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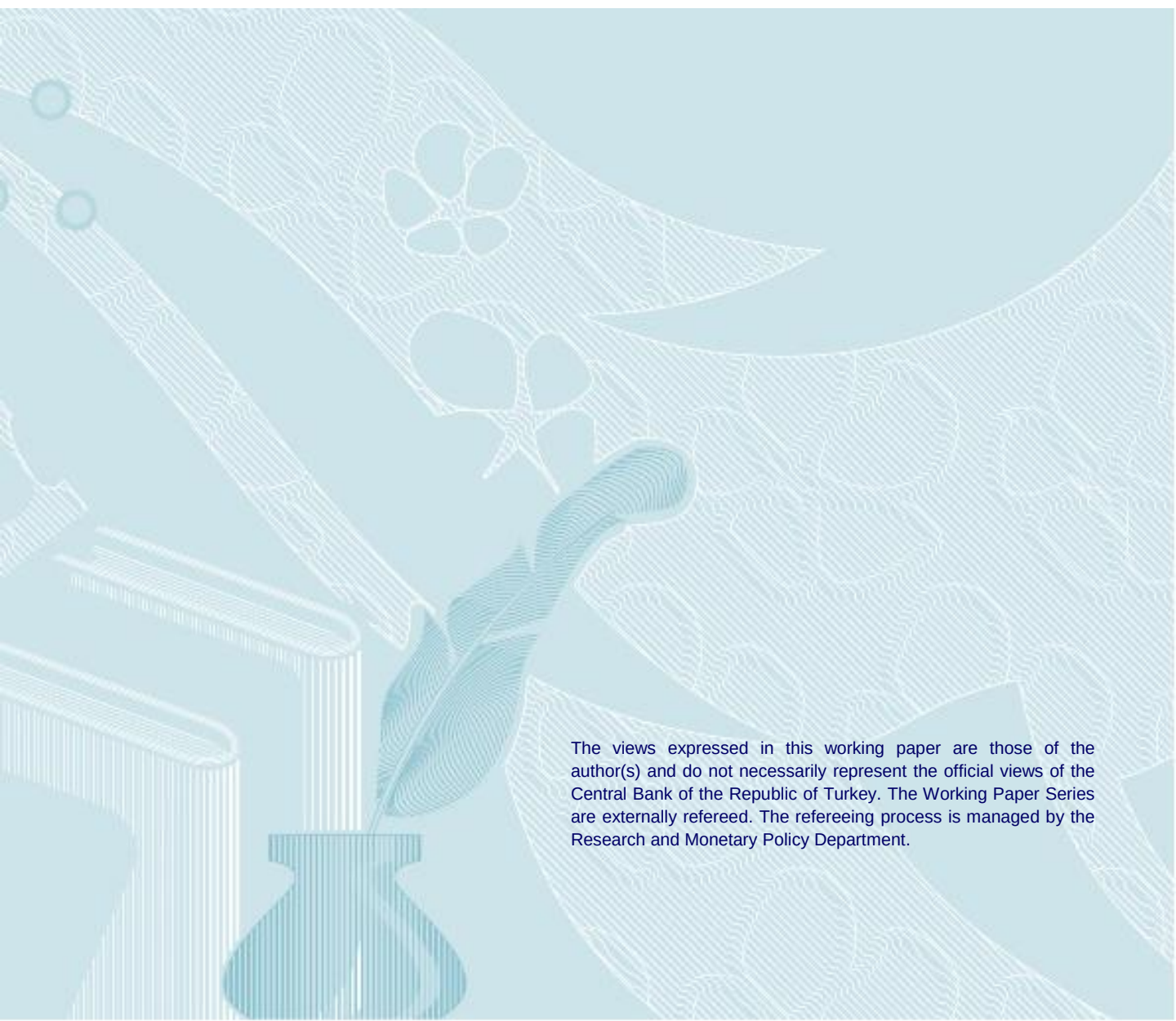
January 2012

Meltem G. CHADWICK
Fatih FAZİLET
Necati TEKATLI

Address:
Central Bank of the Republic of Turkey
Head Office
Research and Monetary Policy Department
İstiklal Caddesi No: 10
Ulus, 06100 Ankara, Turkey

Phone:
+90 312 507 54 02

Facsimile:
+90 312 507 57 33



Common Movement of the Emerging Market Currencies*

Meltem G. Chadwick† Fatih Fazilet‡ Necati Tekatlı§

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Abstract

The aim of this study is to show that there exists a common movement among the currencies of emerging market economies that implemented the flexible exchange rate regime after 2000. Also, we examine if this common movement is closely related to financial markets and some macroeconomic fundamentals commonly referred to as possible driving forces of exchange rates in economics literature. This common movement, which has been derived using a dynamic factor model, is introduced as a composite index of these currencies. Our findings suggest that the currencies of the emerging market economies have a common movement which can be explained to a great extent with the help of financial variables. On the other hand, macroeconomic fundamentals have limited explanatory power for apprehending the common dynamics of currencies. Also, both financial variables and macroeconomic fundamentals are analyzed together, within a nonlinear estimation framework, to see if the explanatory power of macroeconomic fundamentals improves. However, we could not observe a significant improvement. Specifically, the results underline the importance of bond market variables, stock market variables and risk indices in understanding the (common) dynamics of the emerging market currencies after 2000.

Keywords:exchange rate analysis; emerging market economies; dynamic factor model; financial analysis; exchange rate models; nonlinear models

JEL Classification:C32; F31; G15

*The views expressed herein are those of the authors and not necessarily those of the Central Bank of the Republic of Turkey.

†Research and Monetary Policy Department, Central Bank of the Republic of Turkey

‡Research and Monetary Policy Department, Central Bank of the Republic of Turkey

§Research and Monetary Policy Department, Central Bank of the Republic of Turkey

1 Introduction

With the introduction of quantitative easing measures by major industrial nations, increased capital flows to emerging countries became a follow-up topic for policy makers and academicians. These flows revived the agenda of macroeconomic risks, especially after the last global financial crises. While developed countries were declaring quantitative easing measures, emerging countries started taking a number of preventive measures towards handling pressures on their exchange rates, protecting their competitiveness in global markets and keeping their current account movements stable. The last global crisis put a strong emphasis on global linkages and harmonization of capital flows between developed and emerging market countries. In addition to that, emerging market countries are also trying to manage large capital flows among themselves, which in return can cause a parallel effect on their exchange rate movements. We noticed that related research on emerging market currencies is relatively scarce, and therefore, due to an increasing importance of the effect of financial capital flows towards emerging economies and their corresponding effect on exchange rate movements, with this study, we analyzed the common movement of emerging market currencies and studied the driving forces behind this common movement.

In 2000s there have been dramatic changes in the exchange rate policies of emerging countries and the number of countries which prefer more flexible currency regimes increased considerably when compared to the 1990s. As more emerging countries have experienced the flexible exchange rate regime within the recent years, the importance of understanding exchange rate dynamics in these countries has increased significantly for policymakers, economists and investors. In this framework, with this paper we show that the dynamics of exchange rates in emerging markets show a common pattern and there exists a common factor that derives this common pattern. We extract this common factor using a dynamic factor model. We introduce this common factor as a composite index as in Stock and Watson (1989) and call it as the "Exchange Rate Index" for emerging market economies. The "Exchange Rate Index" we introduced explains a significant portion (nearly 60 percent) of the dynamics of currencies.

Next, we studied the link between this common pattern (Exchange Rate Index) and asset markets, certain variables indicating risk appetite and finally some macroeconomic variables within the framework of empirical exchange rate models. In this way, the common pattern can be followed as a fundamental trend that will reflect the aggregated common currency movement of emerging countries and its movements can be studied and explained using certain financial and macroeconomic variables. We begin our analysis with

financial variables and extend the analysis for macroeconomic variables. We pay more attention to financial variables to explain the common dynamics, as the implementation of more flexible regimes within the last ten years made it possible to analyze the effect of financial markets and capital flows on currency movements without any intervention effect, therefore in a more healthy manner. In addition to that, there is a huge gap in the exchange rate literature about the treatment of financial variables to apprehend the movement of exchange rate dynamics.

