Exchange Rate and Monetary Fundamentals: A Panel Data Analysis of Emerging and Developing Asian Countries

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Abstract

This study's main objective is to estimate the long-run relationship between exchange rate and monetary fundamentals by using annual balanced panel data of eight selected emerging and developing Asian countries. We employed a panel cointegration methodology to estimate the exchange rate cointegration connection among monetary fundamentals by using annual balanced panel data of eight selected emerging and developing Asian countries such as Pakistan, China Mainland, Sri Lanka, Thailand, Indonesia, Malaysia, Philippines, India for the period of 1998-2016. The results concluded that the exchange rate has a cointegration connection with monetary variables (money supply, GDP real index, GDP deflator, producer price index. Further, the Granger causality test supported the money model by explaining that emerging and developing countries' currencies exchange rate converges towards long-run equilibrium. Therefore, we concluded that in emerging and developing Asian countries, the performance of the nominal exchange rate is comparatively better, as suggested by the monetary model.

Keywords: Exchange Rate, Panel Co-integration, Asian Countries, Granger Causality.

1. Introduction

Generally, the exchange rate (hereafter ER) denoted the price of a domestic country's currency concerning the price of foreign currency (Gandolfo, 2016; Tera, 2015; Mankiw, 2014). Several channels exist through which the macroeconomic variables play an essential and crucial role in the global economy, such as trade balance, level of prices, restrictions on international debt, and the value of currency credibility. Hence, due to these causes, the ER economic agents bear different loses and gains (Richard, 2013). In asset prices under the purchasing power parity (PPP), the critical determinant of inflation is the ER through the cost side, and it has a strong influence on the

sufficient demand in both short and long-term periods. A longstanding riddle in worldwide financial markets is the trouble in binding the floating ER to large macroeconomic essentials e.g., cash supplies, output and the ER, which represent the cost of loan.

The following papers have taken into consideration and examined the relationship between nominal ER and macroeconomic fundamentals in the line of panel data. (Berben & van Dijk,1998; Giorgianni & Berkowitz,1997). The following studies reveal that the ER has no cointegration relationship with monetary fundamentals. Further, extracted explanatory variables in the regression analysis found to be non-stationary. Therefore, the statistical hypothesis testing procedure gives incorrect inferences that need to be changed. We assume it is possible that the monetary model able to offer a realistic framework for the ER movement in selected developing Asian countries. Hence, in this study, our main objective is to examine the nominal ER cointegration relationship among monetary fundamentals in emerging and developing Asian countries. The results of this study make an important contribution to empirical literature in the context of emerging and developing countries. The findings show that ERs are not separated from monetary fundamentals. Therefore, we can say that the monetary model briefly explains the nominal ERs' behavior in emerging and developing Asian countries. Our findings are also important for policymakers, and it is suggested to keep an eye on the relationship between ER and monetary fundamentals. Any changes in domestic ER also affect the country's monetary variables.

The rest of the paper is organized in a way that section 2 provides a literature review, section 3 explains the econometric methodology and data, section 4 provides results and discussions, and the final section concludes the paper.

2. Literature Review

ER is one of the essential variables and its role is significant in relative prices, which leads to many transactions from an economic point of view (Obstfeld & Rogoff, 2005). Moreover, ER is a crucial variable in the development of econometric modeling with new tools of econometrics. Groen (2005) and Hakkio and Rush (1991) exhibited that nominal ER has no cointegration connection with monetary fundamentals, and they accepted this hypothesis based on the data span, which has a relatively short and low power of standardized tests. Cerra and Saxena (2010) observed that those studies employed the panel data set of advance and emerging economies; their results were relatively more successful in explaining the cointegration relationship between ER and macroeconomic fundamentals. The long-term relationship among nominal ER and

macroeconomic fundamentals were strongly proposed by the following studies which employ non-linear techniques of ER (Baillie & McMahon, 1990; Hsieh,1989). However, the relationship between the macroeconomic fundamentals and currency price was uncorrelated. Klein (1990) investigated the effect of bilateral exports of nine different types of items on ER volatility for the United States. The findings revealed that the response of export value is significantly affected by the volatility of the ER. The real ER volatility is related to increased demand for electricity supply of exports. According to Engel and West (2004), the asset pricing model of ER was broadly consistent with the ER and its fundamentals. Moreover, Bacchetta and Van Wincoop (2013) found that the ER in connection with macroeconomic fundamental was unstable due to unidentified structural coefficients. The main reason of the reduced form ER connection with macroeconomic fundamentals was not only driven by structural parameters themselves but also from the parameters expectations

