Empirical Estimates of the Equilibrium Real Effective Exchange Rate for the Vietnamese Dong

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Abstract

This study examines the equilibrium real effective exchange rate (EREER) for the Vietnamese Dong in the long-term and estimates the misalignment of the real effective exchange rate (REER) by using a vector autoregression (VAR) model and cointegration analysis. The sample consists of quarterly data from 1997Q1 to 2014Q4. Among macroeconomic variables, the openness of economy (OPEN), productivity differential (PROD), money supply (M2), net foreign assets (NFA) and real interest rate differential (RR) are chosen for this study. The result shows that by the fourth quarter of 2014, the Vietnamese Dong was undervalued with respect to real value by about 5.07 percent. Besides, we also apply the impulse response functions (IRFs) to investigate the main factors contributing to the deviation of REER and find that the scale of M2 is a main variable causing the REER misalignment. In order to minimize the deviations of REER, the State Bank of Vietnam (SBV) should consider to extend M2 by 1.64 percent to gradually adjust REER to long-term equilibrium.

Key words: *Cointegration test, Misalignment, REER, EREER, VAR, Vietnamese Dong.*
JEL *classification: codes:* F31, F32, F41.

1. Introduction

A systematic macroeconomic instability of an economy can stem from internal and external imbalance. That imbalance may be caused by many economic crises in the world such as the debt crisis of the Latin American countries in the 1980s, the economic crisis in Mexico in the period of 1994−1995, the Asian financial crisis in 1997−1998 and the crisis in Argentina in 2000. However, while the impacts of the Asian financial crisis were confined within some countries in the Asia region, the global financial turmoil in 2008 and the debt crisis in Europe since 2010 until now have had a strong and lasting effect on global financial markets and countries worldwide. These issues induced many researchers and policy makers to reexamine the ways in which national governments have been regulating and monitoring their financial systems in the context of

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international economic integration. According to Williamson (1994), in order to reach simultaneous internal and external balance, the real effective exchange rate should be maintained in long-run equilibrium. Therefore, the existence of a misalignment in the real exchange rate is also synonymous with instability in an economy.

In recent years, integrating much deeper into the regional and world economies helped Vietnam gain great achievements in the process of economic development. However, along with the economic growth, Vietnam was faced with certain obstacles in the process of her macroeconomic stabilization. The impossible trinity (also known as the Trilemma) (see Mundell, 1963; Fleming, 1962) pointed out that a country cannot simultaneously perform three policies including a fixed foreign exchange rate, free capital flow and independent monetary policy. Therefore, under pressure from the volatility of capital flows in the context of international economic integration, the exchange rate policy of Vietnam should be more actively flexible for achieving the two other objectives (independent monetary policy and free capital flow).

In fact, although Vietnam has officially maintained a managed floating exchange rate regime, the currency has de facto been pegged to the U.S. dollar. In March 2009, the State Bank of Vietnam (SBV) adjusted the band of exchange rate from +/–3% to +/–5% and then in November 2009 decreased it back to +/–3%. Further, due to its inability to maintain that exchange rate policy, in early February 2011, the SBV announced a devaluation of 9.3%, the highest in recorded history, bringing the official rate to 20,693 VND/USD and reducing the marginal band to +/–1% keeping that narrow band of exchange rate up to the end of 2014. In the first 6 months of 2015, the SBV adjusted the exchange rate of the VND vis-à-vis USD 2 times for a total 2%, raised the average interbank exchange rate from 21,246 VND/USD to 21,458 VND/USD in 7th January and to 21,673 VND/USD in 7th May, 2015. In August 2015, in order to flexibly cope with the Renminbi which, in 2015, had its the greatest depreciation in the past two decades, on 12th August 2015 SBV decided to loosen the band of exchange rate from +/–1% up to +/–2%. Subsequently, on 19th August 2015, the SBV announced an increase in the average interbank exchange rate of VND/USD from 21,673 VND/USD to 21,890 VND/USD and adjusted the exchange rate band from +/–2% to +/–3%. With the average interbank exchange rate at 21,890 VND/USD and the band of exchange rate of +/–3%, the ceiling rate was 22,547 VND/USD and the floor rate was 21,233 VND/USD.

However, such a passive way of managing the exchange rate may contribute to the deviation of real effective exchange rate (REER). This makes the overall balance of the economy suffer a negative impact. Therefore, to investigate the misalignment of REER, finding factors causing the deviation and examining if the local currency is currently overvalued or undervalued with respect to other currencies in the region is very necessary and urgent in the current economic context.

Even though the misalignment of REER has not been a new topic in Vietnam so far, the quantitative approach of this issue has not attracted much attention of Vietnamese researchers except Dao & Trinh (2012). However, their study only calculated the deviation of REER and did not address what major factors were causing that deviation. Therefore, their recommendations and policy implications were not yet clear.

This paper tries to tackle the limitations of the previous paper in estimating EREER for the Vietnamese Dong. Besides determining the EREER and calculating the deviation of REER, this study also analyzes explicitly and clarifies factors having most influence on the deviation of REER. Our findings have important and specific policy implications for considering appropriate monetary policy and exchange rate policy for preventing macroeconomic instability.

The rest of the study is organized as follows. In section 2, a brief literature review is presented. In section 3, the analytical framework and empirical model used in this paper are discussed. Section 4 describes data and discusses the empirical results. Finally, section 5 concludes.