To our knowledge, the research on the common dynamics of emerging market currencies is a very intact area[1], whereas the literature on the determinants of exchange rates is extensive. However, the papers on the determinants of exchange rates have mainly focused on developed countries. Accordingly, different groups of variables are used to explain the dynamics of exchange rate movements. Among those variables, the most commonly used variable groups are related to the macroeconomic fundamentals. However, it has become widely accepted that empirical models using macroeconomic variables have notoriously limited success in explaining exchange rate movements for developed countries. Meese and Rogoff (1983), Obstfeld and Rogoff (2000) and Cheung et al. (2005) are the famous papers in economic literature which show the poor explanatory power of macroeconomic fundamentals on exchange rate dynamics of selected industrialized countries. On the other hand, literature on the relationship between exchange rates and macroeconomic fundamentals are not all doom and gloom. Rapach and Wohar (2002) found support for a simple form of the long-run monetary model of exchange rate determination for a collection of 14 industrialized countries. Taylor and Peel (2000) also have supportive evidence for the relationship between exchange rates and macroeconomic fundamentals over the long run with respect to a nonlinear mean reversion towards the monetary fundamental equilibrium.

Another group of variables that are used in the exchange rate literature to explain the determinants of exchange rate movements are the commodity prices. Research on the link between commodity prices and exchange rates is one of the popular topic of the early 1980's. Dornbusch (1987) is one

[1]There exist some papers that are related to the common movement of exchange rates. One of them is by Engel et al. (2009) about forecasting the exchange rates of 17 OECD countries, and constructing factors from a cross section of exchange rates. Another similar study is by Cayen et al. (2010) about the determinants of real exchange rates. They also try to explain the common movements using a factor model approach, however, for only 6 developed countries. On the other hand, Aggarwal and Simmons (2008) examined the common stochastic trend among Carribbian currencies, but this study also gives information about co-movement between two pairs of currencies.

good example. However, considering that the 2000-2007 period can be defined with the rapid appreciation of the currencies for commodity exporters against the US, many countries like the UK that may be considered as commodity importer countries have also experienced appreciation (not depreciation). Therefore, models that try to explain the dynamics of exchange rate movements only using the commodity prices may be missing some important additional variables.

Finally, linkages between financial variables and exchange rates have been examined in economic literature by various papers. For example, Pan et al. (2007) summarize the theoretical and empirical literature on the relationship between exchange rates and stock prices in detail. However, there does not exist a clear empirical paper which finds a significant contemporaneous relationship between exchange rates and stock prices. Existing literature on the determinants of exchange rates basically use stock prices as one of the main financial variables to explain the exchange rate movements. Unfortunately, this literature is rather weak for analyzing the building blocks between significant financial fundamentals and exchange rate dynamics. Hence, with this study we focused more on the linkages between financial fundamentals and exchange rates which became much more essential, especially after the recent global crisis.

In the next section, we give a short analysis of the exchange rate dataset used in our paper. In section three, we introduce a dynamic factor model, with the aim of extracting the common movement of selected emerging market currencies. In section four, we examine the link between the common index and some financial variables using different estimation techniques. In section five, we accomplish a similar analysis to that used in section four, only this time using macroeconomic fundamentals. The reason behind using fundamentals is related with the most prominent exchange rate models in the economic literature, i.e. Purchasing Power Parity and Sticky Price Monetary Models. The final section summarizes our basic results.

2 Short Analysis of Selected Emerging Market Currencies

Before investigating the common dynamics of emerging market currencies, it is essential to examine and understand the exchange rate regimes of the emerging countries in question. The reason for such an inquiry is that; during times of increased risk appetite, an emerging country with a flexible exchange rate regime can experience appreciation due to increased capital

inflow. However, the same exchange rate movement will not be observed in an emerging country with a fixed exchange rate regime. Moreover, currency movements of an emerging country within fixed regimes can move in different ways, compared to other countries with flexible exchange rate regimes in case of increased risk appetite environment. Therefore, emerging countries that have been included in our study are chosen according to their exchange rate regime. Emerging countries with flexible exchange rate regimes are chosen for a healthy analysis.

Determination of exchange rate regimes have been accomplished by using a "de facto" exchange rate classification scheme produced by the International Monetary Fund (IMF). The classification in question is composed of eight course classes where a number is assigned for each course. In this framework, number one refers to most rigid exchange rate regime, where the most flexible regime is represented by number eight, and the numbers in between one to eight represent exchange rate regimes with different ranges of rigidities. Table (1) illustrates the classification used in this study. Before

Table 1: De Facto Exchange Rate Regime Classification

	IMF Exchange Rate Classification
1	Exchange arrangement with no separate legal tender
2	Currency board arrangement
3	Conventional pegged arrangement
4	Pegged exchange rate within horizontal bands
5	Crawling Peg
6	Crawling band
7	Managed floating with no predetermined path for the exchange rate
8	Independently floating

Notes: The information was retroactively updated by A. Bubula and I. Otker-Robe, "The Evolution of Exchange Rate Regimes Since 1990: Evidence from De Facto Policies," WP/02/155. The official definitions of the categories are available at: http://www.imf.org/external/np/mfd/er/index.asp.

estimating and analyzing the common movements of emerging market currencies, we examined the exchange rates of 30 countries and chose 14 among them that have relatively more flexible exchange rate regimes. The exchange rate regime data for 14 countries has been aggregated in two different ways and illustrated in Figure (1).

It can be clearly observed from Figure (1) that between the years 1990-2000, selected emerging market countries mediated their currency markets quiet often. Therefore, for the 1990-2000 period, it is hard to decompose the

effects of intervention from currency movements for analyzing the effect of financial or macroeconomic fundamentals on the dynamics of exchange rate movements alone. Thus we left that period out of analysis when we were conducting our study.

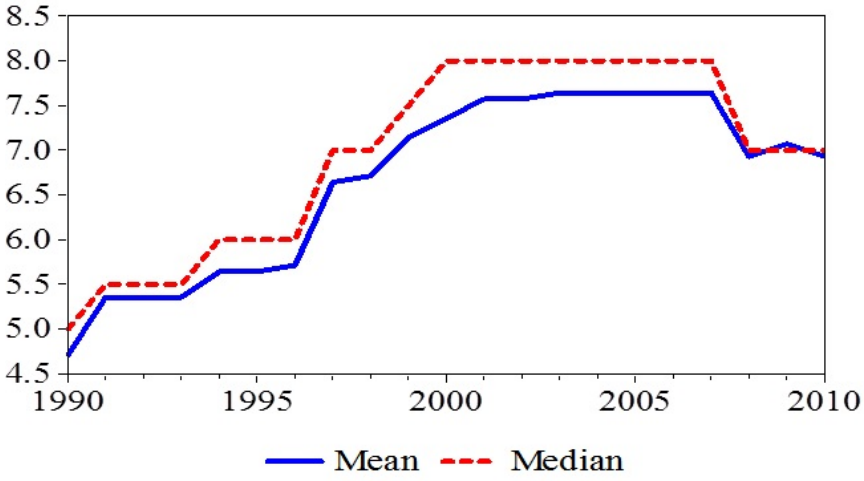

Figure 1: Exchange Rate Regimes of 14 Emerging Countries

Figure (1) also signals slight interventions to exchange rate markets after second quarter of 2009, during the time when emerging market countries were aiming to take some measures to control short term capital flows. This slight intervention is more observable within 2010, when the emerging market currencies started to appreciate with increased capital inflows. However, these interventions are not as strict as those in the 1990-2000 period.

