Saudi Journal of Business and Management Studies **ISSN 2415-6663 (Print)**
Scholars Middle East Publishers **ISSN 2415-6671 (Online)**
Dubai, United Arab Emirates
Website: http://scholarsmepub.com/

What Determines Real Exchange Rates? Evidence from Asia

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Article History
Received: 16.11.2017
Accepted: 22.11.2017
Published: 30.11.2017

DOI:
10.21276/sjbms.2017.2.11.9

Abstract: This study examines the macroeconomic factors which are affecting to real effective exchange rates (REER) from selected ten countries in Asia. Two panel regression approaches namely fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS) and fixed effects are applied using panel data over the period 2002–2016. Empirical results show that presence of a significant long-term association amongst the REER and seven macroeconomic determents namely interest rate, inflation, trade balance, terms of trade, trade openness, foreign reserves and share price index and their significance are remaining same in all models applied. However, trade balance has a positive connection with the REER while other significant variables have a negative association with the REER in long run. Moreover, the money supply (M2) and real gross domestic production (GDP) do not show a significant relationship with the REER.

Keywords: Asia, DOLS, Macroeconomic Fundamentals, FMOLS, Long run, REER
JEL Classifications: F31, F41, C33

INTRODUCTION

The exchange rate movements have been an interesting area for scholars and professional investors. While this research area is subject to abundant theories due to its significance for any economy, the exchange rate behavior model remains unsolved and needs to be addressed. There is a rich collection of earlier studies exploring the relation among exchange rates and economic fundamentals.

A nonlinear association is found by Tang and Zhou [2], Yuan [1] and Ma and Kanas [3] while in difference, many prior researchers concluded on a recurrent linear relationship on the same matter [3-6]. Number of variables is recognized as influencing factors to exchange rates, which are generally economic and political factors in both short run and long run. Therefore, in exchange rate economics there are numerous concepts, including market demand and supply approach, the parity approaches and monetary models to study the connection amid exchange rates and economic fundamentals.

This study analyzes the determination of real effective exchange rates (REER) in 10 economies (Table 1) from Asia pacific and South Asia. Different exchange rate regimes are adopted by selected economies. And also trade openness is not same among the countries (Table 2). Exchange-rate regime is the method chosen by an authority to manage its currency in respect to other currencies and in consideration of the overseas currencies which has an immense influence on international trade and the global financial system. In-between the interval bounded by the fixed and freely floating exchange various combinations remain and can be implemented.

Table-1: Exchange rate regimes in Asia

Country	Currency	Exchange rate regime
China	Yuan (RMB)	Managed floating rate system- market forces and a basket of currencies since 2005.
Hong Kong	HK dollar (HKD)	Linked exchange rate system with the US dollar. US$ 1= HK$7.8 since 1983.
India	Indian rupees (INR)	Managed floating rate system- market forces since 1993.
Indonesia	Rupiah (IDR)	Managed floating rate system -inflation targeting framework since 2005.
Japan	Yen(JPY)	Free- floating rate system -market forces since 1973.
Korea Rep.	Korean won (KRW)	Free- floating rate system - market forces since 2001.
Malaysia	Ringgit(MYR)	Managed floating rate system - against a basket of currencies since 2005.
Singapore	Singapore dollar (SGD)	Managed floating rate system - against a basket of currencies since 1981.
Taiwan	Taiwan dollar (TWD)	Managed floating rate system - market forces since 1979.
Thailand	Thai baht(THB)	Managed floating rate system- market forces since 1997.

Note: Sources are from each country Central Bank websites. US$ stands for United States dollars.

Table-2: Trade Openness

Country	1965-1974	1975-1984	1985-1994	1995-2004	2005-2014	2015	2016
China	6.49	13.17	27.81	40.45	53.25	40.46	37.06
Hong Kong	169.97	175.37	223.92	254.04	391.49	389.38	372.62
India	8.79	13.88	15.87	26.93	49.97	42.20	39.81
Indonesia	32.63	48.63	49.08	63.50	52.27	41.87	37.39
Japan	20.55	25.66	18.52	19.86	31.02	35.59	25.71
Korea Rep.	38.54	57.95	53.77	62.45	92.59	83.71	77.68
Malaysia	82.84	102.39	137.78	201.43	167.99	134.16	128.08
Singapore	260.85	345.65	324.16	352.09	390.66	329.94	318.42
Taiwan	40.77	64.62	58.21	55.32	56.46	45.46	43.07
Thailand	37.86	47.69	68.66	107.07	133.24	126.59	123.12

Note: Trade openness value is calculated via (imports + exports)/Nominal GDP. All values in terms of US$. Source of data are World Bank national accounts and OSIRIS database.

