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Overshooting Indonesian Rupiah's Exchange Rate towards US Dollar: Dornbusch Model Hypotheses Test

I. Made Suidarma^{1*}, I. Gede Sanica², Putu Cita Ayu³, I. Gusti Nengah Darma Diatmika⁴

¹Department of Management, University of Pendidikan Nasional Denpasar, Indonesia, ²Department of Management, University of Pendidikan Nasional Denpasar, Indonesia, ³Department of Accounting, University of Hindu Indonesia Denpasar, Indonesia, ⁴Department of Economics, University of Tabanan, Indonesia. *Email: suidarma@undiknas.ac.id

ABSTRACT

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The study aims at identifying the determinants of overshooting Indonesian Rupiah's exchange rate towards US Dollar and testing Dornbusch model hypothesis. The data applied are Indonesia monthly time series data in the period of 2010.1-2017.12. The Data source is Financial Economy Statistics of Indonesia from the Central Bank of Indonesia. The analysis method used is dynamic Vector Error Correction Model. Several variables employed are exchange rate, inflation level, economy growth, interest rate policy, money supplies and international interest rate. The result shows that in long term, money supply variable or monetary aggregate has negative relation to exchange rate movement in which the increase of money supply or monetary aggregate causes exchange rate depreciation. Short term shock does not affect exchange rate significantly. Dornbusch hypothesis on overshooting of exchange rate did not occur in Indonesia during the observation period.

Keywords: Dornbusch Overshooting, Exchange Rate, Fundamental Macroeconomic, Vector Error Correction Model

JEL Classifications: E10, F31, F41, C32

1. INTRODUCTION

Global economy dynamics which is getting more and more difficult to predict implicates a crucial attempt to maintain macro economy stability in every country. Unlimited resources mobility amongst the countries causes fragile domestic economy dynamics both directly and indirectly. In 2018, global economy recovery has been a continuum as it is followed by high global commodity price. US economy growth continues as consumption and investment remain to be the contributions. On the other hand, Fed Fund Rate is predicted to increase as followed by the decrease of Central Bank balance sheet. Overall, there is a higher potential global economy growth related to positive impact of tax reform towards US economy growth. A continuum in global economy recovery encourages world trade volume and global commodity price including higher oil price compared to the previous years (Bank Indonesia, 2018).

The global economy recovery provides impacts to Indonesia's economy with its relatively stable growth of approximately 5.1%

and controlled lower inflation within inflation target. Economy growth is the result from a strong domestic supply and an increase in investment, household consumption and fiscal stimulation. On the other hand, export performance gets lower amidst the increase of import particularly of oil and gas. Indonesia's balance payment surplus is supported by capital and financial transaction resulting in high surplus mainly from direct and portfolio investment. With such development, Indonesia's foreign exchange reserves reached 130.2 billion US dollar in 2017. The reserves were enough to fund 8.6 months import and pay government's loan. It exceeds 3 months import as the international adequacy standard.

The stability of Rupiah exchange rate towards US dollar in 2017 was relatively stable with slight depreciation of 0.60% to Rp. 13,385 per one US dollar. The stable movement of Rupiah was supported by significant foreign capital flow which corresponded positive external and domestic development. The positive sentiment in domestic sectors such an increase in credit rating, well-maintained inflation, and reciprocal level of results in domestic competitive financial asset investment

becomes the factors affecting foreign capital flow in Indonesia. However, Rupiahs experienced depression due to monetary policy normalization, increased expectation on increase interest rate and the tax reformation plan in the US (Bank Indonesia, 2018). The movement of Rupiah exchange rate toward US Dollar in mid February 2018 was in the range of Rp. 13,600-Rp. 13,700,- in early March 2018. The exchange rate depreciation experienced overshooting although it was relatively lower than that of other countries. The exchange rate attenuation was caused by the US economic condition of the Fed's increased interest rate. However, the macroeconomy stability was maintained since it was supported by stable fundamental macroeconomy (<http://finance.detik.com>).