Figure (2) illustrates the evolution of the selected 14 emerging countries' currencies after 2000.[2] The dataset used in Figure (2) has been standardized due to a significant scale difference between the selected 14 emerging economies. As can be seen from Figure (2), after year 2000 emerging market currencies depreciated first, then switched to a trend of consistent appreciation with the rise of the emerging market countries. In 2008, the deepening effects of the global financial crisis resulted in depreciation and finally currencies appreciated again with short term capital flows to emerging markets. Along with the descriptive statistics, cross correlations of the exchange rates of the 14 countries examined in this study take place in Appendix. On average, correlations are not that high and they seem to be free from regional or any other grouping effects.

[2]Exchange Rate data is monthly averages from IMF, International Financial Statistics (IFS) database. All the definitions for the series used in this research is at Appendix.

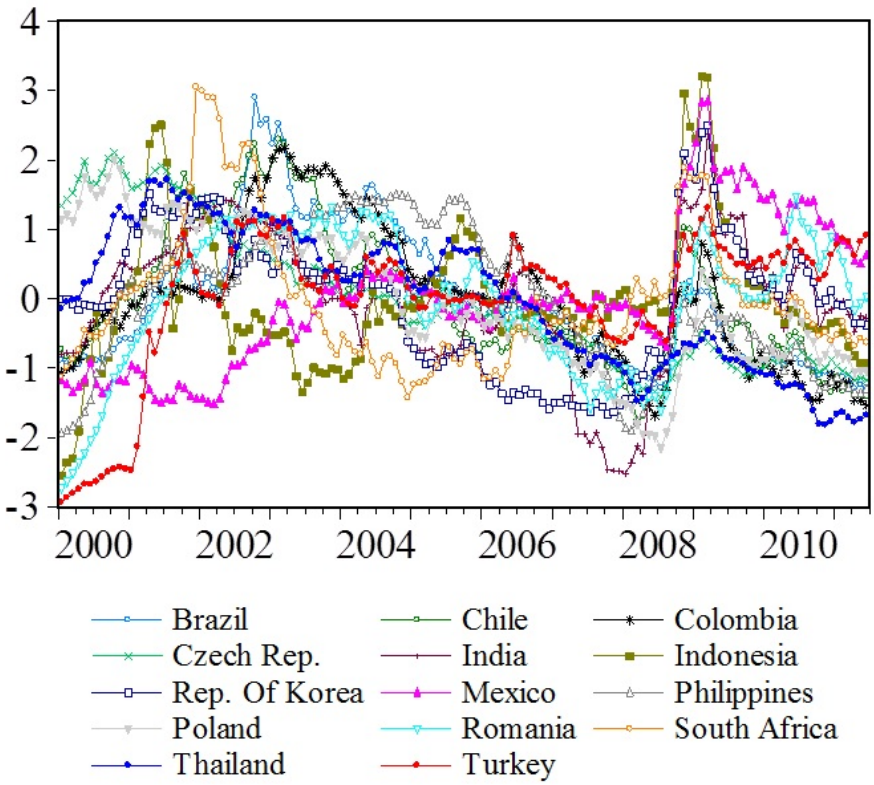

Figure 2: Exchange Rate Series of 14 Emerging Countries

3 Common Movement of Emerging Market Currencies

To estimate the common component of exchange rates of the 14 emerging market countries, we used a dynamic factor model cast in a state space representation. Factor analysis is an econometric approach that can be used to analyze interrelationships between a large number of variables and to explain these variables in terms of their common underlying dimensions. It is a method for condensing the information contained in a larger set of variables into a smaller set of dimensions, while keeping loss of information to a minimum.

Before estimating a dynamic factor model to extract the common dynamics of our dataset, we need to test if there is a significant common pattern among emerging market currencies and if this common pattern can be represented by a common factor using a factor model. To this end, first we conducted the likelihood ratio test with the null hypothesis that the number

of common factors is zero. We rejected the null hypothesis with a probability value of "0.000". Second, we used an information criteria developed by Bai and Ng (2007) to determine if there is at least one factor that can represent the common dynamics. The results show that the variation of selected currencies can be summarized by at least one factor.

The model adopted in this study tries to formalize the idea that the "Exchange Rate Index" is a representative "Reference Cycle" or a "Coincident Index" which is best measured by looking at comovements across several aggregate time series (also see Stock and Watson (1989)).

In this study we follow the approach proposed by Giannone et al. (2008) who develop a parametric dynamic factor model cast in a state space representation and estimate the factors in two steps.[3] Usage of factor models to extract the common fluctuations for some macroeconomic fundamentals is not new in the economic literature. Smith and Zoega (2007) used a factor model to extract the global component of 21 OECD countries. Kose et al. (2003) utilized dynamic factor models to extract the common components among different macroeconomic variables within the framework of business cycles employing Bayesian techniques. In addition to Kose et al. (2003, 2008), Neely and Rapach (2011) also used a very similar procedure. They used a dynamic factor model for the purpose of analyzing the common movement of inflation rates. However, this study will be the first among related studies in extracting the common component of emerging market currencies.

Let $X_t = (x_{1,t}, x_{2,t}, \ldots, x_{n,t})'$ denote the monthly exchange rate series of 14 emerging market countries; hence $n = 14$. We assume that X_t has the following factor model representation:

$$X_t = \mu + \Lambda F_t + \varepsilon_t \tag{1}$$

where, F_t is a 1×1 unobserved component, which represents the common dynamics of the emerging countries, and ε_t is a vector of idiosyncratic components that are assumed to have zero mean. Hence, the constants $\mu = (\mu_1, \mu_2, \ldots, \mu_n)'$ are the unconditional means. Further, factors are modeled as a VAR process of order 1:

$$F_t = \Theta F_{t-1} + u_t, \quad u_t \sim i.i.d.N(0, Q) \tag{2}$$

where Θ is the $k \times k$ matrix of autoregressive coefficients. Finally, we assume that the idiosyncratic component of the observables follows an AR(1) process:

$$\varepsilon_{i,t} = \alpha_i \varepsilon_{i,t-1} + \vartheta_{i,t}, \quad \vartheta_{i,t} \sim i.i.d.N(0, \sigma_i^2) \tag{3}$$

[3]Details of the model and estimation process take place in Doz et al. (2011) and Banbura et al. (2010).

with $E[\vartheta_{i,t}\vartheta_{j,s}] = 0$ for $i \neq j$.

Doz et al. (2006) have shown that, for large cross-sections, the model given by equation (1) can be estimated by maximum likelihood under the assumption of lack of cross-sectional correlation in the idiosyncratic component.[4]

Using the dynamic factor model structure defined above we extracted the unobserved factor, which explains 60 percent of the variation of the emerging market currencies, out of total variation. In the remaining parts of this study, we report and analyze only one factor which we introduce as the "Exchange Rate Index" for emerging economies.[5] In the remaining parts of this paper we will denote this index as "f_t". The evolution of this index as univariate time series, which represents a significant part of the emerging market exchange rate dynamics, can be observed via Figure (3).

As can be observed from Figure (3), the exchange rate index moves parallel to the general trend of country exchange rates within the period of 2000-2010. This figure is a good indication of how well the index represents the common movement of emerging market currencies in a clear way. If the movements of index and the country exchange rates are examined, we can state that effects of precautionary measures against the speculative capital inflows can be clearly observed towards the second half of 2010. How successfully the exchange rate represents the emerging market currencies can be observed more clearly when we plot the exchange rate index with each country currency. You can see those plots at Appendix.

4 Financial Variables and the Common Movement

In the previous section, we pointed out that the exchange rate index that has been extracted from the dynamic factor model represents approximately 60 percent of the total exchange rate movements of the 14 selected emerging market countries. In this section, we will examine the relationship between the exchange rate index and some financial variables. There are two reasons why we tried explaining exchange rate dynamics using financial variables first. The first reason is due to the fact that the implementation of more flexible regimes within the last ten years made it possible to analyze the

[4]Details of the maximum likelihood implemented by Expectation Maximization (EM) algorithm can be found in Banbura et al. (2010)

[5]Robustness of the model results has been tested by two different dynamic factor models estimated using a Bayesian algorithm, and results do not change. Details of these models take place in Tekatli (2010) and Chadwick (2010).