3. Data and Methodology

4. Table 1. Variables Description

Variables	Variable's Name	Variables Clarification	Data Sources
S	Nominal Exchange Rate	End of period 2010 taking as a base year	IMF
M	Monetary Aggregate	M2, 2010=100	IMF
Y	GDP Real Index	2010=100	IMF
P	GDP Deflator	2010=100	IMF
PT	Price of tradeable taking as a proxy	Producer Price Index(PPI) 2010=100	IMF

Source: Author's compilation

3.1.**Data Collection Method**

The study covered the balanced panel annual data of eight emerging and developing Asian countries, namely Pakistan, China Mainland, Sri Lanka, Thailand, Indonesia, Malaysia, Philippine, and India, from 1998 to 2016. A comprehensive description of all selected variables is given in Table 1. For nominal ER (National Currency /US$), the end of period observations was obtained from the International Monetary Fund (IMF), so an increase in it may signal the depreciation of the national currency. The other variables include money stock (taken as Aggregate M2), GDP Real Index, GDP Deflator, and Producer Price Index (the price of tradable variable adopted as a

proxy). The data is collected from the international monetary fund (IMF), and the base year is selected as 2010. Table 1 below shows the description of the variables used in this study.

3.2.**Methodology**

The money model of ER is an essential intellectual instrument for explaining the ER variations over time (Rapach & Wohar, 2002). Moreover, it was incorporated mostly in previous studies to describe the ER variations in advanced economies as well as emerging and developing market economies (Dabrowski et al., 2013; Mark & Soul, 2001; Engel et al., 2004).

According to Sarno and Taylor (2002), the monetary model consists of three main blocks: the money market equilibrium at domestic and foreign countries, the absolute purchasing power parity (PPP), and uncovered interest parity (UIP) conditions. Following these, we write down the following equation:

$$S_{it} = (1-b)v_{it} + bE_tS_{it+1} \qquad 1$$

S_{it} shows the log of nominal ER, stated as the price of home currency concerning the foreign currency where $i = 1, 2, \dots, N$ denotes the no of cross-sectional units, $t = 1, 2, \dots, T$ denote the no of time duration.

$b = \lambda(1-\lambda)^{-1}$ this is the increasing function of interest rate, and λ parameter shows the partial elasticity of demand for money, E_t is the expectation operative which is designed on the set of existing information at time t.

$$V_{it} = -(m_{it} - m^*_t) + K\left(Y_{it} - y^*_t\right) + [(P_{it} - P^*_t) - (P^t_t - P^{t*}_t)] \qquad 2$$

Where m_{it} shows the log of domestic country supply of money, $\mathbf{y_{it}}$ log of domestic country income, P_{it} is the log of the domestic level of price, P^t_{it} is the log of the price of tradable, k is an income elasticity parameter of demand for money. Asterisk sign represented the foreign variables. Squared bracket's terms denote the non-tradeable prices proportional change. Through applying 'no-bubbles' restriction, i.e., is $b^jE_tS_{it+1}$ converges to 0 as t move towards ∞. Hence, we can write the nominal ER solution is:

$$S_{it} = (1-b)\sum_{j=0}^{\infty} b^jE_tV_{it+j} \qquad 3$$

By subtracting V_{it} from the left and right-hand side of equation (3), and by doing some operation, it is likely to demonstrate that (Sarno and Taylor, 2002).

$$S_{it} - V_{it} = \sum_{j=1}^{\infty} b^jE_t\Delta V_{it+j} \qquad 4$$

If fundamentals are not stationary under the integration of order, I (1) procedure than the third equation indicates that the dependent variable S_{it} is also non-stationary. Similarly, equation no 4 indicates that both S_{it} and V_{it} are the vector of cointegration (1, -1). Therefore, in line with the monetary model, which stated that nominal ER intersect the equilibrium level, V_{it} shows the long term.