Japan and Korea adopt a free-floating currency conversion system, where the market forces are driven the conversion rate. Any involvement in the official foreign exchange market aims at mitigating the extreme fluctuations and not to set a level for it. At different regards, Japan is a closed economy and an export driven country [7]. A close observation of the previous-mentioned trade openness ratio for Japan reveals a low value, generally lower than the trade openness ratio observed for Korea republic, which has several characteristics of an open economy. Since 1983, Hong Kong has linked its currency HK$ to the US$ at a fixed rate of US$ 1= HK$7.8. This parity is maintained via different adjustment mechanisms and a diligent currency board system focusing for instance on controlling the monetary base stock [8]. As a result, Singapore and Hong Kong both countries have recorded the highest ratios of trade openness among this sample respectively 372% and 318% for the year 2016.

In many countries over the sample adopt a managed-float exchange system. For China, India, Indonesia, Malaysia, Singapore, Taiwan and Thailand currencies' value is subject to the market forces and consequently moves in line with the economic fundamentals. In manged-float system, Central Banks do interventions for the purpose of avoiding disproportionate volatilities. In July 2005, an Inflation targeting framework was launched in Indonesia. It is a new monetary policy allowing their central bank, namely Bank Central Republic Indonesia, to interfere while rupiah's currency value is essentially set by the market forces [9]. The domestic currency is hence safe from experiencing extreme fluctuations. Meticulous on these features for the selected economies, clearly sample consists of in different exchange rate regimes at diverse trade openness levels.

The research purpose is to recognize the key economic determinants of REER for the sample of Asian countries. This study is grounded on a systematic approach involving different levels of statistical tests such as panel unit root, panel co-integration and Hausman test. Our empirical model is estimated by using number of techniques for panel data including fixed-effect, dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) model estimators to identify the long run association among real exchange rates and other economic determinants.

It is hence an available resource for regulatory authorities and their commitment to understand the factors affecting the exchange rate determination in the region, and for managers of Multinational Corporations in their financing and investment decisions. This paper makes three main contributions. First, this study will enhance the current research work on the association among the REER and macroeconomic variables. Second, this research work will add to and update the empirical literature for Asian countries, which has been limited by data availability. Third, our empirical model is estimated by using number of techniques for panel data including fixed-effect, DOLS and FMOLS model estimators to capture the relationship between macroeconomic determinants and REER in long run.

The rest of the paper is organized as follows: next section 2 shows literature review, the data and methodology adopted are illustrated in section 3, section 4 indicates the empirical results and finally conclusion includes in section 5.

LITERATURE REVIEW

Various theories have focused on exploring the exchange rates association with economic fundamentals. On this matter, the purchasing power parity (PPP) theory for instance argues that exchange rates are inextricably connected with price levels. The currency exchange rate between two nations would change in according to the price-level variation in the selected two economies. This approach supported by an abundant literature is however rich in numerous models challenging each other. First theory is the absolute PPP and relative PPP [10]. While the absolute PPP model stands for the equity of price levels in the selected economies, the relative PPP model focuses on their percentage change, assuming an equity rate of change

in the price levels. Both models remain quite similar since exchange rate variations and price level differences are positively correlated. However, while one relies on absolute values for the calculation of price levels, the other (relative PPP) approaches the same calculation in terms of growth rates. The essence of the relative PPP model is that any change in the relative price index between two countries systematically change with a specific change between these two countries' foreign exchange rates by Che and Mansur [11]. This phenomenon may be tied to the alteration of other economic factors together with money supply, interest rate, inflation rate and real GDP [12, 13].

Secondly, the uncovered interest parity (UIP) theory based on a parity condition existing between two economies, which assume any observed discrepancy of interest rates in the two countries to be identical to the variation of exchange rates among them. These international parity conditions become a strong basis for other theories and models. Chaboud and Wright [14] investigated the asset market model of the exchange rate theory followed by the universal parity conditions through the PPP and UIP.

