]

Based on these criteria, the results show that only two countries (Israel and Uruguay) provide strong support for long horizon out-of-sample predictability. For Israel, the forecast accuracy is improving for longer horizons. This is evident from the *U*-statistics that are significant at k = 12 and 16 under the no drift sticky price model. In addition, the *p* value of the joint test of the *Theil's U*-statistics is also significant. However none of the test statistics for Israel are significant when a drift term is considered in the models. In the case of Uruguay, the monetary models with a drift predict better the exchange rate movements. The joint test of *DM(20)* statistics for sticky price model and *DM(A)* for all three models with a drift are significant compared to none for the driftless case.

The result shows that there is evidence of the short horizon (k = 1 and 8) predictability of Chile, Uruguay and Morocco under the monetary models with a drift term. The out-of-sample test statistics (for k = 1) of all models are significant for Chile and Uruguay but only sticky price model fits the Moroccan market. Another obvious finding from the analysis is that the Chilean, Israelis and Uruguayan markets also provide significant support for in-sample predictability. The *p* values of *t(A)* and *t(20)* for some of the λ_k are significant (in the case of Uruguayan market, the in-sample predictability test statistics are significant for all models with drift term). For the remaining countries (Philippines, Thailand, South Africa and Tunisia), no predictability has been detected in the analysis.

A number of interesting observations can be drawn from the results discussed above. First, the two countries (Israel and Uruguay) for which we find support of long-horizon predictability are characterized by high inflation (see for instance Braumann 2000 for high inflation countries classification and Table 1 for comparison between markets under study). The results confirm the earlier proposition made by

[12] The estimation procedures were conducted using the MATLAB code provided by Lutz Kilian which is available in the Journal of Applied Econometrics data and code archive 1999 Volume 5.

McNown and Wallace (1994) and Rogoff (1999a) who argued that forecast accuracy using monetary models should be higher in countries with unstable macroeconomic fundamentals.

Second, inclusion of a drift term in the estimation has eliminated predictability from the Israelis market. The opposite holds for Uruguay where predictability arises when the benchmark is the random walk with drift. This shows the importance of considering drift or no drift in the estimation, as argued by Kilian (1999). Third, considering alternatives monetary models (sticky price and relative price models) has proved to be useful in the process of predicting exchange rates movements in developing countries. At least the sticky price model seems to be superior to the standard flexible price and the relative price Balassa-Samuelson model. This finding is similar to Chinn (1998) where he suggested the superiority of the sticky price model over relative price Balassa-Samuelson for Philippines peso and Thailand bath.

Finally, the finding of short-term predictability (k = 1 and 8) for Chile, Uruguay and Morocco is relatively surprising. This could be presumably a result of the instantaneous exchange market reaction to the instability of economic fundamental. The evidence is in favour to the growing literature on the integration of currency market (Francis *et al*. (2002) and equity market (Frankel *et al*. 2004, and Golstein *et al*. 2000) in developing economies.[13] The linkages between markets are further speed up by the rapid development in information technology.[14]

5 CONCLUSION

We consider developing countries that are open and adopt floating exchange rate regimes to investigate the exchange rate forecastability puzzle using monetary models. The motivation for this study is based on the hypothesis proposed by McNown and Wallace (1994) and Rogoff (1999a). The hypothesis states that exchange rate predictability should be better off in countries with unstable monetary fundamentals. In addition to the standard flexible price model, we consider two alternatives approaches that account for sticky and relative prices. The method of Kilian (1999) has been employed to reduce problems in the long horizon finite sample forecasting estimations.