The description of V_{it} and Eq. (4) in the empirical analysis, the ER relationship among monetary fundamentals, in the long run, can be analyzed. We can be defined as:

$$S_{it} = \beta_1(m_{it} - m^*{}_t) + \beta_2\left(Y_{it} - y^*{}_t\right) + \beta_3[(P_{it} - P^*{}_t) - (P^t{}_t - P^{t*}{}_t)] + \mathcal{E}_{it} \qquad 5$$

where $\mathcal{E}_{it}$the error term, and the significant coefficients values is are: $b_1 = -1$, $b_2 = K > 0$, $b_3 = 1$.

4. Empirical Analysis

The present research estimated the nominal ER cointegration relationship among monetary fundamentals. Model is adopted from Dąbrowski et al. (2013) which is given below:

$$S_{it} = \beta_1 m^r{}_{it} + \beta_2 y^r{}_{it} + \beta_3 x^r{}_{it} + \varepsilon_{it} \qquad 6$$

where the variables S_{it} is equal to

$$m^r{}_{it} = (m_{it} - m^*{}_t), y^r{}_{it} = \left(Y_{it} - y^*{}_t\right), x^r{}_{it} = [(P_{it} - P^*{}_t) - (P^t{}_t - P^{t*}{}_t)] \qquad 7$$

All variables are expressed in logarithmic form for every selected country i, correspondingly. An r demonstrates that the difference of the variable between the domestic and foreign levels. Moreover, assumed that for each selected country i of the panel, all selected variables are stationary in $I(1)$. The estimated parameters β_1, β_2 and β_3 show the long-term elasticity coefficients of the nominal ER concerning the explanatory variables.

4.1.Cross-Sectional Dependence

The cross-section independence weak axioms appear to be insufficient under cointegration analysis and causality analysis (Pesaran et al., 2008). When fiscal relations among countries are quite powerful, cross-sectional dependence appeared. Hence, to investigate the existence of cross-sectional dependence, we employed four types of statistical tests of cross-sectional dependence with the null hypothesis that no cross-sectional dependence exists in our dataset.

4.2.Panel Unit Root Test

At an early stage of the cointegration process, all variables are stationarity investigated by employing the unit root test. Moreover, the property of non-stationary data, investigated by applying the first-generation test, which is developed by (Im et al., 2003).

4.3.Panel Co- Integration Test

In the second step, we assume that all the selected variables are stationary at first difference level for every selected country$i$. After that, to test the cointegration relationship among variables, the panel cointegration test applied, which was developed by (Pedroni, 2000).

4.4.Panel Co-Integration Estimation Equation

When the cointegration relationship among variables was justified, we employed Fully Modified Ordinary Least Square (FMOLS) technique, which was developed by (Pedroni, 2000). The FMOLS measures the heterogeneity, which mostly exists in the cointegrating relationships among variables. Moreover, FMOLS estimates are comparatively highly elastic than Dynamic Ordinary Least Square (DOLS) for alternate hypotheses as compare to within the group estimator, and it is slightly affected by small sample size discrepancies (Pedroni, 2000).

Table 2 shows the descriptive statistics for the period 1998-2016 of eight selected countries. The data reveals that on average nominal ER of Indonesia is high, which means that it has the largest devalue currency relative to the dollar. On the other hand, average money stock (M), average income(Y), and the average price of tradeable were highest in Pakistan as compared to other selected countries in the selected years. Moreover, on average, the GDP deflator was highest in Thailand.