The monetary models are very crucial as an exchange rate determination theory which is ground on comparative prices of international and local money supply and demand. Money market equilibrium condition exists on PPP with the assumption of flexible prices. In response, Dornbusch-Frenkel sticky-price (DFSP) model introduced by Dornbusch [15] for short-run PPP variations, but due to the price stickiness this model adopts long run PPP variations [11, 16].

Edwards [17] offered a wide explanation for real exchange rate determination grounded on all the local and foreign assets demand and supply. Therefore, this portfolio balance model is a dynamic model which is considering the collaboration of goods and service markets, current account balance, price levels and foreign reserves. Many researchers combined the numerous PPP theories and included the different variables introduced by this portfolio balance model in their studies [11, 18].

Clark and MacDonald [19] suggested a modern theory called behavioral equilibrium exchange rate (BEER) approach by giving a broader explanation for exchange rate determination. They introduced a basic model for the real exchange rate determination by considering many economic factors such as government debt, productivity differences other than the determinants introduced in portfolio balanced model and PPP theories. BEER approach is widely used in many empirical studies due to the flexibility of the approach. Numerous models with many variables have been considered in real exchange rate determination studies [2, 20, 21]. According to Montiel [22] the steady-state of the predetermined variables including domestic supply-side factors, fiscal policy structures, international trade factors, trade liberalization policies will determined the long run equilibrium real exchange rate. Tang and Zhou [2] and Jongwanich and Kohpaiboon [23] selected their independent variables in the model for exchange rate determination according to the Montiel [22] guidelines.

The economic variables of the study are carefully chosen in accordance with the previous studies [22]. Dependent variable REER indicates the real purchasing power of domestic currency in compared to a basket of other foreign currencies. This REER is fair and appropriate for measuring the currency exchange rate since it considers overall performance in terms of relative price changes. Tang and Zhou [2] and AbuDalu and Musa Ahmed [18] considered REER as the dependent variable in their exchange rate determination studies.

Real GDP growth will directly affect to the domestic currency appreciation by stimulating the domestic productivity, exports and decreasing the average level of prices. And in other words, it will decrease the home currency depreciation by influencing the exchange rate fluctuation. In contrast, increases in GDP assume residents are well-off and they are willing to spend more on imported goods which along with the natural decrease in exports will cause the local currency depreciation. Many researchers consider real GDP as an economic determinant in their exchange rate studies and found significant results. Recently in long run panel studies, AbuDalu and Musa Ahmed [18]; Kia [6] and Bhat and Hussain [5] observed a positive association among REER and real GDP. Hence, we develop the following hypothesis:

H1; Real GDP has a positive relationship with REER

There is a close relationship between interest rates and exchange rates. While the interest rate determines the national currency supply and demand, interest rate fluctuations directly affect the price of the national currency in foreign markets. Generally higher interest rates reward lenders and investors with higher returns. It affects to the demand of national currency positively and it will lead to a rise of exchange rates. And also government authorities control exchange rates via the interest rates and monetary policy. According to the previous work, interest rate is associated with exchange rates in positively as well as negatively [24, 18, 5, 6]. Based on the mixed evidence, we propose that there is a significant effect of interest rate on REER. However, the direction of the relationship is not clear. Thus, we formulate following hypothesis.

H2; Domestic interest rate is positively/negatively related with REER

Generally, an increasing money supply could lead to a currency depreciation through the rise of domestic inflation and lower the interest rate. Many scholars found a negative relationship which proves increase of the money supply will lead to domestic currency depreciation in their studies [1, 6, 5, 25]. AbuDalu and Musa Ahmed [18] found significant mixed results for both short and long terms in5 ASEAN countries. However negative sign is expected for money supply.