Based on Levy-Yeyati and Sturzeneggar (2003 and 2005), eight developing countries have been chosen in the analysis to gain insight on exchange rate forecastability. The results suggest that the inclusion of fundamental values derived from the sticky price monetary model appears to improve the out-of-sample forecast accuracy of the exchange rate determination models for four developing economies, Chile, Israel, Morocco and Uruguay. Empirical evidences are in favour of the

[13] Investors could be very prudent on the issue of economic and non-economic uncertainty in developing countries. Study has shown (for example) that the risk of international loan default is very high (see Catao and Sutton, 2002, among others). Consequently, for highly unstable developing countries, there are unlikely to receive huge amount of long-term debt. For instance, Velev (2007) has shown that most of the unstable developing countries have significantly received higher short-term maturity debt compared to the relatively stable developing economies. Uruguay which is more unstable has received 63% short-term credit from the U.S banks compared to only 20% for Peru. Instability has a significant role in determining short- or long-term credit to the developing countries.

[14] The plausibly channels of the linkage are trade linkages (Glick and Rose 1999), “common lender” or stock market (Kaminsky and Reinhart, 2001 and Caramazza et al., 2000), and “common macroeconomic weaknesses” (Eichengreen et al. 1996.

hypothesis that markets with unstable monetary fundamentals such as high inflation have higher forecast accuracy compared to the random walk model.

Overall, predictability of exchange rates in developing countries is very sensitive to the selection of appropriate models and the results are country specific in nature. For future research in developing countries under the same issue, it may be fruitful to explore on the potential of short- or long-term forecast accuracy using non-linear specification.

REFERENCES

Andrews, Donald W. K. (1991), 'Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation', *Econometrica,* 59 (3), 817-58.

Baharumshah, Ahmad Zubaidi and Masih, A. Mansur M. (2005), 'Current account, exchange rate dynamics and the predictability: the experience of Malaysia and Singapore', *Journal of International Financial Markets, Institutions and money* 15 (3), 255-70.

Balassa, Bela (1964), 'The purchasing power parity doctrine: A repraisal', *Journal of Political Economy,* 72 (6), 584-96.

Berkowitz, Jeremy and Giorgianni, Lorenzo (2001), 'Long-Horizon Exchange Rate Predictability?' *The Review of Economics and Statistics,* 83 (1), 81-91.

Candelon, B., Kool, C., Raabe, K., and Veen, T., (2007), 'Long-run real exchange rate determinants: Evidence from eight new EU member states, 1993–2003', *Journal of Comparative Economics* 35 (1), 87-107.

Cavanagh, Christopher L., Elliott, Graham, and Stock, James H. (1995), 'Inference in Models with Nearly Integrated Regressors', *Econometric Theory,* 11 (5), 1131-47.

Chinn, Menzie D. (1998), 'Before the Fall: Were East Asian Currencies Overvalued?' *NBER Working Paper,* No 6491.

Chinn, Menzie D. and Meese, Richard A. (1995), 'Banking on currency forecasts: How predictable is change in money?' *Journal of International Economics,* 38 (1-2), 161-78.

Crespo-Cuaresma, Jesus, Fidrmuc, Jarko, and MacDonald, Ronald (2005), 'The monetary approach to exchange rates in the CEECs', *The Economics of Transition,* 13 (2), 395-416.

Dornbusch, Rudiger (1976), 'Expectations and Exchange Rate Dynamics', *The Journal of Political Economy,* 84 (6), 1161-76.

Faust, Jon, Rogers, John H., and Wright, Jonathan H. (2003), 'Exchange rate forecasting: the errors we've really made ', *Journal of International Economics,* 60 (1), 35-59.

Faust, Jon, Rogers, John H., and Wright, Jonathan H. (2005), 'News and Noise in G-7 GDP Announcements', *Journal of Money, Credit, and Banking,* 37 (3), 403-17.

Ferreira, Jose Eduardo de A. (2006), 'Effects of Fundamentals on the Exchange Rate: A Panel Analysis for a Sample of Industrialised and Emerging Economies', *University of Kent, Department of Economics Discussion Paper* 06/03.