Theoretically, the unanticipated distortion in one country's economy was considered a shock. The fluctuation of Rupiah exchange rate to US Dollar experienced overshooting in responding to the external and internal shock, which then was regarded as a greater short term movement than steady state condition. One of theoretical model of exchange rate is flexible and sticky price. Both models differs in the assumption of long-term occurrence of Purchasing Power Parity (PPP). Dornbusch (1976) with the sticky price model explained the fluctuation of exchange rate occurrence and overshooting hypothesis. Exchange rate overshooting is a mechanism where short term response on the exchange rate towards shock exceeds the long term response. When monetary expansion is unanticipated, the short term exchange rate will be depreciated on a higher level than long term balance. The cause of overshooting is a rapid adjustment between commodity market and money market. Commodity price and wages in the employment market is determined with an assumption of sticky price at **8** changes gradually overtime and based on the reaction toward monetary shock such as changes in money supply. The exchange rate are inconsistent with the price movement and long term PPP deviation. In this model, PPP occurs in the short term due to sticky price, which then causes assymetrical information and a shift in consumption pattern. Monetary shock including increase of money supply results in exchange rate movement on the level above the long term and overtime and adjustment of prices moving to long term balance.

Several studies testing the overshooting in several countries has been done by Driskill (1981), Bhandari (1985), Akiba (1996), Kolmann (1997), Goldfajn dan Gupta (2001), Papell (2004), and Nieh and Yu-Shan (2005). Nieh and Yu-Shan (2005) tested Dornbusch model using Johansen test and ARDL Bound test in Taiwan. The findings demonstrate that there was no long term correlation between NTD/USD exchange rate and macroeconomy variable. Overshooting occurs in short term in terms of overshooting of exchange rate depreciation as stated by Dornbusch model. Overshooting did not applied within on-going period but in a month after. This study aims at identifying the determinants of overshooting of rupiah exchange rate towards US dollar and testing Dornbusch Model Hypothesis.

2. LITERATURE REVIEW

Several studies related to exchange rate overshooting was done by Capistrán et al. (2017) who identified Dornbusch hypothesis

using structural cointegrated vector autoregression (VAR) and its long term relation with macro economy variable such as PPP, uncovered interest parity, money demand and the relation between domestic output and the United States. The finding revealed that there was a long term relation in the structural model, and monetary policy contraction which temporarily affected the negative output and price and causes the appreciation as it was followed slowly by exchange rate depreciation. Chiliba and Alagidede (2016) re-tested the overshooting hypothesis using ARDL procedure towards the exchange rate of United States Dollar/Zambian Kwacha (USD-ZMK). The results showed that there was no evidence of overshooting where long term relation between exchange rate and macroeconomy variable did not exist. This showed inconsistency with monetary model where long term relation between exchange rate and fundamental macroeconomy existed.