H3; Money supply has a negative relationship with REER

The rate of inflation or general price level in an economy has a great influence on domestic currency's values. Economies enjoying a consistently low rate of inflation tend to appreciate their currency due to an increasing purchasing power than other currencies. Countries with higher inflation typically face with local currency depreciation. Commonly inflation has been found negatively correlated to exchange rates [18, 5, 6]. Therefore, we derived fourth alternative hypothesis as follows:

H4; Inflation has a negative relationship with REER

Trade balance is another variable which has influence on exchange rates via the foreign exchange supply and demand. Trade is itself associated with foreign currencies and makes adjustments in the supply and demand of domestic currency. In the situation of a trade deficit domestic currency demand may decrease and local currency will depreciate. On the other hand, a trade surplus increases the demand for domestic goods and currency having as a consequence the appreciation of the national currency. Bergvall [26]; Lane and Milesi-Ferretti [27] concluded that trade balance has a long-term negative association with REER in their empirical studies. According to the general phenomena and previous evidence, the direction of the association is not clear. Nevertheless, we expect that there is a significant effect of trade balance on REER by formulating the hypothesis given below.

H5; Trade balance is positively/negatively related with REER

Terms of trade variable is a comparison of the export and import prices in a particular country. Sometimes the association of terms of trade and real exchange rate is uncertain due to the substitution effect and income effect. In income effect when exports income will rise, non-tradable goods demand will increase and then the prices will go up, it will lead to a real home currency appreciation [26, 28]. Conversely, in the substitution effect, when the import prices are lower than domestic prices and increase the imports demand will affect negatively for the home currency [23, 29]. The same phenomenon is investigated by Tang and Zhou [2] which concluded to the existence of a nonlinear co-integrating relationship. In contrast, Tsen [7] proved that there is no long run association among terms of trade and the real exchange rate based on a sample of Japan, Korea and Hongkong. Hence the direction of the relationship is not certain we derived the hypothesis as follows.

H6; Terms of trade is positively/negatively related with REER

Trade openness is a variable which indicates the trade liberalization. The foreign trade (imports + exports) as a percentage to nominal GDP is used to measure the trade openness even though there are few other methods such as tax rate and Sachs–Werner binary index [30] and closely affected by the changes in tariffs, quotas, level of export tax and the occurrence of income and substitution effects. Automatically, openness will carry both pros and cons to the economy. More open economy will gain more benefits from world economy and ultimately it will lead to home currency appreciation. On the other hand, greater trade liberalization of an economy will cause real currency depreciation due to substitution effect. Many scholars showed that there is a positive connection between trade openness of the economy and real exchange rates [2, 23, 30]. Kim and Korhonen [31] found strong evidence for supporting a negative relationship of trade openness and REER. However, we propose that there is a significant relationship between interest rate and REER and the direction of the relationship is not clear.

H7; Trade openness have a positive/ negative relationship with REER

Through allowing monetary controllers and government authorities to set and adjust the value of a domestic currency according to the countries' targets or in response to economic external shocks, foreign reserves have a key role in the economy. When the reserves increase due to the high demand for the local currency, it will cause home currency appreciation and when reserves decrease due to the higher supply of the local currency it will lead to home currency depreciation. Several researchers concluded that real exchange rates are fluctuated from international reserves movements [29, 32]. Hence, we develop the following hypothesis:

H8; Foreign reserves are positively related with REER

Share price indexes are used to measure the stock market performance and various researchers study its relationship with exchange rates since Branson [33] who introduced stock-oriented exchange rate theory to describe this relationship. The theory supporting this combination of economic variables is tightly related to financial market's attractiveness and a rise in stock

prices attracts generally more investors and finally causes local currency appreciation. The table 3 indicates the share market indexes which are considered in this study. In literature, Bhat and Hussain [5] found stock returns are negatively related with real exchange rates in four south Asian countries. According to Phylaktis and Ravazzolo [34] there is no individual association among share price index and real exchange rates in each Pacific Basin country in long run and only Hong Kong indicated the relationship. Based on the stock-oriented exchange rate theory our final hypothesis is written as follows by expecting a positive relationship between stock returns and REER.