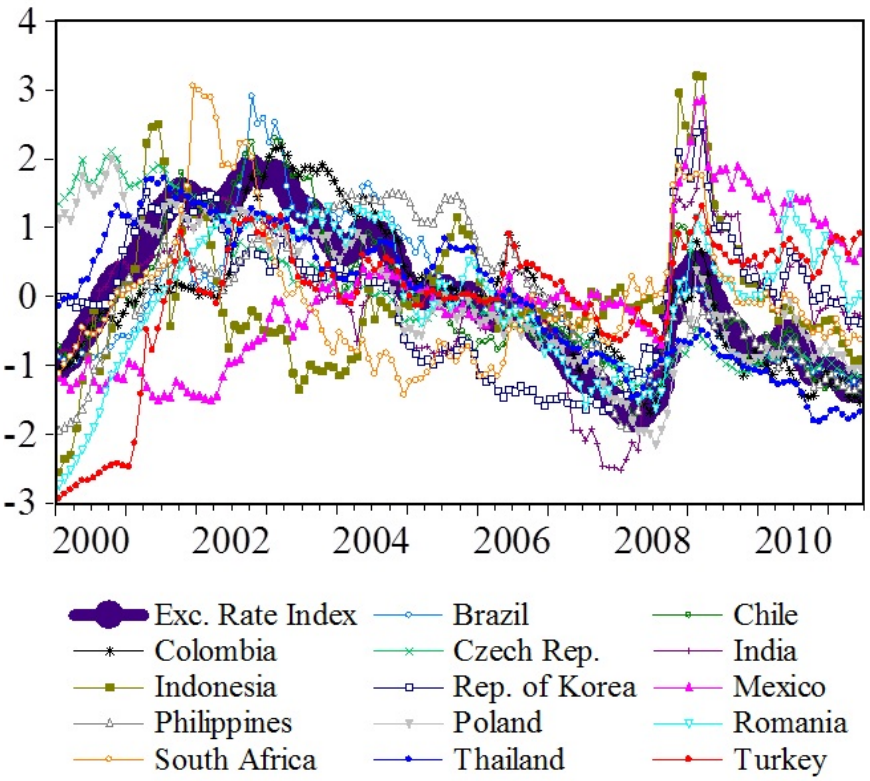

Figure 3: Exchange Rate Index and Exchange Rate Series of 14 Emerging Countries

effect of financial markets and capital flows on currency movements in a much healthier manner that can now be observed without any intervention effect. The second and more important reason is that there is a huge gap in the exchange rate literature about the treatment of financial variables to apprehend the movement of exchange rate dynamics, and remaining parts of this section will illustrate how important it is to fill this gap. We used different financial variable groups in this study. The first group represents the stock market and the variables utilized are S&P500 index and MSCI emerging market stock price indices which reflect the developments in equity markets of the emerging countries. The second group represents bond market and the variables used are EMBI+ Sovereign Spread dataset which can be considered as a risk indicator for the bond markets of emerging market countries. Finally, we use a variable that can represent the (global) economic and financial risk conditions, which is VIX index also considered as a good indicator of risk appetite. Static and dynamic correlations of these financial

variables and the exchange rate index, are illustrated in Table (2).[6] In Table

Table 2: Exchange Rate Index and Financial Variables (Dynamic Correlations)

	Long Term Correlation	Medium Term Correlation	Short Term Correlation	Static Correlation
VIX	0.44	0.62	0.55	0.54
S&P500	-0.82	-0.82	-0.57	-0.57
MSCI Emerging Markets	-0.91	-0.90	-0.78	-0.83
MSCI Emerging Asia	-0.87	-0.84	-0.70	-0.77
MSCI Emerging Europe	-0.90	-0.92	-0.73	-0.81
MSCI Latin	-0.87	-0.89	-0.72	-0.79
EMBI+ SS Main	0.56	0.71	0.61	0.64
EMBI+ SS Asia	0.53	0.63	0.51	0.55
EMBI+ SS Europe	0.35	0.62	0.61	0.61
EMBI+ SS Latin	0.63	0.72	0.58	0.62

(2), while negative correlations are related with the equity returns, positive correlations refer to indicators related to risk. The signs of the correlation coefficients are in line with the expectations. In short, medium and long term the MSCI indices are the ones that are highly correlated with the exchange rate index (the coefficients are around -0.80) and these indices are related to equity markets. On the other hand, exchange rate index and other financial variables have a correlation coefficient of around 0.60. Therefore, this correlation analysis signals that the exchange rate index that represents the emerging market currency dynamics is strongly related to financial variables that are commonly used for representing bond and stock markets.

In order to understand if financial conditions can explain the dynamics of the exchange rate index for emerging economies, we studied each group of financial variables in a separate manner. Before starting the analysis of financial variables, we will consider the relationship between exchange rate index and equity market indicators separately as these two variables may be

[6]We used the definition of dynamic correlation from Croux et al. (2001) for bivariate time series analyses, to analyze the covariance matrices between exchange rates and financial series in frequency domain, instead of the time domain. This approach describes the dynamic properties of comovements between two series through their frequency spectrum. The advantage of dynamic correlation is to measure the strength of the relationship between two time-series within different horizons.

endogenous.[7] Figure (4) shows the relation between the exchange rate index and the MSCI return index in a clear manner.

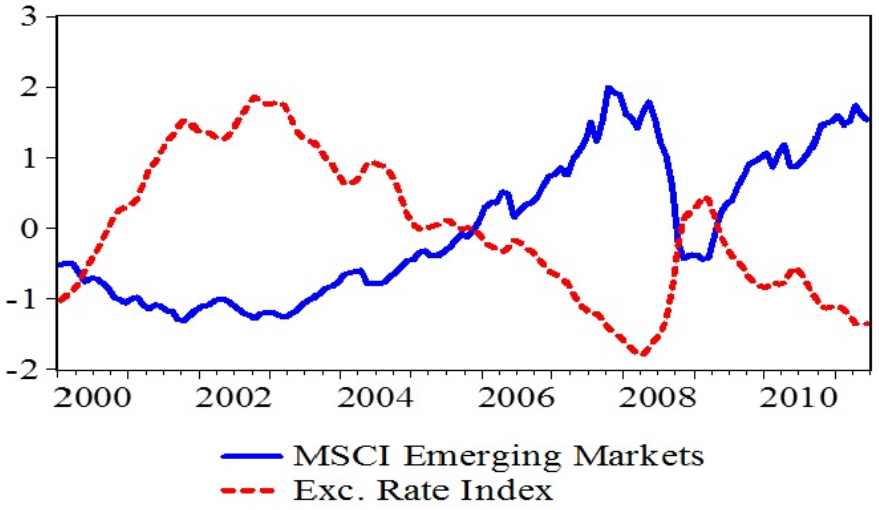

Figure 4: Exchange Rate Index and MSCI Emerging Markets Index

We analyzed the relationship between exchange rates and equity returns using the "Uncovered Equity Return Parity" (UERP) model explained below. To illustrate the dynamics of this relation in a much healthier manner we used an estimation technique which is robust to the endogeneity problem, i.e. Generalized Method of Moments (GMM) of Hansen (1982).[8] The UERP model can be explained briefly as: When expected equity returns in a country/region are lower than expected equity returns in another country/region, the currency associated with the market offering lower returns is expected to appreciate (see also Cappiello and Santis (2005)). Accordingly, the UERP model can be represented as:

$$\Delta f_t = \gamma + \alpha(r_t - r_t^{US}) + u_t \tag{4}$$

[7]Theory behind the relationship between exchange rates and stock prices is not well-built and clear as the causality between the two remains an open ended question. Dornbusch and Fischer (1980) suggests that changes in exchange rates affect the competitiveness of multinational firms and hence it affects the stock prices. Accordingly the causality is from exchange rates to stock prices. On the other hand, according to the portfolio balance approach, exchange rates are determined through a market mechanism and when the stock market is on the rise, it will attract capital flows from foreign investors which can increase the demand for the country's currency. Accordingly, the causality is from stock markets to exchange rates.