Francis, Bill, Hasan, Iftekar, and Hunter, Delroy (2002), 'Emerging market liberalization and the impact on uncovered interest rate parity', *Journal of International Money and Finance,* Volume 21 (6), 931-56.
Frankel, J. (1976), 'A monetary approach to the exchange rate: doctrinal aspects and empirical evidence', *The Scandinavian Journal of Economics,* 78 (2), 200-24.
Frankel, Jeffery A and Poonawala, Jumana (2004), 'The Forward Market in Emerging Currencies: Less Biased than in Major Currencies', *Mimeo,* Kennedy School of Government, Cambridge, MA.
Goldstein, Morris, Kaminsky, Graciela, and Reinhart, Carmen (2000), *Assessing Financial Vulnerability: An Early Warning System for Emerging Markets* (Washington, D.C.: Institute for International Economics).
Kilian, Lutz (1999), 'Exchange rates and monetary fundamentals: what do we learn from long-horizon regressions? ' *Journal of Applied Econometrics,* 14 (5), 491-510.
Kilian, Lutz and Taylor, Mark P. (2003), 'Why is it so difficult to beat the random walk forecast of exchange rates?' *Journal of International Economics,* 60 (1), 85-107.
Levy-Yeyati, Eduardo and Sturzenegger, Federico (2003), 'To Float or to Fix: Evidence on the Impact of Exchange Rate Regimes on Growth', *The American Economic Review,* 93 (4), 1173-93.
Levy-Yeyati, Eduardo and Sturzenegger, Federico (2005), 'Classifying exchange rate regimes: Deeds vs. words ', *European Economic Review,* 49 (6), 1603-35.
MacDonald, R. and Ricci, L. A. (2001), 'PPP and the Balassa Samuelson Effect - The Role of the Distribution Sector', *IMF Working Paper* 01/38
Manzan, Sebastiano and Westerhoff, Frank (2007), 'Heterogeneous Expectations, Exchange Rate Dynamics and Predictability', *Journal of Economic Behavior and Organization* xx (xx).
Mark, Nelson C. (1995), 'Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability', *The American Economic Review,* 85 (1), 201-18.
Mark, Nelson C. and Sul, Donggyu (2001), 'Nominal exchange rates and monetary fundamentals: Evidence from a small post-Bretton woods panel ', *Journal of International Economics,* 53 (1), 29-52.
McNown, Robert and Wallace, Myles S. (1994), 'Cointegration Tests of the Monetary Exchange Rate Model for Three High-Inflation Economies', *Journal of Money, Credit and Banking,* 26 (3), 396-411.
Meese, Richard A. and Rogoff, Kenneth (1983a), 'Empirical exchange rate models of the seventies: Do they fit out of sample?' *Journal of International Economics,* 14 (1-2), 3-24.
Meese, R. and Rogoff, K (1983b), *The out-of-sample failure of empirical exchange rate models: Sampling error or misspecification?*, ed. J. Frankel (Exchange rates and international macroeconomics; Chicago: University of Chicago Press).
Moosa, Imad A. (2000), 'A structural time series test of the monetary model of exchange rates under the German hyperinflation ', *Journal of International Financial Markets, Institutions and Money,* 10 (2), 213-23.
Neely, Christopher J. and Sarno, Lucio (2002), 'How Well Do Monetary Fundamentals Forecast Exchange Rates?' *The Federal Reserve Bank of St. Louis* 02/09/51, 21-74.
Rogoff, Kenneth (1996), 'The Purchasing Power Parity Puzzle', *Journal of Economic Literature,* 34 (2), 647-68.

Rogoff, Kenneth (1999a), 'Monetary Models of Dollar/Yen/Euro Nominal Exchange Rates: Dead or Undead?' *The Economic Journal,* 109 (459), 655-59.
Rogoff, Kenneth (1999b), 'International Institutions for Reducing Global Financial Instability', *The Journal of Economic Perspectives,* 13 (4), 21-42.
Samuelson, Paul A. (1964), 'Theoretical Notes on Trade Problems', *The Review of Economics and Statistics,* 46 (2), 145-54.
Valkanov, Rossen (2003), 'Long-horizon regressions: theoretical results and applications', *Journal of Financial Economics,* 68 (2), 201-32.
Wang, Jian-Xin and Wong, Hoi-In (1997), 'The predictability of Asian exchange rates: evidence from Kalman filter and ARCH estimations', *Journal of Multinational Financial Management,* 7 (3), 231-52.