H9; Stock returns are positively related with REER

Table-3: Share Market Indexes

Country	Share Index	Base Year
China	Shanghai Stock Exchange A Share Index (SHASHR)	21/02/1992=100
Hong Kong	Hang Seng Composite Index (HSCI)	31/07/1964=100
India	Bombay Stock Exchange Sensitive Index (BSE Sensex)	01/04/1979 =100
Indonesia	Jakarta Composite Index (JKSE)	10/08/1982=100
Japan	Nikkei Stock Average Index (Nikkei 225)	16/05/1949=176
Korea Rep.	Korea Composite Stock Price Index (KOPSI)	04/12/1980=100
Malaysia	Kuala Lumpur Composite Index (KLCI)	04/04/1986=100
Singapore	Strait Time Index (STI)	31/08/1989=1356
Taiwan	Taiwan Stock Exchange Weighted Index (TWSE)	06/30/1966=100
Thailand	Stock Exchange of Thailand Index (SET)	30/04/1975=100

Note: As per the official stock exchange websites and all index values are in terms of local currencies.

DATA & METHODOLOGY

Data

Data was obtained from Bureau Van Dijk's OSIRIS database and International Monetary Fund (IMF) for the period of 2002Q1-2016Q4 in quarterly basis. The sample consists of 10 countries China, Hong Kong, Singapore, India, Indonesia, Japan, Korea Republic, Malaysia, Taiwan and Thailand representing Asia-pacific region and South Asia. The selection of sample countries is limited due to the data accessibility and availability. This study used seasonally adjusted data and then transformed to natural logarithms except trade balance, percentage change of real GDP and percentage change of M2 money supply (existence of negative values). There are several factors which are related to the economies and the trading relationship between the countries. In this study we considered nine independent economic variables (Table 4).

Table-4: Variables used in the study

Variable	**Symbol**	***Measurement***
Real effective exchange rate	REER	Trade-weighted basket of currencies converted to an index (1997=100) and adjusted for relative prices
Real GDP	RGDP	Change in real GDP at end-period at constant market prices to 1995 (%)
Interest rate	IR	90-day interbank market rate (%)
Money supply	M2	Change in M2 money supply at end-period (%)
Inflation	CPI	The consumer price index based to 2005=100
Trade balance	TBAL	Trade balance value in US$ Millions.
Terms of trade	TOT	(Exports value / Imports value) *100
Trade openness	OPEN	(Exports value + Imports value)/ nominal GDP *100
Foreign reserves	RESV	foreign exchange reserves +reserve position at end-period(excluding gold) in US$ Millions
Share price index	SPI	Stock market price index value

Note: Data collected from OSIRIS & the IMF databases.

Methodology

The behavior of the REER of 10 local currencies is expected to be derived by given economic determinants in the equation 1:

$$REER_i = \alpha_0 + \beta_1 RGDP_{it} + \beta_2 IR_{it} + \beta_3 M2_{it} + \beta_4 CPI_{it} + \beta_5 TBAL_{it} + \beta_6 TOT_{it} + \beta_7 OPEN_{it} + \beta_8 RESV_{it} + \beta_9 SPI_{it} + \varepsilon_{it} \quad [Equation\ 1]$$

Where REER=real effective exchange rate, RGDP= real GDP, M2=M2 money supply, CPI=consumer price index, TBAL=trade balance, TOT=terms of trade, OPEN=trade openness, RESEV=foreign reserves, SPI=share price index, i =i^{th} observation, t= time dimension and ε = error term.

The independent variables are the proxies for economic fundamentals and Share Price is a proxy for non-economic fundamentals. Equation 2 indicates the model after transformed the variables into natural logarithms(*ln*) except trade balance, percentage change of real GDP and percentage change of M2 money supply (existence of negative values).

$$ln(REER_i) = \alpha_0 + \beta_1(RGDP_{it} - RGDP_{it-1}) + \beta_2 ln(IR_{it}) + \beta_3(M2_{it} - M2_{it-1}) + \beta_4 ln(CPI_{it}) + \beta_5 TBAL_{it} + \beta_6 ln(TOT_{it}) + \beta_7 ln(OPEN_{it}) + \beta_8 ln(RESV_{it}) + \beta_9 ln(SPI_{it}) + \varepsilon_{it} \quad \text{[Equation 2]}$$

Where REER=real effective exchange rate, RGDP= real GDP, M2=M2 money supply, CPI=consumer price index, TBAL=trade balance, TOT=terms of trade, OPEN=trade openness, RESEV=foreign reserves, SPI=share price index, i =ith observation, t= time dimension and ε = error term.