2. Literature Review

How to adjust the exchange rate for a country to recover its external and internal balance is open to argument. Even using a conventional measurement, misalignment in the real effective exchange rate (REER), there are many conceptual and calculation methods, (Iimi, 2006). However, empirical research can be classified into four approaches to determining the equilibrium exchange rate.

The first, the macroeconomic balance approach, is based on an equilibrium relationship between the current account (CA) and a set of fundamentals (including REER) (see Di Bella et al., 2007). This equilibrium relationship is only expressed by an equation in order to estimate a "nominal CA". Besides, a country has a target CA level, which is called the "current CA" at each time. Thus, the REER adjustment is necessary to close the gap between the "current CA" and "nominal CA". This can be determined by using the elasticity of the current account balance to the REER.

The second approach investigates the exchange rate misalignment by using purchasing power parity (PPP), which relates the nominal exchange rate to the ratio of the domestic consumer price index (CPI) to foreign CPI. For example, MacDonald and Nagayasu (2000) find some minor deviation of the observed data from the Japanese yen-US dollar exchange rate, based on the PPP.

The third approach concentrates on the exchange rate adjustment to recover internal and external macroeconomic balances over the long term. Here the equilibrium exchange rate is determined by the current account balance target which is based on desired levels of saving and investment, as well as national income based on full employment and prices being stable.This approach is also known as the fundamental equilibrium exchange rate (FEER) approach. Jeong, Mazier & Saadaoui (2010) showed that after 2000, currencies including the euro, yuan and yen became undervalued against the dollar (22% for the euro, 47% for the yuan, 36% for the yen and 18% for the pound in the last quarter of 2006) in spite of the dollar depreciation.

The last is the behavior equilibrium exchange rate approach (BEER). This approach is based on the empirical calculation of a REER misalignment, by means of estimating the statistical long-run relationship between the real exchange rate (RER) and its fundamentals (Clark & MacDonald, 1988). Elbadawi (1994), for instance, estimated the long-term equilibrium exchange rates for Chile, Ghana, and India. His fundamentals include terms of trade, resource balances, the degree of openness of economy, the share of government expenditure in GDP, and a measure of excess money supply.

This paper employs the last approach because it seems to be a more general method for calculating the real exchange rate consistent with the concept of economic equilibrium. Thus far, there are a number of studies that investigate misalignment in the equilibrium exchange rate as well as misalignment using BEER. However, most of these papers concentrate on determining misalignment in the exchange rate in the industrialized countries such as European Union countries and a few Asian countries. For instance, El-Shagi et al. (2016) estimate the equilibrium exchange rate and misalignment to the Euro area, meanwhile, Cline & Williamson (2008) and Jongwanich (2009) focus on estimates of the equilibrium exchange rate and misalignment in a few Asia countries.

Up to the present, only a few studies about the equilibrium exchange rate and misalignment in Vietnam have been done partly because of a lack of data. For example, Dao & Trinh (2012) estimated the misalignment in exchange rate using FEER approach. This study will be based on the BEER approach in order to calculate the equilibrium exchange rate and misalignment.

Econometrically, this paper uses the cointegration model to estimate the equilibrium exchange rate in the long term and uses a VAR model in order to find cause of misalignment in the exchange rate of Vietnam through the calculation of the variance decomposition (VDF) and impulse response functions (IRFs). One of the limitations of previous studies is they only focused on long-term relationships and ignored the impact of fundamental macroeconomic variables in the short-term.

3. The Empirical Model

This paper uses an empirical model to determine how many percent REER is biased compared with the Vietnamese Dong's EREER. The quantitative analysis steps were conducted in the following order: calculating the REER (a basket of currencies of 20 countries having the largest share of trade with Vietnam, see Table A1 in Annex), defining the fundamental macroeconomic variable affecting REER in the period from 1997Q1 to 2014Q4, estimating the EREER for Vietnamese Dong and misalignment, and finally analyzing the factors having the most important role in explaining the causes of the deviation of REER.

3.1. Definition of REER

The bilateral nominal exchange rate (NER) between two currencies is defined as the price of one unit foreign currency in terms of domestic currency. The RER is defined as the ratio of the price level abroad and the domestic price level, where the foreign price level is converted into domestic currency units via the current nominal exchange rate (Krugman & Obstfeld, 1997).

$$RER_t = NER_t \frac{P_t^*}{P_t}$$

where P_t^* is foreign price and P_t is domestic price.

$$REER_t = \prod_{i=1}^{n} \left(RER_{i,t} \right)^{w_{i,t}}$$

Where $j = 1, \ldots, n$ is trading partner country, w_i is trade weight of country i in the domestic country's total exports, and t is time.

3.2. Fundamental Equilibrium Real Effective Exchange Rate

One of the most widely used concepts in determining the equilibrium REER is the fundamental EREER (Williamson, 1994). The fundamental EREER is defined as the REER that simultaneously attains internal and external balances. The fundamental macroeconomic variables that can affect EREER are:

Openness of economy (OPEN): is defined as the ratio of the sum of exports and imports (in absolute values)

to GDP. Edwards (1989) and Elbadawi (1998) pointed out that the more openness of economy, the cheaper the price of imported goods and services in the future. As a result, domestic consumers tend to shift from non tradable to tradable goods and services, causing domestic prices to decrease and real exchange rates to increase.