Table 1: Economic Fundamentals for Selected Developing Countries from 1984Q1 to 2005Q4

Country	Exchange Rate Regime		Income Volatility	Inflation	Total Trade
	Lowest	Highest			(% GDP)
Chile	1	2	2.75	11.63	60.32
Israel	1	2	2.27	41.12	83.41
Morocco	1	1	4.84	4.11	60.84
Philippines	1	3♠	3.89	9.91	79.11
South Africa	1	3♦	2.59	9.99	48.50
Thailand	1	2	4.78	3.61	90.73
Tunisia	1	2	2.60	5.00	87.36
Uruguay	1	2	5.08	43.41	42.22
United States	1	1	1.53	3.11	21.64

Classification of exchange rate regime is base on Levy-Yeyati and Sturzenegger (2003 and 2005). The index ranges from 1 = float; 2 = intermediate; and 3 = fixed. We do include Philippines and S. Africa since the fixed regime only for these three years ♠ 1987, 1993 and 1996; ♦ 1990, 1993 and 1995, respectively. The indices for the remaining countries and years are either 1 or 2. Income volatility is the standard deviation of the growth rate of GDP per capita. Inflation is a measure of mean inflation over the sample period. Total trade is an average of total import and export per GDP.

Table 2: Cointegrating Coefficient Estimates Based on Dynamic OLS (DOLS) , $s_t = \alpha + \beta f_t + \sum_{j=-q}^{q} \delta_j \Delta f_{t-j} + \varepsilon_t$ **for 1984Q1 to 1995Q4.**

Country	Flexible Price		Sticky Price				Balassa-Samuelson Effect				
	β_m	β_y	β_m	β_y	β_i	β_π	β_m	β_y	β_i	β_p	β_π
Chile	0.744	-0.232	0.896	-0.441	0.017	0.104	-0.333	1.210	0.005	-4.089	0.009
	(0.179)	(0.218)	(0.217)	(0.265)	(0.007)	(0.055)	(0.476)	(0.634)	(0.006)	(1.674)	(0.049)
Uruguay	-2.971	4.097	-2.796	3.879	-0.015	-0.024	-3.491	4.829	-0.045	-2.255	-0.005
	(0.053)	(0.066)	(0.239)	(0.289)	(0.036)	(0.013)	(0.521)	(0.658)	(0.059)	(1.051)	(0.015)
Philippines	0.679	-0.314	0.638	-0.277	0.012	-0.008	0.504	-0.027	-0.011	-1.148	-0.074
	(0.029)	(0.038)	(0.066)	(0.077)	(0.005)	(0.029)	(0.078)	(0.114)	(0.007)	(0.303)	(0.031)
Thailand	1.430	-1.494	1.588	-1.695	-0.016	-0.005	1.546	-1.599	-0.026	-1.607	-0.062
	(0.019)	(0.028)	(0.053)	(0.076)	(0.004)	(0.027)	(0.071)	(0.113)	(0.006)	(0.714)	(0.035)
Israel	-0.813	1.149	-0.877	1.229	0.008	0.001	-0.007	0.132	0.004	2.590	0.003
	(0.067)	(0.084)	(0.087)	(0.105)	(0.004)	(0.017)	(0.277)	(0.348)	(0.008)	(0.812)	(0.019)
Morocco	-1.025	0.672	-1.010	0.649	0.021	-0.030	-0.895	0.624	-0.023	-1.208	-0.033
	(0.156)	(0.075)	(0.359)	(0.190)	(0.033)	(0.018)	(0.447)	(0.263)	(0.097)	(2.162)	(0.029)
S. Africa	-1.110	1.390	0.254	-0.072	-0.011	-0.016	0.851	-0.815	0.003	2.706	-0.016
	(0.125)	(0.139)	(0.377)	(0.407)	(0.005)	(0.018)	(0.504)	(0.568)	(0.013)	(1.320)	(0.022)
Tunisia	0.108	-0.040	-0.348	0.372	-0.082	0.023	0.667	-0.525	-0.020	2.208	0.029
	(0.248)	(0.216)	(0.151)	(0.132)	(0.009)	(0.027)	(0.260)	(0.230)	(0.015)	(0.575(	(0.025)

Number in the parenthesis is robust standard errors. Sample from 1984Q1 to 1995Q4. $q = 3$. β_m is the elasticity of money stock, β_y is the income elasticity of money demand, β_p is the relative price elasticity, β_i and β_π are the interest and inflation semi-elasticity, respectively.