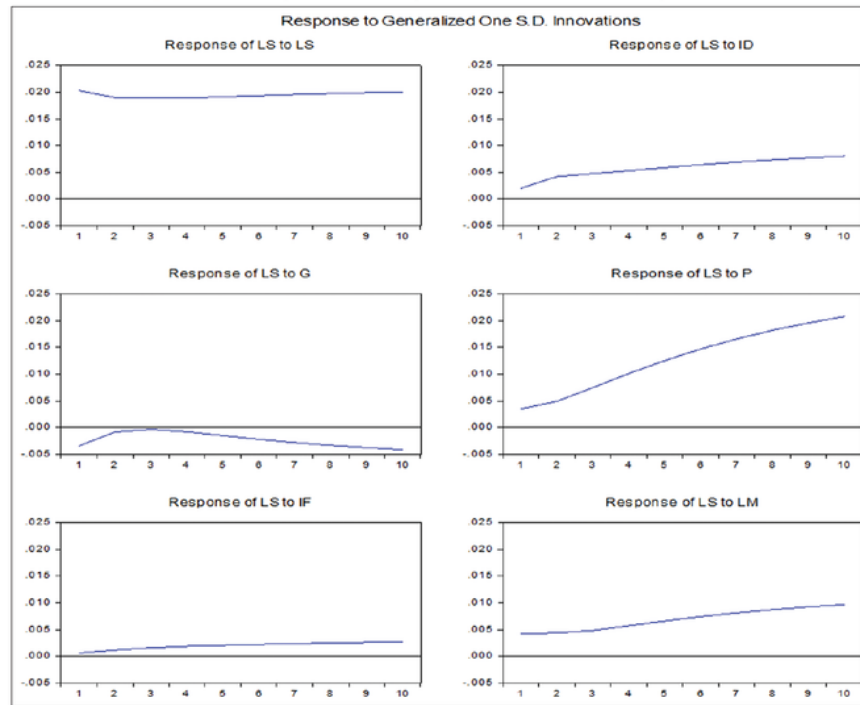
Renani et al. (2014) mentioned that the assumption of exchange rate overshooting affected significantly as it became short term abnormal behaviour. Dornbusch (1976) stated that it resulted from slow balance rapidity towards market asset and sticky commodity price in short term period. Thus, the commodity price increased and reduced the real money supply that stimulated an increase of interest rate. Eventually, exchange rate were appreciated. The study by Renani et al. (2014) within the period of 2001:3-2010:2 revealed that monetary shock happened during short term and long term and affected the overshooting of exchange rate in Iran. Meanwhile, in Indonesia, Pratomo (2005) analyzed whether Rupiah experienced overshoot during the mid 1998s crisis. The study demonstrated that economy crisis caused the exchange rate overshoot and structural changes of exchange rate after the economy crisis in 1998 from the system of managed floating to free floating.

Mohapatra and Basudeb (1997) studied the cointegration of US exchange rate and other countries' such Germany, Japan, UK and Switzerland during the periode of 1973Q1 to 1993Q4. The finding indicated that the balance of real exchange rate was not constant as stated by PPP, yet it changed overtime in correspond to the variable of real factors. The exchange rate balance was more likely caused by fundamental variable. Therefore, the implication of the finding was that misalignment of exchange rate was not corrigible by merely applying monetary policy or other policy without considering real variable such as term of trade, productivity and oil price shock. Williamson and Miller (1987) prescribed that real exchange rate did not experienced deviation more than 10% out of fundamental balance of the exchange rate. The exchange rate, in this case, was maintained in safe fluctuation zone.

Cheung et al. (2004) investigated the cointegration relation, saddle-path and stasioneritas. Monte Carlo findings showed that Johansen test was adequately representative to explain saddle path by using monthly data form five industrial countries, and indicates that the exchange rate and price were co-integrated. Study by Lee (2013) analyzed exchange rate overshooting by including foreign reserves in the model affecting the exchange rate to respond financial vulnerability.

Study by Haq and Iftikhar (2014) described the dynamics of anti-intuitive exchange rate undershooting in Pakistan in responding

Figure 1: The response of exchange rate toward macroeconomy variables



Source: Data processed, 2018

the increase of money supply. Dornbusch (1976) in his theory explained that the significance of exchange rate value depreciation occurs because of increase in money supply. Sticky price emerging in commodity market bring the change on the exchange rate. During monetary shock, when price responds slowly, exchange rate goes over reacting, or overshooting. Dornbusch assumes that PPP will be achieved in long term period and exchange rate is determined by the flexible system and perfect capital mobility. A perfect expectation and the economy are in the state of full employment (Dornbusch, 1976). When full employment is assumed with real output, the overshooting of exchange rate was not simple. When the price is sticky, the slow response to real output cause overshooting exchange rate or undershooting due to the increase of money supply. Pakistan exchange rate indicated undershooting when responding to monetary shock. This means the increase of money supply occurred resulting in reaction of output, yet being constant when exchange rate is appreciated. The output growth is declining when exchange rate is appreciated or income elasticity exchange rate and there is more than one output. The monetary influence the price change and output significantly. Thus, adjustment on balance requires longer period of time.