Empirical model is estimated by using number of techniques for panel data including descriptive statistics, correlation matrix, panel unit root, panel co-integration and Hausman test. In this study four different models namely fixed effect, least square dummy variable (LSDV), DOLS and FMOLS models are applied. In literature numerous scholars considered fixed country effects [35-37] and panel FMOLS and DOLS models [5, 6, 25, 38] in exchange rate studies.

Table-5: Descriptive Statistics

Variable	Mean	Std. Deviation	Minimum	Maximum
REER	73.15	39.93	6.72	167.09
RGDP	4.96	3.71	-8.82	18.99
IR	2.98	2.71	0.00	17.06
M2	9.52	5.93	-3.18	32.16
CPI	113.49	26.09	77.20	227.91
TBAL	6.01	25.81	-55.01	174.89
TOT	106.44	20.20	54.60	200.31
OPEN	119.63	103.23	17.43	392.22
RESV	457.97	735.87	27.17	4010.83
SPI	6607.17	7075.62	331.79	27957.49

EMPIRICAL RESULTS

Descriptive Statistics

Descriptive statistics in table 5 showed that REER has an average of 73.15. Maximum 167.09 rate is observed for the 3rd quarter of 2016 in Indonesia while minimum 6.72 value observed for same year in Hong Kong. The average of real GDP growth rate is 4.96 and the maximum value 18.99 from Singapore in 1st quarter of 2009 . In parallel, the average IR rate is found at 2.98 with a maximum 17.06 from China in 2007Q2 and a minimum of zero rate observed for Hong Kong in 2002Q3. The highest M2 growth rate is 32.16 from Malaysia in 2005. During the first quarter of 2002 in Hong Kong M2 growth records a negative rate of 3.18 as the minimum rate from the sample. For the CPI the lowest value being recorded from Korea Republic at 77.20, when India has the highest value of 227.91 and sample average is 113.49. India records the minimum value of TBAL US$ -55.01millions and China has the highest value US$ 174.89millions. TOT has an average of 106.44 and a maximum of 200.31 recorded for Indonesia during the 2nd quarter of 2003 where lowest value 54.60 is attributed to India in 2008. The average value of OPEN is 119.63 and a minimum of 17.43 form Japan in 2002, highest value is 392.22 is from Hong Kong during the 2nd quarter of the year 2010. RESV has a maximum value of US$ 4010.83 millions from China during the 2nd quarter of 2014, its average value stands at 457.97 and its lowest value observed from Indonesia of 1st quarter in 2002. Furthermore, the highest SPI value 27957.49 records from India in 1st quarter of 2015 and minimum is from Thailand in 2002.

Correlation Matrix

In order to detect multicollinearity Pearson correlation analysis was conducted among variables. The results indicated that none of the correlation coefficients have an extreme value higher than 0.7 (Table 6). So, the variables do not appear to be substitutes of each other. Results showed that CPI, OPEN and SPI has negative significant association with REER, whereas RGDP, IR, M2, TBAL, TOT and RESV have positive significant association. This correlation analysis is an ex-ante method to detect multicollinearity. An ex-post way is to test for variance inflation factor (VIF) after estimation of the model.

Table-6: Correlation Matrix

	REER	RGDP	IR	M2	CPI	TBAL	TOT	OPEN	RESV	SPI
REER	1									
RGDP	0.09**	1								
IR	0.15***	0.33***	1							
M2	0.13***	0.48***	0.49***	1						
CPI	-0.02	0.01	0.33***	0.12**	1					
TBAL	0.48***	0.15***	-0.11***	0.08**	-0.28***	1				
TOT	0.51***	-0.02	-0.01	-0.09**	-0.37***	0.56***	1			
OPEN	-0.38***	-0.03	-0.42***	-0.10**	-0.06	-0.15***	0.07*	1		
RESV	0.32***	0.12***	-0.04	0.14***	-0.09**	0.68***	0.11***	-0.28***	1	
SPI	-0.53***	-0.10**	-0.04	-0.05	0.40***	-0.40***	-0.57***	0.19***	0.02	1