Productivity Differential (PROD): Differences in the rate of productivity growth in tradable goods production of a country compared to that of the main trading partner countries (PROD) are potential factors that affect the REER. In this paper, PROD is calculated by the ratio of real GDP per capita of Vietnam and that of the U.S. (representing the production capacity of the world). In Harrod-Balassa-Samuelson, and Obstfeld & Rogoff (1996), style models the economy exists in only two regions which produce tradable goods and services and non-tradable goods and services. An increase in PROD will raise the demand for labor employed in the tradable sector. Under full employment conditions, labor must be drawn from the non-tradable sector toward the tradable one and this puts pressure on wage rates in the non tradable sector. This causes the REER to decline to restore both internal and external balance. Thus, the effect is a negative relationship between PROD and REER.

The scale of the Money Supply (M2): is defined as the ratio of money supply to nominal GDP. In the short run, an increase in the money supply has a positive effect on REER due to an increase in nominal exchange rate. On the other hand, an increase in M2 puts upward pressure on the common price of the economy, which may lead to a decrease on REER. Therefore, the effect of M2 on REER needs to be tracked more.
The scale of the Net Foreign Assets (NFA): is the ratio of the net foreign assets to GDP. The increase in net foreign currency assets will increase income and spending of domestic goods, which leads to a rise in the common price. Thus, REER will decrease.

The real interest rate differential (RR): is calculated by the difference between the actual rates of VND to that of USD. In theory, an increase in the real interest rate differential implies that income of the deposit in Vietnamese Dong increases. This leads to increased demand for the local currency and the supply of the domestic currency will decrease on the foreign exchange market, thereby leading to an increase in the Vietnamese Dong and a decrease in the REER.

Thus, the relationship between the REER and fundamental variables can be represented by the following function:

$$REER_t = f\left(OPEN_t, PROD_t, M2_t, NFA_t, RR_t\right) \quad (1)$$

3.3. Behavior equilibrium real effective exchange rate approach (BEER)

This study is based on the theoretical model of the behavior equilibrium real effective exchange rate as developed by Clark and MacDonald (1988). The form of REER equation customized is presented as following:

$$REER_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} + \tau T_t + \varepsilon_t \quad (2)$$

Where, T_t is set of economic variables in short run, Z_{1t} and Z_{2t} is that in medium run and long run. While, EREER is determined by the group' s sustainable economic variables in the medium and long term $\left(\overline{Z}_{1t}, \overline{Z}_{2t}\right)$ is expressed by the equation:

$$EREER_t = \beta_1 \overline{Z}_{1t} + \beta_2 \overline{Z}_{2t} \quad (3)$$

From the above two equations, we can determine easily the real exchange rate misalignment:

$$TM_t = \beta_1(\overline{Z}_{1t} - Z_{1t}) + \beta_2(\overline{Z}_{2t} - Z_{2t}) + \tau T_t + \varepsilon_t \quad (4)$$

3.4. The econometric model

This study uses the Johansen cointegration equation (Johansen, 1988), which is based on the linear forms of two or more I(1) sequences. If a result of the linear forms is I(0), the conclusion of long-term relationship between the I(1) variables exists. The general case is represented as follows:

$$e_t = \alpha_0 + \alpha_i Y_{it} \sim I(0) \quad (5)$$

Where, $Y_{it} = (REER_t, OPEN_t, PROD_t, M2_t, NFA_t, RR_t)'$. Besides, $\alpha_i = (\alpha_1, \alpha_2, ..., \alpha_6)$ is defined as the cointegrated vector, corresponding to Y_{it}. The α_1 standardized coefficient would equal 1.

However, the cointegration model has only analyzed the relationship of these variables in the long run and has not investigated the short run. To do this, the paper will use the vector auto regression model (VAR). By using impulse response functions (IRFs) and variance decomposition function (VDF), which require a logical arrangement of the order of the variables in Cholesky decomposition. In particular, the role of the IRFs is analyzing the responses of REER to shocks of other endogenous variables in the short run. VDF allows assessment of the relative importance over time of each shock to the volatility of the variables in the model.

The paper will use Eviews 6 software to perform all of the quantitative calculations which includes: estimating the cointegration equation and analyzing the VAR model.

4. Data and empirical results

4.1. Data

The data in the study was collected from the first quarter of 1997 to the fourth quarter of 2014, including: Value Imports and exports of Vietnam, the consumer price index (CPI), nominal and real GDP, the nominal exchange rate between VND and currencies of Vietnam's 20 biggest trade partners, net foreign assets (NFA), quasi money supply (M2), deposit interest rate of VND and that of USD. GDP data is extracted from General Statistics Office of Vietnam (GSO). The consumer price index (CPI), net foreign asset (NFA), the M2 money supply, deposit interest rate of VND and that of USD, Vietnam's import and export data are extracted from the database of the IMF's International Financial Statistics (IFS). Data of the nominal exchange rate is extracted from the Oanda Forex Trading. REER can be expressed as:

$$REER_t = \prod_{i=1}^{n} \left(\frac{CPI_{i,t}}{CPI_{vn,t}} \frac{e_t}{e_o} \right)^{w_{i,t}}$$