Table 2. Descriptive Statistics Period: 1998-2016

Countries	S		M		Y		P		PT	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
China	7.35	0.8823	24.83	2.4533	84.33	45.40	86.72	17.06	98.40	5.6120
India	50.23	8.58	21.53	2.57	83.97	33.30	86.30	26.76	88.63	27.01
Indonesia	10000	1798.83	20.87	3.56	89.27	26.30	74.94	37.15	82.37	39.65
Malaysia	3.63	0.3764	8.09	90.51	90.51	24.60	88.12	17.74	89.12	16.44
Philippine	47.27	5.15	19.73	3.85	90.86	25.82	87.26	19.14	85.50	18.05
Sri Lanka	108.84	21.84	17.61	4.08	89.50	28.74	74.20	36.39	73.34	31.48
Thailand	36.45	4.30	9.67	0.65	89.53	18.95	93.17	16.58	84.22	18.78
Pakistan	75.02	20.59	31.60	2.0	91.02	20.70	81.30	44.61	80.20	41.91

Source: Author's compilation

Table 3 explains the results of four different cross-section dependence tests. Each test-statistics results strongly rejected H_0 of the non-existence of cross-sectional dependence because all of the coefficients of the above variables are significant at a 1% level in our framework. Therefore, we conclude that in our data set, cross-sectional dependence exists. Table 4 results

reveal that all of the variables in this model are non-stationary at the level. Whereas, all variables are stationary in $I(1)$ as justified by the unit root test.

Table 3. Cross Section Dependence Test

Method	s	Mr	yr	xr
Breusch-Pagan LM	114.63***	84.18***	260.78***	322.60***
Pesaran scaled LM	13.37***	8.67***	35.92***	45.46***
Bias-corrected scaled LM	13.17***	8.47***	35.72***	45.26***
Pesaran CD	3.46***	9.90***	10.81***	17.88***

Note: ***, ** and * indicates the level of significance at 1%, 5% and 10%, respectively.

Table 4. Panel Unit Root Test IM by Pesaran and Shin (2003)

	Level with Intercept		First Difference with Intercept	
Variables	**Test- Statistic (W-Stat)**	**Outcomes**	**Test- Statistic (W-Stat)**	**Outcomes**
S	0.30	Non-Stationary	5.70***	Stationary **I(1)**
mr	-1.01	Non-Stationary	-3.99***	Stationary **I(1)**
Yr	1.44	Non-Stationary	-5.26***	Stationary **I(1)**
Xr	1.77	Non-Stationary	-10.17***	Stationary **I(1)**

Note: ***, ** and * indicates the level of significance at 1%, 5% and 10%, respectively.

To investigate the cointegration relationship among selected variables, Pedroni, Engel-Granger Co-integration test was employed, which is developed by (Pedroni, 2000). Table 5 results conclude that out of 11 statistical values, and nine statistical values significantly rejected the null hypothesis of the non-existence of the cointegration relationship at a 1% level of significance. Hence, the results concluded that ER has a cointegration relationship with monetary fundamentals.

Table 5. Panel Co-integration test statistics (null hypothesis: no Co-integration). Pedroni (2000) Engel Granger based Co-integration

Alternative hypothesis: Common AR coefficient (within-dimension)		
	Statistic	Weighted Statistics
Panel v-Statistic	0.94	0.27
Panel rho-Statistic	-4.38***	-3.20***
Panel PP-Statistic	-3.14***	-6.05***
Panel ADF-Statistic	-3.38***	-6.05***
Alternative hypothesis: Individual AR coefficient (between-dimension)		
Group rho-Statistic	-5.42***	
Group PP-Statistic	-11.90***	
Group ADF-Statistic	-7.44***	

Note: ***, ** and * indicates the level of significance at 1%, 5% and 10%, respectively.