Table 3a: Results of the VEC Bootstrap Model with No-Drift

Country	Horizon	*Flexible Price Model* *t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*	*Sticky Price Model* *t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*	*Relative Price Model* *t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*
Chile	1	**0.059**	**0.017**	**0.071**	**0.081**	**0.074**	**0.029**	**0.010**	0.149	0.133	0.140	**0.043**	**0.013**	**0.064**	**0.076**	**0.067**
	8	0.157	**0.073**	0.295	0.266	0.308	**0.071**	**0.027**	0.230	0.204	0.225	0.123	**0.055**	0.222	0.207	0.237
	12	0.198	0.137	0.251	0.283	0.282	**0.080**	**0.046**	0.178	0.178	0.178	0.149	0.111	0.196	0.197	0.196
	16	0.241	0.216	0.287	0.625	0.389	**0.081**	**0.071**	0.174	0.135	0.138	0.146	0.128	0.207	0.229	0.218
	Joint	0.285	0.190	0.319	0.296	0.293	0.120	**0.077**	0.248	0.210	0.211	0.200	0.153	0.294	0.266	0.261
Uruguay	1	0.353	0.165	0.990	0.542	0.426	0.353	0.163	0.990	0.539	0.419	0.373	0.183	0.970	0.538	0.416
	8	0.340	0.330	0.980	0.668	0.720	0.336	0.327	0.990	0.663	0.722	0.359	0.349	0.990	0.660	0.724
	12	0.285	0.301	0.980	0.639	0.674	0.290	0.303	0.980	0.648	0.688	0.319	0.340	0.980	0.658	0.689
	16	0.210	0.221	0.980	0.638	0.675	0.216	0.232	0.980	0.639	0.673	0.239	0.267	0.980	0.631	0.660
	Joint	0.283	0.300	0.980	0.732	0.612	0.288	0.300	0.990	0.738	0.616	0.310	0.330	0.980	0.731	0.618
Philippines	1	0.577	0.613	0.487	0.567	0.423	0.750	0.755	0.384	0.396	0.316	0.661	0.670	0.391	0.449	0.333
	8	0.789	0.787	0.145	0.124	0.134	0.805	0.807	0.212	0.226	0.226	0.795	0.793	0.205	0.216	0.212
	12	0.811	0.812	0.208	0.233	0.220	0.838	0.839	0.325	0.544	0.448	0.816	0.813	0.281	0.474	0.386
	16	0.883	0.887	0.211	0.183	0.193	0.874	0.879	0.360	0.545	0.593	0.867	0.868	0.320	0.482	0.472
	Joint	0.773	0.809	0.289	0.266	0.278	0.851	0.852	0.475	0.424	0.417	0.814	0.819	0.513	0.410	0.406
Thailand	1	0.641	0.500	0.988	0.602	0.506	0.636	0.581	0.551	0.735	0.628	0.595	0.500	0.632	0.689	0.649
	8	0.748	0.751	0.265	0.676	0.550	0.722	0.720	0.327	0.765	0.606	0.752	0.747	0.456	0.968	0.896
	12	0.795	0.797	0.325	0.888	0.776	0.812	0.812	0.616	0.618	0.658	0.803	0.802	0.656	0.638	0.664
	16	0.829	0.827	0.460	0.636	0.673	0.842	0.844	0.654	0.529	0.573	0.852	0.852	0.704	0.517	0.554
	Joint	0.843	0.837	0.684	0.795	0.688	0.813	0.801	0.623	0.863	0.821	0.801	0.794	0.698	0.819	0.828