Table 1. Max-EigenTest for cointegration rank

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None*	0.544585	55.05824	40.07757	0.0005
At most 1	0.363072	31.57686	33.87687	0.0918
At most 2	0.315709	26.55603	27.58434	0.0673
At most 3	0.167879	12.86444	21.13162	0.4648
At most 4	0.0974	7.173337	14.2646	0.4688
At most 5	0.012552	0.884198	3.841466	0.3471

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Authors' estimation

Table 2. Result of the long run equilibrium equation

Independent variables	Coefficient	T-statistic
lnPROD: productivity differential	− 3.767	9.622**
lnM2: money supply	0.471	2.279
lnNFA: Net foreign assets	− 0.542	3.841**
lnOPEN: openness of economy	0.552	− 2.665**
RR: real interest rate differential	− 0.061	3.360**

**Denotes rejection of the hypothesis at the 0.05 level

Source: Authors' estimation

where, t is time, n is the amount of Vietnam's main trade partners, $CPI_{i,t}$ is the consumer price index of the country i at t, $CPI_{vn,t}$ is the consumer price index of Vietnam at the time t, e_t is the nominal exchange between Vietnamese Dong (VND) and currency i at the certain time t, e_0 is the nominal exchange rate at the based time, 1997.

The variables in the econometric model include: the real effective exchange rate (REER), economic openness (OPEN), the productivity differential (PROD), net foreign assets (NFA) and the scale of the money supply (M2) are corrected by taking the natural logarithm of these variables, except the real interest rate differential (RR). In addition, all the fundamental variables have also been seasonally adjusted.

4.2. Empirical Results

4.2.1. Result of the cointegration equation and the error correction model

Before estimating the cointegration equation, we need to consider issues of the integration of data series. Results from Table A2 show that all economic variables are stationary the first difference. In the next step, the paper uses the Johansen methodology to find the number of the cointegrating equations. The analytical results are showed in Table 1.

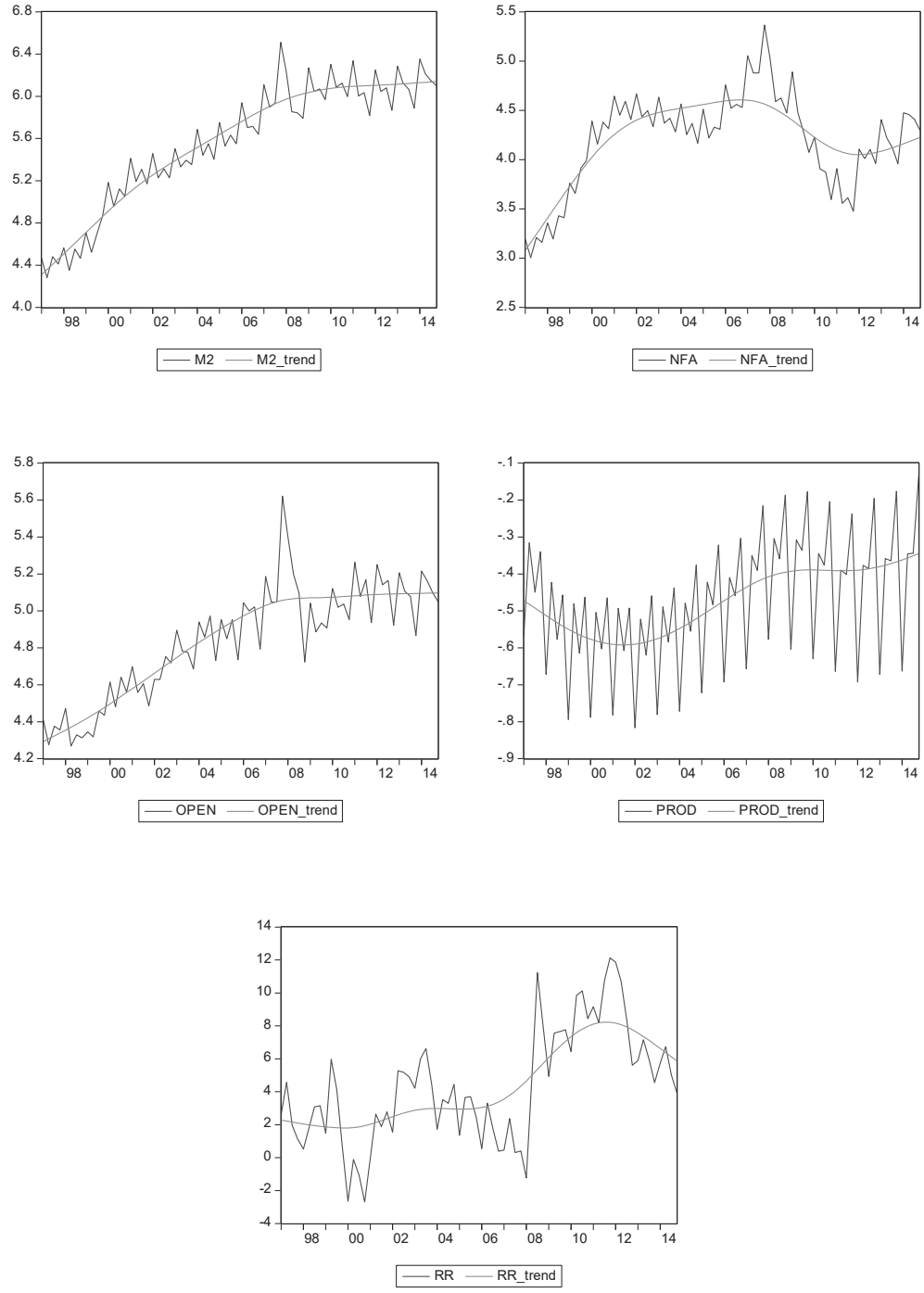


Figure 1: The fundamental varialbes processed by Hodrick- Prescott filter.
Source: Authors' estimation