The study by Bhadury and Taniya (2015) revisited Dornbusch model by including real money demand in the model. Classical money neutrality states that in the long term period, monetary shock becomes neutral or does not affect the real variable. Bhadury and Taniya (2015) tested the overshooting hypothesis of exchange rate in four countries such as Australia, Canada, New Zealand dan Sweden. The finding indicated that monetary policy contraction

caused overshooting of exchange rate as stated by Dornbusch hypothesis. The exchange rate is appreciated significantly due to monetary shock and then is depreciated. Money supply shock affects the fluctuation of exchange rate vis-a-vis Bjornland model. Bjornland (2009) did not find the existence of puzzle. The contractive monetary policy brings about considerable impact to exchange rate appreciation. The maximum impact happens in the quarter 1-2 and afterwards the exchange rate will be gradually depreciated, which then corresponds to Dornbusch hypothesis and uncovered interest parity.

¹ 3. RESEARCH METHOD

3.1. Type and Data Resources

The data used in this research is Indonesia monthly time series in the period of 2010.1-2017.12. Data were collected from the Indonesia Finance Economy Statistics of Central Bank of Indonesia. Several variable applied in the model were exchange rate, inflation level, economic growth, policy interest rate, money supply and foreign interest rate.

1. Indonesia's Gross Domestic Product (GDP) is a change of GDP in percentage.
2. Domestic inflation is Consumers' Price Index average change (headline inflation).
3. The money supply or M2 is the amount of narrow money supply consisting currency outside common bank and People's Credit Institution as well as current account in Rupiah, quasi

- money including time deposit, savings, current account in foreign currency and securities bond other than stocks.
- Interest rate as the reference of Central Bank of Indonesia in percentage.
 - Nominal exchange rate from the middle value of domestic currency Rupiah to US Dollar.
 - Foreign interest rate policy of US Central Bank in percentage.

3.2. Vector Error Correction Model (VECM) Method of Analysis

VAR is a dynamic equation system testing the relation among economy variables using minimum assumption on the economy structure and theory as its basis. VAR less emphasize on economy assumption, but it focuses more on obtaining better statistical value from past interaction amongst economy variables and determining model based on such data. The representation from unrestricted VAR model is as follows: (Harris, 1995, p. 77):

If z_t is a vector of n endogen variable and unrestricted VAR model with lag p as follows:

$$Z_t = A_1 Z_{t-1} + \dots + A_p Z_{t-p} + \mu_t \quad \mu_t \sim IN(0, \Sigma)$$

Z_t is a vector of $n \times 1$ and each A_i is a matrix parameter ($n \times n$).

There are four matters to consider in VAR model to form equation system such as data description, forecasting, structural inference and policy analysis. VAR is equipped with impulse response, an endogen variable responds due to innovation (shock) from other endogen variable. Using impulse response analysis, real time response and the future of each variable caused by changes or shock of particular variable can be tracked. If the data is not stationary and VAR is estimated on the level without cointegration restriction, the parameter estimated in VAR becomes consistent but inefficient due to cointegration information is ignored. The alternative solution is using VECM which can generate a more precise and efficient parameter estimation.

The function of impulse response can be generated from two types of VAR, which is VAR with variable in level and VECM using Variabel I (1) with cointegration relation. To reduce the impulse response function from VAR level or VECM requires a representation of a model is such as shock with vector-moving average representation. The determination of the lag length is considered a problem in VAR or VECM. An overly long Lag decreases the degree of freedom, implicating lost of information required and overly short lag produces (miss specification model). On the other hand, the issue on determining the length of lag becomes more and more important as related to an argument that

the correct lag option produces Gaussian residue (Gujarati, 2003, p. 853; Enders, 1995, p. 313; Harris, 1995, p. 81).

4. RESULT OF ANALYSIS

4.1. Stationerity Test and Cointegration

Unit root test is a data stationerity tes to observe whether particular coefficient form autoregressive model estimated to have one value or not. The unit root test Dickey Fuller test has weaknesses especially on the laternative hypothesis using unit root nearly one. According to Blough in Harris (1995), trade-off between size and power has tendency to reject null hypothesis when the data generated process (d.g.p) approaches stationary especially those for limited sample.