Note: The figure under *t(20)*, *t(A)*, *U, DM(20)* and *DM(A)* headings are bootstrap *p*-values for the VEC model with or without drift (Kilian 1999). Flexible price model, sticky price model and Balassa-Samuelson effect model have been considered to construct the fundamental variables. *t(20)* refers to *t*-statistic for the slope coefficient in the long-horizon regression with robust standard errors calculated based on a fixed truncation lag of 20. *t*(A) refers to the case of standard errors using Andrew (1991) rule. *DM* and *U* refer to the corresponding Diebold-Mariano and Theil's *U*-statistics (ratio of out-of-sample and random walk model) respectively. Results are shown for alternative forecast horizons *k* = 1-, 8-, 12- and 16-quarter. *Joint* refers to the *p*-value for the joint test statistics for all horizons. Boldface *p* values denote significance at the 10 percent level.

Table 3b: Results of the VEC Bootstrap Model with No-Drift

		Flexible Price Model					*Sticky Price Model*					*Relative Price Model*				
Country	Horizon	*t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*	*t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*	*t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*
Israel	1	0.547	0.493	0.134	0.149	0.150	0.146	0.122	0.177	0.129	0.126	0.424	0.359	0.102	0.121	0.124
	8	0.480	0.464	0.184	0.199	0.198	0.135	0.126	0.204	0.174	0.173	0.391	0.369	0.230	0.204	0.204
	12	0.321	0.319	**0.051**	0.122	0.124	**0.066**	**0.066**	**0.047**	**0.086**	**0.090**	0.256	0.246	**0.064**	0.123	0.124
	16	0.242	0.284	**0.081**	0.133	0.141	**0.060**	**0.073**	**0.085**	0.104	0.114	0.186	0.225	**0.080**	0.109	0.116
	Joint	0.313	0.358	**0.097**	0.205	0.211	**0.086**	**0.092**	**0.086**	0.151	0.152	0.245	0.279	**0.094**	0.167	0.177
Morocco	1	0.142	0.168	0.336	0.357	0.360	0.142	0.187	0.311	0.402	0.353	**0.058**	**0.058**	**0.096**	**0.094**	**0.086**
	8	0.072	0.073	0.146	0.143	0.145	0.155	0.151	0.261	0.819	0.806	0.104	0.120	0.214	0.240	0.230
	12	0.183	0.186	0.195	0.166	0.165	0.262	0.248	0.210	0.558	0.684	0.181	0.185	0.205	0.180	0.180
	16	0.197	0.203	0.313	0.376	0.407	0.284	0.268	0.332	0.411	0.508	0.176	0.185	0.335	0.380	0.422
	Joint	0.190	0.196	0.275	0.291	0.287	0.294	0.307	0.453	0.663	0.558	0.257	0.248	0.293	0.291	0.282
S. Africa	1	0.607	0.594	0.460	0.188	0.202	0.724	0.722	0.382	0.190	0.197	0.611	0.612	0.414	0.183	0.192
	8	0.496	0.467	0.536	0.271	0.290	0.583	0.556	0.414	0.255	0.273	0.489	0.464	0.506	0.255	0.278
	12	0.569	0.544	0.355	0.238	0.250	0.651	0.637	0.266	0.218	0.224	0.566	0.538	0.340	0.240	0.245
	16	0.689	0.683	0.212	0.215	0.215	0.751	0.749	0.134	0.175	0.170	0.679	0.675	0.188	0.204	0.202
	Joint	0.676	0.644	0.329	0.344	0.343	0.750	0.725	0.169	0.279	0.263	0.662	0.634	0.259	0.320	0.313
Tunisia	1	0.525	0.581	0.780	0.939	0.767	0.187	0.239	0.121	0.121	0.121	0.415	0.451	0.608	0.326	0.355
	8	0.508	0.519	0.659	0.521	0.566	0.268	0.260	0.316	0.231	0.236	0.305	0.325	0.696	0.564	0.626
	12	0.567	0.538	0.586	0.592	0.633	0.338	0.330	0.192	0.189	0.190	0.398	0.360	0.703	0.887	0.900
	16	0.705	0.703	0.295	0.295	0.306	0.497	0.497	**0.095**	0.135	0.121	0.587	0.591	0.331	0.313	0.328
	Joint	0.538	0.626	0.815	0.474	0.510	0.395	0.401	0.119	0.196	0.171	0.382	0.438	0.671	0.538	0.565