***, **, * denote 1%, 5% and 10% significance levels respectively.

Table-7: Panel unit root results

	Levin-Lin-Chu test		Im-Pesaran-Shin test		Test
	t- statistic	p-value	t-statistic	p-value	
REER	-1.3580	0.0872*	-1.2959	0.0975*	level
RGDP	-8.7009	0.0000***	-7.8423	0.0000***	level
IR	-2.0010	0.0227**	-2.8178	0.0024***	level
M2	-3.4917	0.0002***	-2.7374	0.0031***	level
CPI	-1.5340	0.0625*	0.4088	0.6587	level
TBAL	-2.2624	0.0118**	-1.9444	0.0259**	level
TOT	-3.1404	0.0008***	-3.3604	0.0004***	level
OPEN	-4.2937	0.0000***	-2.5212	0.0058***	level
RESV	-6.0881	0.0000***	-2.8673	0.0021***	level
SPI	-3.7678	0.0001***	-2.1627	0.0153**	level

***, **, * denote 1%, 5% and 10% significance levels respectively.

Panel unit root tests & panel cointegration test

Levin, Lin, and Chu [39] introduce a strong panel unit root test instead of carrying out individual unit root tests assuming that existence of a common unit root process in the panel data. And also results are compared with Im-Pesaran-Shin (IPS) individual unit root process test. The unit root results in table 7 indicate almost similar results for the individual variables where the null hypothesis can be rejected at the level test. The variables are stationary in the level form in both tests other than REER and CPI in IPS test. This study, found that all the variables are stationary at level and there is a possibility of long term cointegration among REER and other independent variables.

Among the panel cointegration tests, Kao Residual Cointegration test is used to investigate the long-term relationship of REER and independent variables. The test results showed that existence of long run association between REER and economic determinants at 1% significant level (t-statistic -3.6467). So, the next part is estimation of the long-run parameters since cointegration relationship is established by panel cointegration test.

Table-8: Panel Regression Results

Variable	Model			
	LSDV	Fixed effect	FMOLS	DOLS
RGDP	0.0027*	0.0027*	0.0305**	0.0082
IR	-0.01431**	-0.0143**	-0.1048**	-0.0537*
M2	0.0018	0.0018	0.0075	0.0041
CPI	0.0528	0.0528	0.7522***	0.9399***
TBAL	0.0034***	0.0034***	0.0021***	0.0043***
TOT	-0.5331***	-0.5331***	-1.2158***	-1.1356***
OPEN	-0.3409***	-0.3409***	-0.5414***	-0.5575***
RESV	-0.0282*	-0.0281*	-0.1768***	-0.2028***
SPI	-0.0354*	-0.0354*	-0.4720***	-0.5267***
Constant	8.5573***	8.1795***	----	----
China	omitted			
Hongkong	-1.9309***			
India	-1.1397***			
Indonesia	0.1893***			
Japan	-0.2325***			
Korea Rep.	0.2125***			
Malaysia	0.1742***			
Singapore	0.5946***			
Thailand	-0.8514***			
Taiwan	-0.7947***			
R2	0.4882	0.4924	0.6559	0.6416
R2 adjusted	0.4733	0.4767	0.6512	0.6368
VIF	1.9539	1.9701	2.9063	2.7901

Note: Dependent variable is REER. ***, **, * denote 1%,5% and 10% significance levels respectively. Country 1 china is omitted by software in LSDV model. One lag and one lead used for DOLS model. The White Heteroscedasticity test concludes that the aggregate results are free from Heteroscedasticity error.

Panel regression results

Hausman test results showed that fixed effect model is more appropriate than random model. For a clear output of fixed effect additionally we used LSDV model creating dummy variables for each countries with parallel to fixed effect model. Long run cointegration parameters are regressed by using the panel FMOLS and DOLS methods. Both methods are superior to OLS due to the consideration of endogeneity by adding the leads & lags in panel data. Kao and Chiang [40] suggested that DOLS estimators are better than FMOLS and outperforms in cointegration panel estimations due to its' simple computation methods, reducing the bias and t-statistic approximates the standard normal distribution much better than FMOLS.