When the variables cointegration connection was justified, we estimated the cointegration vector. For this purpose, we employed (FMOLS) methods proposed by (Pedroni, 2000). The estimated regression[1] is:

$$S_{i,t} = 0.2994^{***}\, m^{r}{}_{it} + 0.0939^{NS}\, y^{r}{}_{it} + 0.1850^{**}\, X^{r}{}_{it} \qquad 8$$

All the selected variables were taken in a logarithmic form. Hence, the estimated coefficients show long-run elasticities. The statistical results reveal that long-run elasticities of money variable are statistically significant at 1 percent level. This result is consistent with the opinion of the monetary model. Specifically, our results show that in the long run, as 1% increases in the M^S leads to reduce home currency value contrary to the dollar by 0.29%. The coefficient of β_1 relative money stock is less than one as proposed by the monetary model and this result is consistent with other studies like Beckmann et al. (2012) who found $\beta_1$value 0.20 for eighteen selected OECD countries. However, estimated coefficient of CEE countries which were proposed by Cuaresma et al. (2005) range from 0.30 to 0.975. The sign of the relative income coefficient is insignificant. Our result is consistent with Uz and Ketenci (2008), whose result is non-significant except the ordinary least square term. Thus, one might suppose that the income elasticity coefficient is less than one in a typical background concerning money stock and income only. The study results demonstrate that the elasticity of income is lower than the money supply elasticity. These results are consistent with the result available for CEE economies by Cuaresma et al. (2005) ranges from 0.01 to 1.11. The ER long-run elasticity as compared to the changes in the relative price of non-tradable is significant at the 5% level, and the coefficient value is less than one. As1% rise in the relative price of non-tradable leads to a decrease in the value of a home currency relative to the dollar by 0.18%. There were mixed results available in the literature about this variable. These findings carried out by Crespo-Cuaresma et al. (2005) having a range from 0.2 to 1.8, but Uz and Ketenci (2008) found an incorrect sign of this coefficient, which ranges from -0.93 to -0.36. After finding the long term relationships among the selected variables. The next important step is to find out the causal relationship between the variables. Hence, the Pairwise Dumitrescu Hurlin Panel Causality test was used to estimate the causal relationship among variables.

The above Table 6 results reveal that money stock to nominal ER is significantly rejected at a 1% level. Thus, the result shows that money supply homogenously causes to nominal ER.

[1] Note: ***, ** and * indicates the level of significance at 1%, 5% and 10%, respectively.

Further, the income variable does not homogenous cause to nominal ER is firmly rejected at a 1% level. Similarly, estimated parameter changes in the relative price of non-tradable do not homogenous cause to nominal ER is firmly rejected at a 10% level. Thus, these results reveal that income elasticity and difference in the relative price of non-tradeable homogenous cause to nominal ER. Moreover, changes in the relative price of non-tradeable do not homogenous cause to money stock is rejected significantly at a 1% level. Therefore, test results explain that differences in relative prices of tradeable homogeneously cause to the money supply.

Table 6. Granger Causality Test

Dependent Variables	S	mr	yr	xr
s	-	2.83***	3.79***	1.86*
mr	1.58	-	0.42	2.99***
yr	1.59	1.16	-	1.32
xr	0.35	0.51	-0.43	-

Note: ***, ** and * indicates the level of significance at 1%, 5% and 10%, respectively.

5. Conclusion

According to Obstfeld (2001), in a small open economy, ER is an essential relative price, and it is a key that better explains the variations for supporting macroeconomic sustainability, i.e., the developing and emerging countries lie in this group. This study investigated the monetary model to suggest a realistic outline for the movement of ER towards emerging and developing Asian countries? By estimating the panel cointegration test, the results give definite answers to these questions. Moreover, we found evidence that the cross-sectional dependence exists among developing and emerging Asian countries, and the results concluded that the ER has a cointegration relationship with monetary fundamentals. Further, the variables found significant long-run elasticities of the money stock and relative price of non-tradeable, which were related to the prediction of the money model.

Furthermore, monetary fundamentals also supported the Granger Causality analysis: the ER of emerging and developing countries' currencies move towards the long-run equilibrium relationship indicated by the monetary model. Overall, our analysis reveals that in emerging and developing countries, the ER is not separated from monetary fundamentals. Hence, we can say that the monetary model briefly explains the nominal ERs' behavior in Emerging and Developing Asian countries.

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