Note: Refer to note in Table 3a

Table 3c: Results of the VEC Bootstrap Model with Drift

Country	Horizon	*Flexible Price Model* t(20)	t(A)	U	DM(20)	DM(A)	*Sticky Price Model* t(20)	t(A)	U	DM(20)	DM(A)	*Relative Price Model* t(20)	t(A)	U	DM(20)	DM(A)
Chile	1	**0.030**	**0.010**	**0.024**	**0.043**	**0.026**	**0.044**	**0.013**	**0.013**	**0.040**	**0.024**	**0.054**	**0.016**	**0.012**	**0.059**	**0.037**
	8	**0.070**	**0.026**	0.237	0.221	0.222	0.122	**0.051**	0.252	0.225	0.228	0.149	0.067	0.349	0.266	0.271
	12	**0.080**	**0.047**	0.582	0.373	0.433	0.147	0.111	0.596	0.383	0.408	0.200	0.136	0.694	0.422	0.454
	16	**0.080**	**0.069**	0.771	0.484	0.495	0.144	0.126	0.798	0.515	0.507	0.237	0.207	0.859	0.572	0.555
	Joint	0.120	**0.077**	0.259	0.281	0.259	0.197	0.151	0.246	0.262	0.233	0.280	0.193	0.281	0.320	0.289
Uruguay	1	**0.098**	**0.029**	**0.003**	**0.025**	**0.018**	**0.099**	**0.027**	**0.003**	**0.025**	**0.017**	0.102	**0.028**	**0.003**	**0.027**	**0.017**
	8	**0.069**	**0.056**	0.126	0.120	0.121	**0.068**	**0.057**	0.126	0.119	0.122	**0.071**	**0.058**	0.125	0.120	0.122
	12	**0.056**	**0.044**	0.124	0.122	0.123	**0.055**	**0.045**	0.120	0.118	0.121	**0.057**	**0.050**	0.121	0.120	0.121
	16	**0.043**	**0.039**	0.153	0.150	0.150	**0.043**	**0.039**	0.152	0.151	0.153	**0.047**	**0.040**	0.151	0.148	0.151
	Joint	**0.045**	**0.040**	0.121	0.102	**0.098**	**0.045**	**0.040**	0.120	**0.099**	**0.095**	**0.049**	**0.041**	0.122	0.100	**0.095**
Philippines	1	0.746	0.752	0.778	0.843	0.789	0.628	0.650	0.700	0.588	0.744	0.310	0.344	0.230	0.412	0.583
	8	0.803	0.803	0.721	0.772	0.759	0.778	0.774	0.464	0.654	0.599	0.620	0.617	0.171	0.912	0.743
	12	0.833	0.836	0.813	0.910	0.920	0.833	0.833	0.592	0.879	0.918	0.602	0.600	0.197	0.922	0.930
	16	0.870	0.877	0.874	0.853	0.896	0.877	0.879	0.631	0.828	0.864	0.539	0.542	0.244	0.905	0.854
	Joint	0.851	0.849	0.834	0.942	0.903	0.739	0.764	0.726	0.772	0.735	0.466	0.531	0.320	0.633	0.757
Thailand	1	0.636	0.581	0.593	0.711	0.720	0.720	0.584	0.942	0.712	0.624	0.585	0.445	0.993	0.675	0.586
	8	0.722	0.719	0.390	0.898	0.867	0.798	0.804	0.429	0.948	0.877	0.677	0.680	0.291	0.259	0.272
	12	0.811	0.811	0.719	0.685	0.728	0.858	0.858	0.813	0.781	0.769	0.725	0.727	0.354	0.822	0.551
	16	0.843	0.843	0.792	0.626	0.670	0.891	0.891	0.919	0.644	0.671	0.754	0.759	0.511	0.645	0.667
	Joint	0.813	0.801	0.721	0.911	0.903	0.865	0.850	0.917	0.848	0.757	0.779	0.768	0.485	0.457	0.471