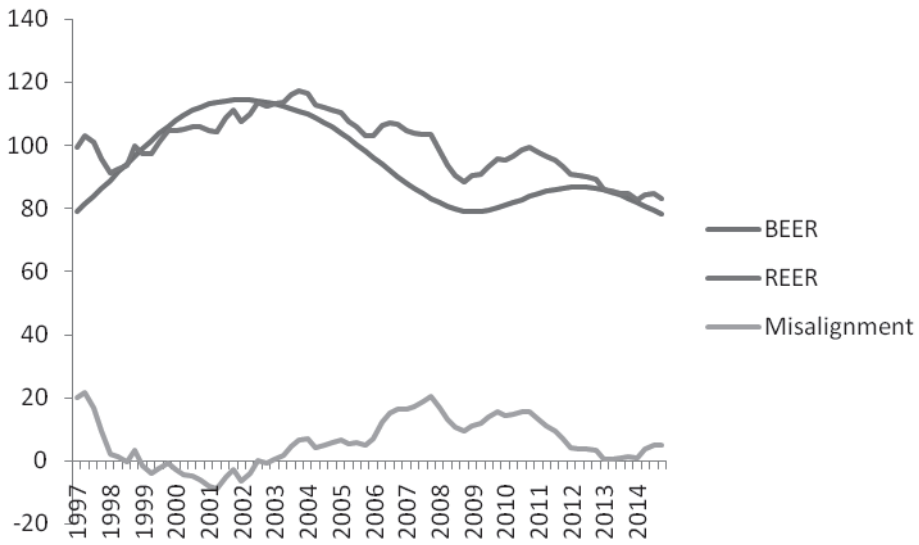


Figure 2: The real effective exchange rate misalignment in Vietnam (1997–2014)
Source: Authors' estimation

Results of the single estimated cointegration equation are presented in Table 2. Therefore, equilibrium equation of REER in the long run is defined as follows:

$$\ln REER_t = 0.552 \ln OPEN_t - 3.767 \ln PROD_t + 0.471 \ln M2_t - 0.542 \ln NFA_t - 0.061 RR_t \quad (6)$$

According to the estimation results in Table 2, all the fundamental variables have the expected sign and are significant at 5 percent. The productivity differential, the interest rates differential and the net foreign asset have negative relationships with the real effective exchange rate. In contrast, the scale of the money supply and the openness of economy have a positive impact on the REER.

In the size, the productivity differential has the biggest impact for the REER. One percent increase in PROD causes REER to decrease 3.767 percent. In contrast, the real interest rate differential (RR) has the smallest impact for REER, 1 percent increase in RR cause REER to decrease 0.061 percent.

However, the objective of the long run equilibrium equation is only to estimate the equilibrium real effective exchange rate (EREER). Thus, to analyze more clearly the role of the variables on the REER, we will analyze the response of REER to the shocks of the fundamental variables in short run. This will be presented in the VAR model in the next section.

Figure 1 illustrates the typical macroeconomic quantities in the long run. The fundamental variables will be smoothed through Hodrick-Prescott filter (HP) to remove the cycle components and only keep the trend components. Smoothing parameter is selected as 1600, with quarterly data.

After having EREER, we calculate the misalignment in the real exchange rate based on the equation (4). The results are presented in Figure 2.

Table 3: Variance decompositions in VAR model

Period	S.E.	d(LnREER)	d(LnOPEN)	d(LnM2)	d(RR)	d(LnNFA)	d(LnPROD)
1	0.02187	88.76407	1.854351	9.280642	0.100942	0	0
2	0.023877	83.63423	1.762689	8.68525	5.36731	0.000198	0.55032
3	0.024159	82.05394	2.365505	8.657249	6.178631	0.066161	0.67851
4	0.024216	81.66647	2.394955	8.616562	6.403481	0.132376	0.786153
5	0.024235	81.54563	2.416845	8.606538	6.408569	0.220281	0.80214
6	0.02424	81.5163	2.425339	8.604093	6.406032	0.245181	0.803057
7	0.024244	81.49768	2.428598	8.601475	6.406057	0.257563	0.808623
8	0.024245	81.49291	2.429382	8.600637	6.406985	0.260079	0.810012
9	0.024245	81.49036	2.430282	8.600235	6.406685	0.261819	0.810624
10	0.024246	81.48915	2.430459	8.600085	6.406981	0.262254	0.811069
11	0.024246	81.48855	2.430641	8.60001	6.406936	0.262616	0.81125
12	0.024246	81.48832	2.430693	8.599982	6.406971	0.262698	0.811338