[8]The details about estimated model and "Uncovered Equity Return Parity Condition" take place in Cappiello and Santis (2005)

The UERP model tries to explain the percentage change in exchange rates with excess equity returns. In Equation (4), f_t represents the exchange rate index representing the common movement of 14 emerging market countries and r_t refers to equity returns. Results of the estimated model illustrated in Equation (4), is reported in Table (3). Table (3) illustrates the esti-

Table 3: Uncovered Equity Return Parity Condition

	Constant	Excess Equity Return
Coefficient	0.27	-0.38
Standard Error	0.17	0.04
R^2	0.39	
Direction of Change	28%	

mated UERP model. UERP model is based on market efficiency and risk neutrality assumptions. Therefore, we expect coefficient γ to be statistically insignificant and coefficient α to be minus one.[9] When the results are examined through Table (3), the constant being insignificant signals the market efficiency meaning that the theory underlying the model is met. Negative coefficient attached to the excess equity return illustrates the fact that when the equity returns are relatively higher, exchange rates appreciate to compensate for it, which is in line with the theory. However, the coefficient attached to excess equity returns being smaller than one in absolute terms signals to a risk premium that is not captured by the model. On the other hand, the last row of Table (3) underlines the strong relation between exchange rates and the excess equity returns, as the direction of change in both exchange rate and equity returns match intuitively by 72 percent and are consistent with the expectations.[10] Estimation results show that there exists a risk premium that we cannot price with these simple models, which are priced by agents in the market. These results are very essential for understanding the relationship between emerging market countries' exchange rates and excess equity returns.

The current financial crisis has caused sharp imbalances in global exchange rate structures and some other financial fundamentals, which clearly demonstrates the financial frailties of countries on a global scale. With the recent crisis, collapse in asset prices and underlying capital flows, flight-to-safety phenomenon gained a special emphasis where both the US and other

[9]This would be in line with what the UERP model predicts to arbitrage away any profit possibilities. Extended discussion can be found in Cappiello and Santis (2005).

[10]The R^2 of similar estimations in the literature appears to be much lower than what we have found after estimating Equation (4).

investors have shifted from equities into fixed income instruments, particularly to safe government bonds. After some European countries announced the big debt ratios and default risk they face, European governments and the markets struggled to find a solution to possible crisis due to government debt. Therefore, it is important to understand how global risk conditions influence currency dynamics. Accordingly, risk exposures of emerging market countries became very vital, and we used two series that carry necessary information about risk exposures, EMBI+ Sovereign Spread and VIX.[11]

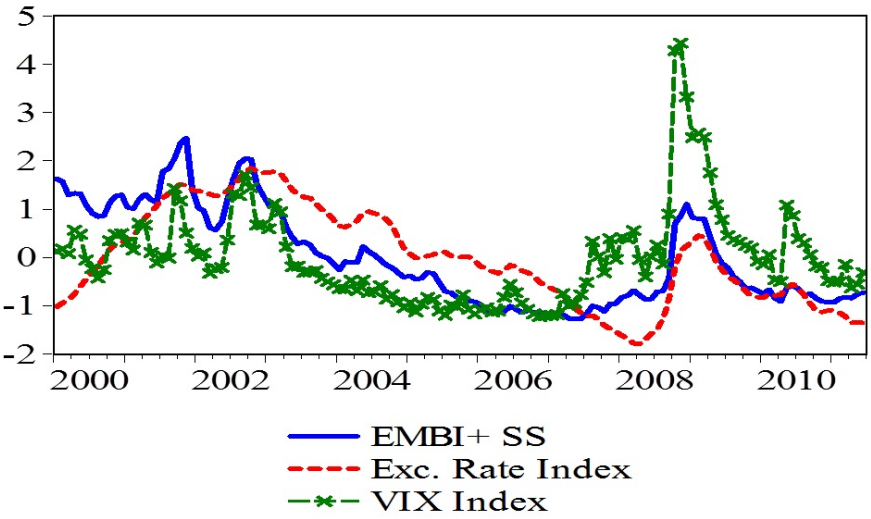

Figure 5: Exchange Rate Index and Financial Variables (EMBI+ SS and VIX)

Figure (5) demonstrates the strong correlation between the exchange rate index, VIX and EMBI+ sovereign spreads in a visual way. Hence, first we performed an OLS to examine the explanatory power of VIX and EMBI+SS on exchange rate index of the 14 emerging market countries. Linear regression results of the exchange rate index on the financial variables are demonstrated in the first row of Table (4).

The first row shows us that, when there is an increase in VIX or sovereign bond spreads of emerging market countries, the situation refers to the increased financial risks in those countries, which results in capital outflows from these countries. Capital outflows from emerging countries increase the

[11]There exists a literature using the asset pricing approach to explain foreign exchange movements in terms of compensation for risk. Details can be found in papers such as; Fama (1984), Hodrick (1989), Dumas and Solnik (1995) and a very recent one Adrian et al. (2009).

demand for the global currency (the US dollar), but at the same time increases the supply of currencies in question. Therefore, VIX and EMBI+ SS have a positive relation with the exchange rate index. Figure (5) also indi-

Table 4: Linear and Nonlinear Estimation Results of Financial Variables and Exchange Rate Index

			VIX	EMBI+ SS
I.Linear Model		Coefficient	**8.29**	**16.13**
(OLS)		R^2	0.29	0.41
		Direction of Change	59%	63%
II.Nonlinear Model	Regime 1	Coefficient	**8.29**	**16.13**
(TAR)		No of Observations	105	106
		R^2	0.10	0.30
		Direction of Change	51%	54%
	Regime 2	Coefficient	**15.75**	**27.24**
		No of Observations	32	31
		R^2	0.64	0.78
		Direction of Change	84%	94%
	All Observations	R^2 Total	0.53	0.64

cates that sudden big changes in the financial variables affect the exchange rate index relatively more compared to small changes. In other words, when there is a significant change in the risk environment, the exchange rate index can be more sensitive to changes in financial variables.[12] This observation of the sensitivity of exchange rate index can refer to a situation where the relation between exchange rate index and the financial variables in question being nonlinear, and therefore, we will examine the explanatory power of EMBI+SS and VIX on the exchange rate index via the threshold model of Hansen (2000).[13] The threshold model used in this study can be illustrated as[14]:

$$\begin{aligned} f_t &= \theta_1' z_t + e_t, \quad q_t \leq \gamma \\ f_t &= \theta_2' z_t + e_t, \quad q_t > \gamma \end{aligned} \tag{5}$$

where f_t represents the exchange rate index of emerging countries extracted from the dynamic factor model, z_t represents the financial variable (either

[12]For reference and details please see Cairns et al. (2007).

[13]We confirm the nonlinearity of the relationship using the nonlinearity test offered by Hansen (2000). We showed the test results in the Appendix

[14]See also Franses and van Dijk (2000).

VIX or EMBI+ SS) and q_t is the threshold variable used in the model. Absolute value of the change in the exchange rate index has been used as the threshold variable in this model. Using this threshold variable, the sample has been divided into two regimes, where first regime represents the small changes in the exchange rate index and second regime represents the big changes in exchange rate index. On the other hand, the threshold value which is important for deciding two regimes has been decided endogenously within the model estimation procedure.[15]

The results of the nonlinear regression have been illustrated in the second row of Table (4). Bold numbers in Table (4) refer to statistically significant variables, and results demonstrate that the nonlinear regression results are more significant, especially for the second regime when compared to OLS.[16] If the results are examined closely, regime two which refers to the sample with higher values than the threshold value, both VIX and EMBI+ SS have a higher explanatory power, and also, this regime includes most of the variation in the whole sample. These results point out that when there is a significant change in the global risk appetite, or the risk exposure of the emerging market countries, their currencies depreciate or appreciate accordingly in relation to the risk conditions.