Table 1 displays Augmented Dickey Fuller test to observe variables which have yet reached stationary on I(0) on the trust degree of $\alpha = 5\%$. This indicates that all variables have not become stationary on the level except domestic inflation variables and the money supply. Since not all variable has similar stationerity level, the first integration degree test is done (1), which then demonstrate that not all stationerity variable do not have similar integration degree to I(1). Thus, it is important to conduct a test for the second integration degree I(2) which can be seen by all stationary variable on the second degree I(2).

After all stationary variables are on the same degree, the next step is determining the number of optimal lag by using Schwarz Information Criterion indicating lag one is optimum. Then the long term relation or cointegration using Johansen Cointegration Test. The result reveals that there is a long term correlation among the variables in the model with intercept and trend in the cointegration equation and in VAR.

4.2. Hypothesis Dornbusch Model

Dornbusch model hypothesis test using estimation of VECM is able to identify long term and short term relation amongst domestic and international macroeconomy variable towards the exchange rate. Dornbusch (1976) with sticky price model explain the occurrence of exchange rate fluctuation and overshooting hypothesis. The overshooting of exchange rate is a mechanism in which short term respond to shock exceeds long term response. Following is the estimation result of VECM.

Based on Table 2, long term relation (cointegrating equation) shows significant affecting variables of output or GDP, inflation and money supply on error level of $\alpha = 5\%$. In the long term, money supply variable or monetary aggregate affects negatively

Table 1: Test result on unit root I(0) and the degree of integration I(1) and I(2)

Variable	I(0)	I(1)	I(2)
Exchange rate (LS)	-0.390	-9.216***	-10.038***
GDP (G)	-0.915	-5.416***	-13.126***
Domestic inflation (P)	-2.700*	-2.817*	-9.394***
Domestic interest rate Suku Bunga Domestik (ID)	-0.451	-6.566***	-15.549***
The amount of money supply (LM)	-2.737*	-1.647	-7.031***
Foreing interest rate (IF)	7.192	1.136	-8.575***

****. *Each indicates significant to $\alpha=1\%$, 5% and 10%

Table 2: Estimation result of VECM

Cointegrating Eq:	CointEq1			
LS(-1)	1.000000			
ID(-1)	0.023744 (0.03202) [0.74156]			
G(-1)	0.434753 (0.18315) [2.37378]			
P(-1)	-0.190722 (0.04245) [-4.49299]			
IF(-1)	-0.075649 (0.15748) [-0.48037]			
LM(-1)	-1.806425 (0.78879) [-2.29012]			
@TREND(10M01)	0.016858 (0.00930) [1.81294]			
	16.51565			
Error Correction:	D(LS)	D(ID)	D(G)	D(P)
CointEq1	-0.043954 (0.01925) [-2.28380]	-0.554802 (0.15247) [-3.63868]	0.016116 (0.03983) [0.40466]	0.271423 (0.18332) [1.48061]
D(LS(-1))	-0.025507 (0.10874) [-0.23457]	0.505165 (0.86147) [0.58640]	0.167903 (0.22502) [0.74617]	-0.401902 (1.03573) [-0.38804]
D(ID(-1))	0.014537 (0.01335) [1.08927]	0.159209 (0.10573) [1.50586]	0.005353 (0.02762) [0.19383]	0.137731 (0.12711) [1.08353]
D(G(-1))	0.073146 (0.04829) [1.51473]	0.759121 (0.38257) [1.98428]	0.410749 (0.09993) [4.11045]	-0.261816 (0.45996) [-0.56922]
D(P(-1))	-0.001512 (0.01043) [-0.14496]	0.079718 (0.08265) [0.96451]	0.009419 (0.02159) [0.43627]	0.464493 (0.09937) [4.67435]
D(IF(-1))	0.000859 (0.04455) [0.01928]	0.215278 (0.35291) [0.61001]	0.007528 (0.09218) [0.08166]	0.357600 (0.42430) [0.84279]
D(LM(-1))	-0.082118 (0.17140) [-0.47911]	-1.191979 (1.35787) [-0.87783]	-0.988388 (0.35468) [-2.78670]	-0.276956 (1.63256) [-0.16965]
C	0.005241 (0.00271) [1.93553]	-0.012525 (0.02145) [-0.58385]	0.008080 (0.00560) [1.44204]	0.003258 (0.02579) [0.12632]
R-squared	0.126766	0.286512	0.231311	0.224878
Adj. R-squared	0.055689	0.228437	0.168744	0.161786
Sum sq. resids	0.035623	2.235818	0.152544	3.231898
S.E. equation	0.020352	0.161239	0.042116	0.193856
F-statistic	1.783497	4.933512	3.696980	3.564317
Log likelihood	236.8883	42.33810	168.5289	25.02037
Akaike AIC	-4.869963	-0.730598	-3.415509	-0.362135
Schwarz SC	-4.653513	-0.514147	-3.199058	-0.145685
Mean dependent	0.003959	-0.023936	-0.001277	0.000851
S.D. dependent	0.020944	0.183562	0.046193	0.211740