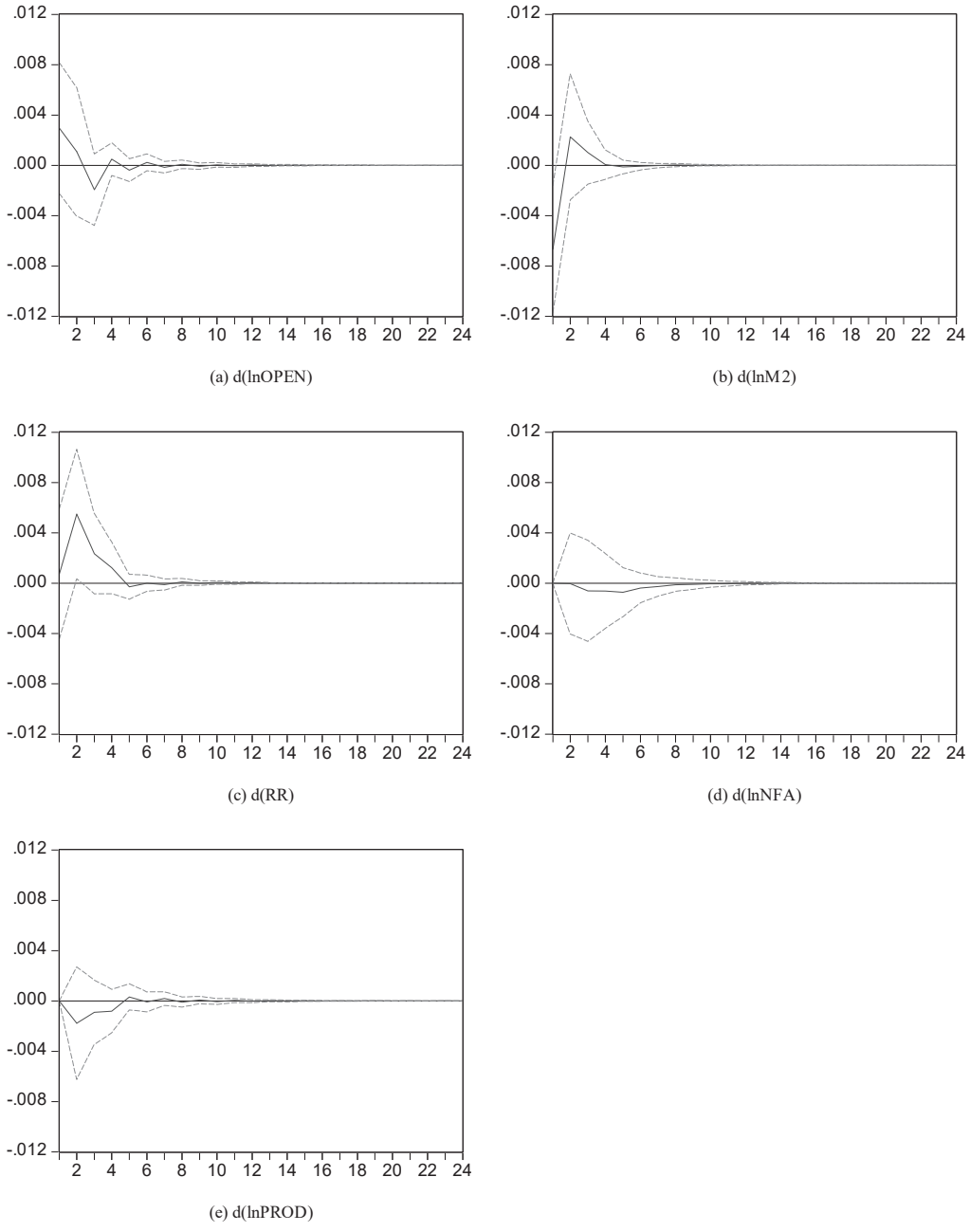
Source: Authors' estimation

Figure 2 illustrates the movement of the real exchange rate (REER) around the long run equilibrium position. Combined with the misalignment of the real effective exchange rate, we can see the general trend of the exchange rate during the study period, which was classified into three episodes: 1997Q1−1998Q2, 1998Q3−2002Q4 and 2003Q1−2014Q4. In the first episode, the VND was undervalued compared to the real value and the REER is larger than the EREER (BEER). Especially, the VND was undervalued by 21.79 percent in the second quarter of 1997. However, the gap between REER and BEER tends to decrease until the second quarter of 1998. From 1998 to 2002, the influence of the financial crisis from 1997 to 1998 has caused severe consequences for the economies of Asia, in which, Indonesia, South Korea and Thailand are the countries most affected. Hong Kong, Malaysia, Laos and the Philippines were also impacted by this crisis. Thus, the currencies of these countries were devalued constantly, which extended until a few years after the crisis. However, Vietnam was not severely affected by the crisis so the VND also remained stable. Therefore, from 1998 to 2002, the VND was constantly overvalued; the highest overvaluation of VND is 9.1 percent in the second quarter of 2001. The final episode from 2003Q1 to 2014Q4, the trend of Vietnamese Dong' s misalignment reversed so VND was undervalued once again. By the end of 2014, the misalignment of Vietnamse Dong was 5.07 percent.

4.2.2. The results of the vector autoregressive model (VAR)

The lag length of the variables also plays a crucial role in forming the VAR model. In this study, we choose the lag length of 1 for the VAR model because of the short time series. Moreover, testing the stability of the VAR model (with lag length of 1) shows that the VAR model is perfectly stable and no roots lie outside the unit circle (Table 1.a). Thus, the standard errors in the impulse responses in the model are valid.