5 Macroeconomic Fundamentals and the Common Movement

In the previous part, we showed that the exchange rate index which we constructed using the nominal exchange rates of 14 emerging market countries, can be explained significantly by indices related to equity prices (MSCI), volatility index related with the stock market (VIX) and indices related with bond market (EMBI+ SS). In this part, we will focus on the most prominent exchange rate models in the economic literature used to explain exchange rate dynamics, but we will do it from a different perspective relative to existing literature. With the Purchasing Power Parity (PPP) Model being the cornerstone of international finance literature, and the Sticky Price Monetary (SPM) Model being the most widely used structural model in the literature, they are most commonly referred and cited exchange rate models. However, as mentioned in the introduction, they do not have good score in explaining exchange rate dynamics. In this paper, we wanted to estimate and see if both

[15]Estimated threshold values are given in Appendix alongside nonlinearity test results.

[16]We would like to state that all the estimations (OLS and TAR) are done with transformed variables. We take the log difference of the variables used to make them stationary. Unit root test results are shown in Appendix.

PPP and SPM models have any significant explanatory power for the dynamics of the exchange rate index of emerging market countries. To do so, as in the previous section, first we will estimate these two models as explained in the literature using OLS[17], and then we will test if there is any nonlinearity. After confirming nonlinearity, we will continue with the nonlinear estimation procedure.

The PPP Model is one of the most well accepted theories about exchange rate movements, as it is commonly used to measure the degree of exchange rate misalignment. According to the PPP theory, a certain amount of money should have the same purchasing power in two different countries to prevent arbitrage opportunity. Hence exchange rate movement reflects the changes in price levels in both countries. The theory can be formally stated as:

$$f_t = \beta_0 + \beta_1 \widehat{P}_t \tag{6}$$

where in our setup f_t is the exchange rate index of emerging markets, $\widehat{P}_t$ denotes the difference of emerging countries' price level from the US price level. The estimation results of the model are conducted using all the variables in log differences. In the first row of Table (5) the results according to the PPP

Table 5: Linear and Nonlinear Estimation Results of Macroeconomic Fundamentals and Exchange Rate Index (PPP Model)

			Constant	Prices	EMBI+ SS
I.Linear Model		Coefficient	-0.45	**216.76**	
(OLS)		R^2	0.10		
II.Nonlinear Model	Regime 1	Coefficient	-0.24	48.91	2.53
(TAR)		No of Obs.	104		
		R^2	0.04		
	Regime 2	Coefficient	-0.16	126.40	**25.62**
		No of Obs.	31		
		R^2	0.80		
	All Obs.	R^2 Total	0.66		

Model are given, as it is used in the exchange rate literature. Although the price variable is significant, it has got hardly any explanatory power to understand the exchange rate dynamics. We included EMBI+ SS to see if the explanatory power of the model will improve, and similar to the previous part first we conducted a nonlinearity test. Once more we confirmed that prices and EMBI+ SS have a nonlinear relationship with the exchange rate index.[18]

[17]Cheung et al. (2005) gives an excellent review on these two models and for the two exchange rate models (PPP and SPM models) we used the same notation.

[18]Test results related with the nonlinearity is shown in Appendix.

The second row of Table (5) illustrates the threshold model estimation results that we defined by Equation (5). Exchange rate index is basically explained by EMBI+SS with the whole sample results; R square changes from 0.10 to 0.66. It is clear that the inclusion of EMBI+SS and splitting the data into two regimes improves the estimation results immensely.

The SPM Model [19] can be interpreted as an extension of the PPP Model, where the price variable is replaced by some macroeconomic fundamentals that capture money demand and overshooting effects (Cheung et al. (2005)). The SPM Model can be formally stated as:

$$f_t = \beta_1 \widehat{m_t} + \beta_2 \widehat{y_t} + \beta_3 \widehat{i_t} + \beta_4 \widehat{\pi_t} + u_t \tag{7}$$

where m_t is the logarithm of money, y_t is the logarithm of real output, i_t is the interest rate, π_t is the inflation rate and u_t is the error term. $\widehat{\ }$ refers to the difference between emerging country macroeconomic fundamentals and US macroeconomic fundamentals.[20] β_1 and β_4 are expected to be positive, since an increase in money supply or inflation lead to depreciation of money. On the other hand, the coefficients of y_t and i_t are expected to be negative, since an increase in output leads to a decrease in real money balances, and an increase in i_t leads to an appreciation because of Uncovered Interest Rate Parity condition. The first row of Table (6) illustrates the results of typical

Table 6: Linear and Nonlinear Estimation Results of Macroeconomic Fundamentals and Exchange Rate Index (SPM Model)

			Constant	Output	Interest Rate	Monetary Base	Inflation	EMBI+ SS
I.Linear Model		Coefficient	0.01	-5.54	**1.31**	15.20	**1.43**	
(OLS)		R^2	0.13					
II.Nonlinear Model	Regime 1	Coefficient	-0.11	-4.18	-0.80	-2.36	0.56	4.28
(TAR)		No of Obs.	109					
		R^2	0.15					
	Regime 2	Coefficient	-0.18	47.40	1.29	82.78	2.82	**23.17**
		No of Obs.	26					
		R^2	0.85					
	All Obs.	R^2 Total	0.69					

SPM Model estimated in logarithmic differences, and we clearly observe that theoretical linear models have little explanatory power. On the other hand, the nonlinear version of the SPM Model has a high explanatory power in regime 2, which is due to the inclusion of EMBI+ SS.[21]

[19] See Dornbusch (1976) and Frankel (1979) for details.

[20] See Chinn and Alquist (2006) for a detailed analysis of SPM Models.

[21] Nonlinearity test results and the estimated threshold values takes place at the Appendix.

When the results in Table (5) and Table (6) are summed up, we can clearly state that macroeconomic fundamentals utilized in most popular models to explain the currency dynamics do not have a satisfactory performance in explaining the emerging market currency dynamics. Although, some of the coefficients are significant in these benchmark models, the R-square was improved significantly only when we included a financial variable, which supports the results given in the previous section.

6 Conclusion

With this study we have shown that the exchange rates of emerging market economies, which practice flexible currency regimes, can be represented as a common movement that we name the "Exchange Rate Index". Accordingly, this common movement can be followed as a time series index that represents approximately 60 percent of the total variation of emerging markets' currency dynamics. When the relationship between exchange rate index and some financial variables are investigated, we clearly see that the financial variables have a significant explanatory power in currency movements of emerging countries in question. In particular, usage of nonlinear estimation techniques underlines and strengthens this explanatory power, both for the whole sample and when there are sharp changes in the exchange rate index.

When we conduct similar analysis using macroeconomic fundamentals within the framework of the most popular empirical exchange rate models (Purchasing Power Parity Model and Sticky Price Monetary Model), we observe that macroeconomic fundamentals have hardly any explanatory power in explaining the exchange rate index. On the other hand, using a nonlinear estimation method and including a financial variable, in addition to macroeconomic fundamentals, strengthened the explanatory power of models estimated via OLS significantly to understand the exchange rate index dynamics.

Thus, we conclude that financial markets, particularly bond and stock markets, and risk factors in the global economy, are quite important determinants of the exchange rate movements of emerging countries. Specifically, when there is a significant change in the risk environment, the effects of this change on exchange rates are more pronounced and clearly observable. Therefore, as we have experienced in the near past, any precautionary measures taken by developed countries, such as liquidity management and controls on capital flows, will have an important effect on the trend of the exchange rate movements of emerging market countries.