Table 8 indicates panel regression results with coefficients and level of significance according to the four models. Aggregate results from LSDV and fixed effect models are generating almost same output, and all the independent variable's coefficients are significant at 10% level on REER except M2 and CPI, which have positive sign coefficients. The dummy variables representing the individual countries in LSDV model are indicating important country effect in all the countries. There are some unobserved constant effects from different countries due to the different factors which didn't consider in this study. Further, RGDP and TBAL economic determinants have a positive significant relationship while rest of variables shows a negative significant relationship with REER at 1% significance level. R2 has a value of 48.8% and 49.2% form LSDV and fixed effect models respectively, which clearly describes the moderate explanatory power of the regression model. Furthermore, the panel FMOLS and DOLS results are showing similar signs of coefficients as previous two models. However, individual significance of the variables is changed with REER. RESV and SPI variables are more significant a significant level at 1% under cointegrating regression models. Real GDP is showing a significant positive relationship at 5% significant level in FMOLS method only. The strong significance of TBAL, TOT and OPEN is remaining same in all models applied. CPI has identified as a significant variable in both panel cointegrating regression models.

The results show that there is a positive relationship of real GDP with REER and it is significant at 10% significance level except in DOLS regression model. This result is in line with the hypothesis and previous scholars' findings. The change in IR has a negative impact on the REER as it was expected theoretically where that a high interest rate could cause

an inflation in the long run which results from a lower real exchange rate. M2 has a positive but insignificant relationship with REER which contradicts the hypothesis. Generally, an increasing money supply could lead to a currency depreciation through the rise of domestic inflation and lower the interest rate. CPI have positive and significant relationship with REER, hence the hypothesis of the study is not accepted. The variable TBAL results are consistent with the Ng, Har, and Tan [41] which had a significant positive relationship with the real exchange rate. A negative relationship of TOT and real exchange rate is given because of the substitution effect and previously Jongwanich and Kohpaiboon [23]; Tang and Zhou [2] and Bouraoui and Phisuthtiwatcharavong [29] have found same results. OPEN is an important variable in real exchange rate determination. This paper, confirm that OPEN variable has a negative significant relationship with REER, which is consistent with the finding of Kim and Korhonen [31]. Usually, greater openness indicates higher trade liberalization of an economy with fewer barriers of trade such as low tariffs on imports. So, substitution effect will cause real currency depreciation when trade openness increases. The RESV has a negative coefficient value, representing that an increase in foreign reserves tended to lead to a decrease of the REER which is not in line with the theory. However, when foreign reserves are increased monetary authorities would depreciate between the real exchange rate since more foreign currencies are purchased by the country. SPI has a negative significant relationship with REER which contradicts the hypothesis and the stock-oriented exchange rate theory. However this results are in accordance with the Bhat and Hussain [5] findings where they found stock returns are negatively related with real exchange rates in four south Asian countries.

In order to identify the multi-collinearity problems in the data, Variance Inflation Factor (VIF) was calculated with the formula [1/(1-R2)]. Since calculated VIF value is always less than 10 in all considered models, so there is no perfect multi-collinearity problem in the data.

CONCLUSION

Numerous recent researchers studied the exchange rate determination of economies across the world. This paper aimed at recognizing the key economic determinants of real exchange rates for a sample of ten economies from Asia. Secondary data was collected for the period of 2002-2016 in quarterly basis. We compared the FMOLS and DOLS results with fixed effect and cointegrating regression outcomes. Fixed effect and LSDV model results showed that measured economic variables apart from M2 and CPI have a strong significant effect on the REER through the study period at 95% confidence level. There are strong significant relationships between REER and six determents namely interest rate, trade balance, terms of trade, trade openness, foreign reserves and share price index and their significance are remaining same in all models applied. Interest rate, terms of trade, trade openness, foreign reserves and share price index have a negative association with the REER. Nevertheless, trade balance has a positive connection with the REER. However, most of the independent variables are found to be important in the REER determination.

The policy makers shall consider the evidence of different effects and contributions by the economic determinants when maintaining the real exchange rate equilibrium. Results show that trade policies intended to raise the trade openness ratio and trade balance will make a strong negative impact on real exchange rates. Therefore, regulators need to be more careful when executing trade policies. The economies in this study are approximately similar because they are all from the same region, and they face same influences from the rest of the world. Our outcomes may be suitable for identifying exchange rate variations in rest of the Asian economies which are excluded from the sample. Obviously, the analysis of exchange rates and its determinants for a comprehensive set of economies will be helpful for future researchers.

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