The study conducted the variance decomposition functions (VDF) in the VAR model to filter the



(a) d(lnOPEN)

(b) d(lnM2)

(c) d(RR)

(d) d(lnNFA)

(e) d(lnPROD)

Figure 3: Results of the impulse response functions (IRF) in VAR model

Source: Authors' estimation

variability of the real effective exchange rate (REER) over time by other shocks. However, the sort order of the variables in the Cholesky triangular matrix will also impact on the entire results, which are to calculate IRFs and VDF. In this study, the order of the variables is arranged as following: d(lnOPEN), d(RR), d(M2), d(lnREER), d(lnPROD), d(lnNFA). This order is based on the economic relationship among these variables.

The results of variance decompositions show that the volatility of the REER is explained mainly by the shock of REER in the past. However, the effect level of the REER in the past tends to decrease for the next period. In addition, M2 has the largest effect compared to the remaining variables except REER. Therefore, this study will focus on analyzing the impact of M2 on REER in the short term, to suggest some policy implications to minimize the degree of the real exchange rate misalignment.

We calculate the impulse response functions (IRFs) to analyze the changes of REER from other endogenous shocks in the short run.

Figure 3 illustrates the impacts of one-time shocks to the fundamental variables on the real effective exchange rate. These have shown that with the exception of the real interest rate (RR), the impacts of endogenous shocks to REER are as expected. On the other hand, the shocks will be eliminated entirely after 12 quarters.

The increase in openness of the economy has a considerably positive impact on REER (Figure 3.a) and this is also consistent with the economic theories. The response of REER to the change in the openness of the economy is somewhat different, positive in two first quarters before decreasing markedly in the next quarter. After three quarters, this trend will come back like before.

Figure 3.b illustrates the response of REER to the increase in money supply. REER decreases significantly after a rise in money supply and reaches a peak in the first quarter because when the money supply increases, not only does it put upward pressure on the nominal exchange rate but also on the domestic price of the economy leading to inflation. Thus, according to the calculated results of impulse response functions, the domestic price will increase more than the nominal exchange rate, as a result, REER decrease. However, this trend is removed completely from the second quarter.

Figure 3.d and Figure 3.e describe respectively the response of the real effective exchange rate to the change of net foreign assets (NFA) and that of the productivity differential (PROD). They are consistent with economic theories and the expected sign. Specially, these factors have a negative relationship with REER and after 12 quarters, these shocks are removed completely.

As mentioned above, in order to suggest policy implications and minimize the real exchange rate misalignment, the study will focus on analyzing the impact of the money supply (M2) to REER.

Supposing that the current misalignment is x percent (of which: x = REER − EREER), to return to the equilibrium position the real exchange rate needs to change x percent. The question is how to adjust money supply in order that the real exchange rate can change x percent. To do this, the paper will calculate the pass-through coefficient between money supply (M2) and the real effective exchange rate based on the impulse response functions (IRFs) in the VAR model. The econometric theory of the pass-through coefficient (see Leigh & Rossi, 2002) is defined as following:

$$MT_{t,t+1} = \frac{M_{t,t+1}}{E_{t,t+1}}$$

Table 4: The money supply pass-through coefficients

Period	The pass- through coefficient
1	− 0.323
2	0.313
3	0.696
4	− 0.427
5	0.889
6	− 0.563
7	− 0.123
8	0.109

Source: Authors' estimation

Where, $M_{t,t+1}$ is defined as the change of the REER at time t in response to the initial shock of money supply; (M2), $E_{t,t+1}$ is the cumulative response of the money supply to itself over time. Therefore, we calculate the pass-through coefficient ($MT_{t,t+1}$) as following:

Thus, 1 percent increase of M2 causes REER to decrease by 0.323 percent in the first period. Or alternatively, the money supply pass-through in REER is −0.323. The current misalignment of the real effective exchange rate as of the fourth quarter of 2014 is 5.07 percent. Thus, the REER needs to decrease 5.07 percent to return to equilibrium position. According to the result of M2 pass-through by −0.323, M2 need to increase by 1.64 percent.

5. Conclusions

In this study, we found the evidence of the misalignment in the real effective exchange rate of Vietnam from 1997 to 2014 by using the behavior equilibrium exchange rate approach (BEER). In addition, we also analyzed the impacts of macroeconomic fundamentals to real effective exchange rate, in which we use a vector autoregressive model (VAR) to analyze these impacts in the short run and cointegration analysis for the long run. These models passed diagnostic and stability tests, so they can be used with confidence in analyzing and forecasting.

Using the BEER approach, we could determine the set of fundamentals which related to the real effective exchange rate in order to calculate the misalignment in exchange rate. Combined with the cointegration method, we estimated the equilibrium equation in the long run to calculate the misalignment in exchange rate. As a result, at the end of 2014, the Vietnamese Dong was undervalued by 5.07 percent compared to the actual value. We also determined the fundamental variables which have high impacts on the real effective exchange rate. In particular, the scale of the money supply has the biggest influence to REER, in which, the productivity differential impacts negatively to REER and the positive influence belongs with the openness of economy.