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Appendix

Data Definitions and Transformations

We use monthly data from 2000:01 to 2011:06 for the reasons explained in the introduction. The data of financial variables are from Bloomberg while

the monetary variables and nominal exchange rate data are from IMF's IFS. Although we use original data in graphs, log differences of variables are used in analysis that requires being stationary (PPP Model, SPM Model). After taking log differences of variables, the data which have a seasonal pattern namely industrial production and monetary base are seasonally adjusted. Lastly, simple averages are taken in constructing the common movement of monetary variables.

Descriptive Statistics for Emerging Market Currencies (Raw Data)

	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Jarque-Bera (JB)	JP p-value
Braz.	2.27	2.16	3.79	1.58	0.53	0.80	2.85	14.73	0.00
Chil.	574.50	549.64	746.18	442.25	74.72	0.58	2.35	10.05	0.01
Col.	2269.59	2276.11	2959.30	1733.28	317.58	0.40	2.36	6.10	0.05
Cz. Rep.	25.56	23.75	41.29	14.94	7.45	0.65	2.17	13.77	0.00
Ind.	45.52	45.66	51.30	39.37	2.44	-0.58	3.25	8.02	0.02
Indon.	9308.49	9158.50	11876.00	7263.00	800.79	0.93	4.84	39.26	0.00
Kor.	1130.45	1143.46	1453.23	915.20	129.40	0.06	2.27	3.11	0.21
Mex.	11.00	10.90	14.65	9.06	1.28	0.58	2.88	7.70	0.02
Phil.	49.43	49.84	56.34	40.45	4.61	-0.18	1.91	7.50	0.02
Pol.	3.40	3.25	4.64	2.07	0.62	-0.02	1.99	5.88	0.05
Rom.	2.90	2.96	3.47	1.83	0.39	-0.70	2.72	11.66	0.00
S. Afr.	7.63	7.30	11.68	5.73	1.33	1.32	4.18	47.82	0.00
Thai.	37.98	38.68	45.62	29.90	4.44	-0.14	1.80	8.76	0.01
Turk.	1.35	1.42	1.71	0.55	0.27	-1.66	5.13	89.05	0.00

Descriptive Statistics for Emerging Market Currencies (Standardized Data)

	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Jarque-Bera (JB)	JP p-value
Exc. Rate Ind.	0.00	-0.04	1.85	-1.79	1.00	0.15	1.94	6.97	0.03
Braz.	0.00	-0.20	2.90	-1.30	1.00	0.80	2.85	14.73	0.00
Chil.	0.00	-0.33	2.30	-1.77	1.00	0.58	2.35	10.05	0.01
Col.	0.00	0.02	2.17	-1.69	1.00	0.40	2.36	6.10	0.05
Cz. Rep.	0.00	-0.24	2.11	-1.43	1.00	0.65	2.17	13.77	0.00
Ind.	0.00	0.06	2.37	-2.52	1.00	-0.58	3.25	8.02	0.02
Indon.	0.00	-0.19	3.21	-2.55	1.00	0.93	4.84	39.26	0.00
Kor.	0.00	0.10	2.49	-1.66	1.00	0.06	2.27	3.11	0.21
Mex.	0.00	-0.08	2.86	-1.52	1.00	0.58	2.88	7.70	0.02
Phil.	0.00	0.09	1.50	-1.95	1.00	-0.18	1.91	7.50	0.02
Pol.	0.00	-0.24	2.00	-2.15	1.00	-0.02	1.99	5.88	0.05
Rom.	0.00	0.15	1.47	-2.74	1.00	-0.70	2.72	11.66	0.00
S. Afr.	0.00	-0.25	3.06	-1.43	1.00	1.32	4.18	47.82	0.00
Thai.	0.00	0.16	1.72	-1.82	1.00	-0.14	1.80	8.76	0.01
Turk.	0.00	0.24	1.31	-2.94	1.00	-1.66	5.13	89.05	0.00

Correlations of Emerging Market Currencies

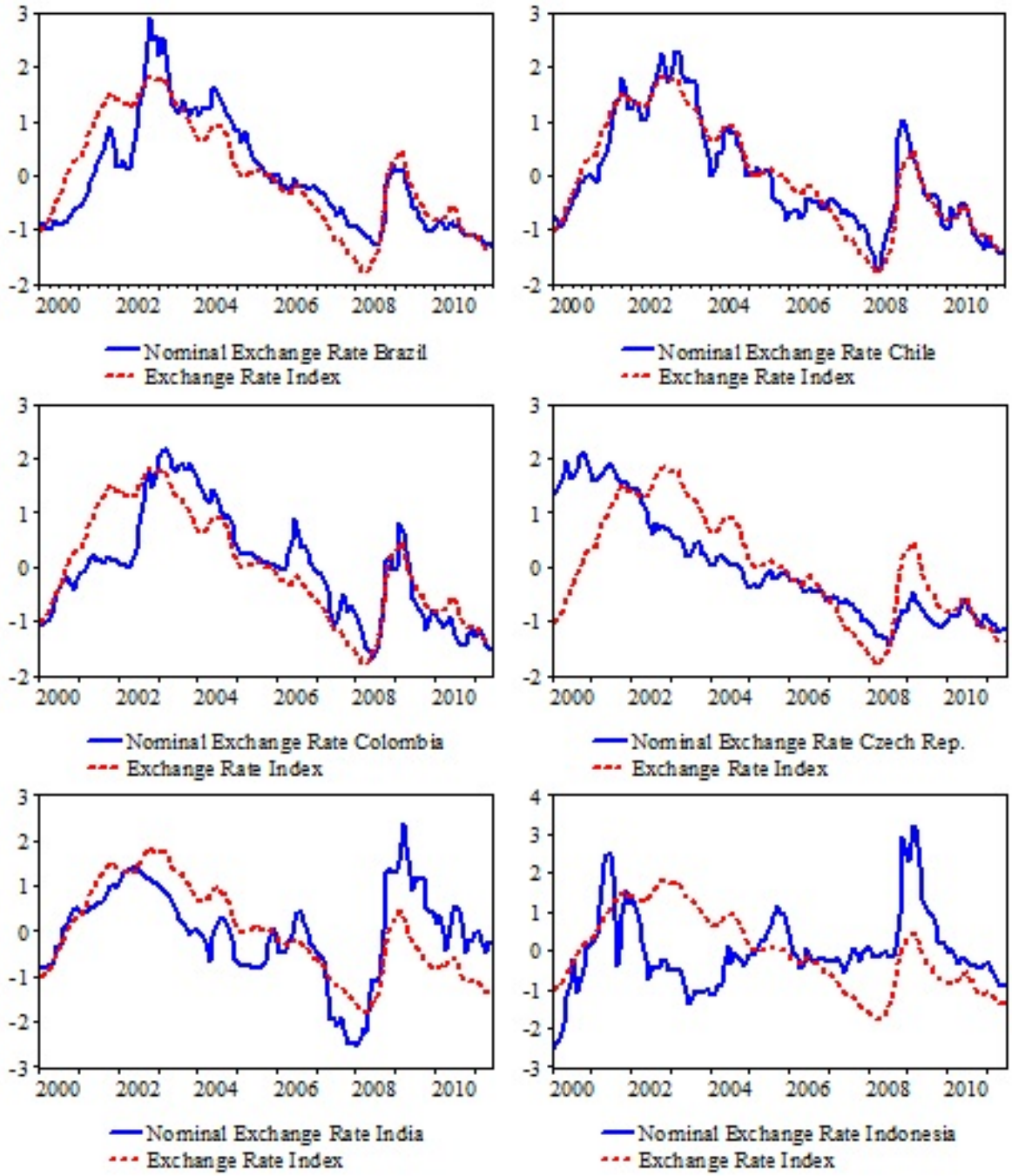
	Exc. Rate Ind.	Braz.	Chil.	Col.	Cz. Rep.	Ind.	Indon.	Kor.	Mex.	Phil.	Pol.	Rom.	S. Afr.	Thai.	Turk.
Exc. Rate Ind.	1.00														
Braz.	0.86	1.00													
Chil.	0.95	0.86	1.00												
Col.	0.84	0.93	0.81	1.00											
Cz. Rep.	0.63	0.34	0.53	0.37	1.00										
Ind.	0.68	0.40	0.63	0.41	0.34	1.00									
Indon.	0.16	-0.02	0.14	-0.02	-0.04	0.38	1.00								
Kor.	0.60	0.30	0.59	0.27	0.41	0.82	0.44	1.00							
Mex.	-0.33	-0.20	-0.28	-0.18	-0.74	0.14	0.27	0.10	1.00						
Phil.	0.75	0.81	0.65	0.82	0.25	0.35	0.14	0.15	-0.13	1.00					
Pol.	0.76	0.51	0.66	0.55	0.92	0.52	-0.09	0.54	-0.53	0.39	1.00				
Rom.	0.64	0.62	0.58	0.56	-0.04	0.62	0.21	0.50	0.31	0.61	0.23	1.00			
S. Afr.	0.48	0.23	0.55	0.14	0.27	0.63	0.45	0.65	-0.11	-0.01	0.28	0.32	1.00		
Thai.	0.85	0.68	0.76	0.69	0.84	0.40	0.11	0.35	-0.67	0.68	0.81	0.24	0.27	1.00	
Turk.	0.24	0.38	0.29	0.28	-0.52	0.35	0.29	0.16	0.54	0.35	-0.32	0.75	0.28	-0.18	1.00