Note: Refer to note in Table 3a

Table 3d: Results of the VEC Bootstrap Model with Drift

		Flexible Price Model					*Sticky Price Model*					*Relative Price Model*				
Country	Horizon	*t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*	*t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*	*t(20)*	*t(A)*	*U*	*DM(20)*	*DM(A)*
Israel	1	0.148	0.114	0.435	0.267	0.455	0.398	0.313	0.217	0.217	0.224	0.532	0.476	0.292	0.289	0.313
	8	0.140	0.128	0.502	0.284	0.302	0.363	0.335	0.441	0.320	0.329	0.464	0.450	0.378	0.337	0.344
	12	0.068	0.069	0.211	0.223	0.223	0.228	0.224	0.282	0.277	0.277	0.302	0.306	0.275	0.314	0.312
	16	0.063	0.070	0.389	0.284	0.288	0.170	0.203	0.293	0.301	0.301	0.234	0.272	0.357	0.370	0.370
	Joint	0.089	0.090	0.383	0.427	0.426	0.220	0.250	0.413	0.438	0.438	0.300	0.331	0.404	0.480	0.477
Morocco	1	0.142	0.189	0.317	0.317	0.282	**0.058**	**0.058**	**0.060**	**0.075**	**0.061**	0.142	0.169	0.318	0.270	0.287
	8	0.153	0.151	0.236	0.232	0.234	0.104	0.120	0.135	0.177	0.185	**0.072**	**0.073**	**0.078**	0.146	0.147
	12	0.261	0.247	0.207	0.198	0.194	0.181	0.185	0.143	0.201	0.185	0.183	0.186	0.139	0.196	0.178
	16	0.282	0.266	0.497	0.391	0.424	0.175	0.184	0.543	0.401	0.435	0.197	0.203	0.492	0.370	0.385
	Joint	0.295	0.307	0.340	0.358	0.347	0.256	0.247	0.251	0.338	0.331	0.190	0.196	0.197	0.373	0.354
S. Africa	1	0.723	0.721	0.676	0.481	0.416	0.586	0.542	0.490	0.403	0.325	0.586	0.542	0.490	0.403	0.325
	8	0.584	0.555	0.655	0.501	0.532	0.543	0.522	0.529	0.376	0.395	0.543	0.522	0.529	0.376	0.395
	12	0.651	0.635	0.664	0.455	0.495	0.615	0.591	0.429	0.358	0.372	0.615	0.591	0.429	0.358	0.372
	16	0.750	0.750	0.684	0.545	0.589	0.747	0.747	0.414	0.356	0.367	0.747	0.747	0.414	0.356	0.367
	Joint	0.748	0.722	0.782	0.748	0.674	0.665	0.630	0.528	0.546	0.441	0.665	0.630	0.528	0.546	0.441
Tunisia	1	0.186	0.240	0.134	0.130	0.129	0.415	0.451	0.796	0.771	0.671	0.524	0.579	0.868	0.753	0.787
	8	0.265	0.261	0.562	0.618	0.693	0.305	0.327	0.852	0.968	0.989	0.506	0.520	0.799	0.943	0.977
	12	0.339	0.330	0.484	0.423	0.461	0.397	0.362	0.908	0.994	0.999	0.565	0.540	0.826	0.983	0.991
	16	0.500	0.500	0.382	0.359	0.372	0.588	0.592	0.775	0.973	0.987	0.706	0.704	0.712	0.982	0.992
	Joint	0.397	0.401	0.469	0.457	0.455	0.381	0.439	0.863	0.960	0.901	0.539	0.627	0.908	0.887	0.927

Note: Refer to note in Table 3a