From the analysis in the short run using the vector autoregressive model, we found that the scale of money supply was one of the main factors which caused the misalignment in the real effective exchange rate. Although the scale of money supply was not an independent variable which has the highest degree of influence on the misalignment of real exchange rate, it is the most conveniently controlled of these main factors. Therefore, we

focused on calculating the pass-through coefficient of the scale of money supply to the real effective exchange rate to suggest the policy implications. In particular, the study recommended that the State Bank of Vietnam should increse money supply by 1.64 percent to annually adjust REER to long-term equilibrium.

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Appendix:

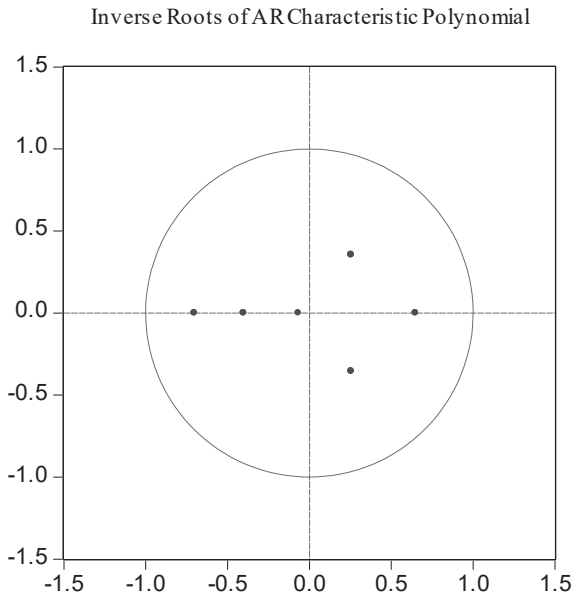

Figure 1.a: Stability test of the VAR model
Source: Authors' estimation

Table A1. List of the largest trading partners of Vietnam

Number	Country	Number	Country
1	Australia	11	Philippines
2	Canada	12	Russia
3	China	13	Singapore
4	Germany	14	South Korea
5	Hong Kong	15	Spain
6	India	16	Switzerland
7	Italy	17	Taiwan
8	Japan	18	Thailand
9	Malaysia	19	United Kingdom
10	Netherlands	20	United States

Source: Authors' estimation

Table A2. Results from Unit Root Tests

Variable	ADF-statistic	P-value	Status
lnREER	− 0.765	0.823	Non-stationary
d(lnREER)	− 6.258	0.000	Stationary
lnPROD	− 1.411	0.899	Non-stationary
d(lnPROD)	− 11.836	0.000	Stationary
lnM2	− 2.014	0.280	Non-stationary
d(lnM2)	− 10.971	0.000	Stationary
lnNFA	− 2.455	0.131	Non-stationary
d(lnNFA)	− 8.677	0.000	Stationary
lnOPEN	− 1.841	0.358	Non-stationary
d(lnOPEN)	− 11.523	0.000	Stationary
RR	− 2.712	0.077	Non-stationary
d(RR)	− 8.399	0.000	Stationary

Rejection of the hypothesis at the 0.05 level

Source: Authors' estimation

Table A3. Variance of errors no change in the VAR model

Dependent	R-squared	F(12,57)	Prob.	Chi-sq(12)	Prob.
res1*res1	0.291456	1.953891	0.0464	20.40194	0.0599
res2*res2	0.154227	0.866165	0.5846	10.7959	0.5465
res3*res3	0.081271	0.420188	0.9493	5.688993	0.9309
res4*res4	0.375539	2.85656	0.0039	26.28773	0.009*
res5*res5	0.039726	0.196504	0.9981	2.780808	0.9969
res6*res6	0.237266	1.477596	0.1598	16.60861	0.1649
res2*res1	0.451117	3.903945	0.0002	31.57822	0.001*
res3*res1	0.25955	1.665022	0.0996	18.16853	0.1107
res3*res2	0.089496	0.466891	0.9258	6.264716	0.9022
res4*res1	0.169379	0.968612	0.4888	11.85652	0.4573
res4*res2	0.326052	2.298022	0.0181	22.82365	0.029*
res4*res3	0.219186	1.333394	0.2259	15.34301	0.2232
res5*res1	0.353087	2.592561	0.008	24.71607	0.016*
res5*res2	0.077175	0.39724	0.959	5.40227	0.9432
res5*res3	0.067996	0.346545	0.9761	4.759719	0.9655
res5*res4	0.295359	1.991025	0.042	20.67516	0.0553
res6*res1	0.423614	3.491012	0.0007	29.65301	0.003*
res6*res2	0.11369	0.609301	0.8254	7.958327	0.7884
res6*res3	0.156064	0.878387	0.5729	10.92447	0.5354
res6*res4	0.269496	1.752364	0.0794	18.86475	0.0918
res6*res5	0.167863	0.958196	0.4982	11.75042	0.4659

*Null hypothesis Ho: variance of errors are the same

Source: Authors' estimation

Table A4. Normality test of the VAR model

Component	Jarque-Bera	df	Prob.
1	1.813257	2	0.4039
2	5.954013	2	0.0509
3	3.079023	2	0.2145
4	4.338301	2	0.1143
5	0.720776	2	0.6974
6	42.65646	2	0.000*

* Null hypothesis Ho: normal distribution at level of 5%

Source: Authors' estimation

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