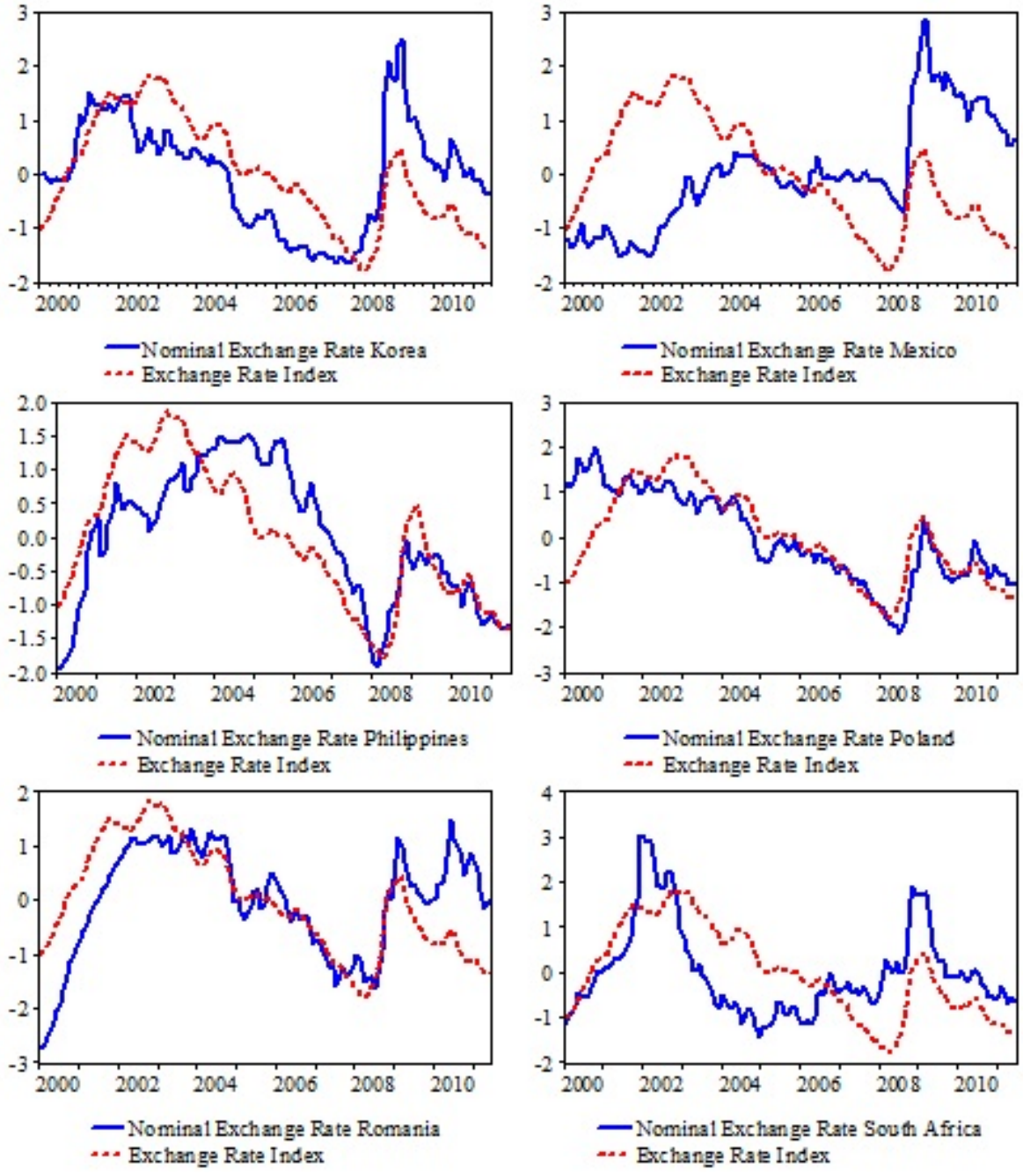
Unit Root Tests for Emerging Market Currencies

	Level/ERS	Level/PP
Exchange Rate Index	-1.56	1.36
Brazil	-1.29	-1.50
Chile	-1.61***	-1.56
Colombia	-1.42	-1.42
Cz. Republic	0.25	-0.86
India	-1.99**	-2.23
Indonesia	-1.23	-3.15**
Korea	-2.04**	-1.88
Mexico	-1.11	-1.75
Phillipines	-0.88	-1.77
Poland	-0.78	-1.35
Romania	-0.66	-2.85**
S. Africa	-1.69***	-2.17
Thailand	-0.62	-0.31
Turkey	-0.36	-2.87***

Notes: 'ERS is Elliot, Rothenberg, and Stock ADF-GLS test statistics. ***, ** and * stand for 10 percent, 5percent and 1 percent significance levels respectively.

Exchange Rate Index and Emerging Market Currencies




Nominal Exchange Rate Korea
Exchange Rate Index
Nominal Exchange Rate Mexico
Exchange Rate Index
Nominal Exchange Rate Philippines
Exchange Rate Index
Nominal Exchange Rate Poland
Exchange Rate Index
Nominal Exchange Rate Romania
Exchange Rate Index
Nominal Exchange Rate South Africa
Exchange Rate Index

Nonlinearity Test Results and Estimated Thresholds

EMBI+ SS	VIX
Test of Null of No Threshold	Test of Null of No Threshold
Against Alternative of Threshold	Against Alternative of Threshold
Allowing Heteroskedastic Errors (White Corrected)	Allowing Heteroskedastic Errors (White Corrected)
Number of Bootstrap Replications: 1000	Number of Bootstrap Replications: 1000
Trimming Percentage: 0.150	Trimming Percentage: 0.150
Threshold Estimate: 2.186	Threshold Estimate: 2.310
LM-test for no threshold: 19.871	LM-test for no threshold: 13.197
Bootstrap P-Value: 0.000	Bootstrap P-Value: 0.003

PPP Model	SPM Model
Test of Null of No Threshold	Test of Null of No Threshold
Against Alternative of Threshold	Against Alternative of Threshold
Allowing Heteroskedastic Errors (White Corrected)	Allowing Heteroskedastic Errors (White Corrected)
Number of Bootstrap Replications: 1000	Number of Bootstrap Replications: 1000
Trimming Percentage: 0.150	Trimming Percentage: 0.150
Threshold Estimate: 2.186	Threshold Estimate: 2.312
LM-test for no threshold: 22.840	LM-test for no threshold: 28.711
Bootstrap P-Value: 0.000	Bootstrap P-Value: 0.000

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