Source: Data processed, 2018. VECM: Vector Error Correction Model

the movement of exchange rate in which the increase of money supply or monetary aggregate causes exchange rate depreciation. Domestic inflation indicates an increased inflation causing Rupiah depreciation. On the other hand, the increased economy growth stimulates an appreciation of the exchange rate. The aggregate demand through exports, investment and household consumption brings about an increase of exchange rate in the

middle of maintaining economy growth momentum. International variable, in this case, US policy on interest rate did not affect significantly in the long term during observation. This is caused by the still relatively stable fundamental Indonesia that the changes in interest rate policy by Central Bank of Indonesia still managed to be anticipated by macro economy fundamental reinforcement.

On short term, all variables does not affecting significantly on $\alpha = 5\%$. t indicates shock or surprise during short term period did not affect exchange rate. Overshooting exchange rate in responding external and internal shock indicates bigger short term condition movement than steady state condition is not proven during observation period. This shows Dornbusch hypothesis on overshooting the exchange rate did not occur in Indonesia during observation period. Pratomo study (2005) shows difference in terms of significant effect of money supply and interest rate during economy crisis period in Indonesia in the mid 1998 with period of observation from 1997 to 2004. The significance of rapidity of short term adjustment to long term balance done by economy agent occurred on $\alpha = 5\%$. All in all, the stability of macro economy in Indonesia was adequately maintained amidst the recovery of global economy after 2008 financial crisis occurring in the US and several European countries.

4.3. The Response of Rupiah Exchange Rate

The analysis of impulse response depicts the effect of shock towards endogen variables in the model and to observe dynamic relation amongst variables in the model.

Figure 1 illustrate that shock resulted form several macro economy fundamental variable such as money supply, domestic interest rate, domestic inflation indicates positive permanent relation. The shock emerged form domestic interest rate affects positively in which 1% standard increased interest rate deviation causes depreciation as much as 0.002 in the early period and it is permanent. The shock of economy growth in the early period gives impact on the exchange rate appreciation of 0.003 reaching the level of 0.0002. It inclines in the fourth period and is permanent. The price increase causes exchange rate depreciation as much as 0.003 in the early period, but the increase of 0.02 occurs after the fourth period and is permanent. Meanwhile, the impact of money supply in the early period brings a greater deviation than macroeconomy variable with 0.004. However, it is relatively smaller than the price after the early period and is permanent. Moreover, the influence of foreign policy on interest rate such as the US is relatively small with 0.0005 and is permanent. This indicates the influence of macro economy variable shock which brings impact to time horizon permanently in long term period.

Therefore, the policy implication to manage the exchange rate is considered crucial by maintaining internal and external balance. The management of capital inflow is done by considering the use of interest rate instrument and macroprudential in mitigating the risk of sudden and reversal of foreign capital flow. Capital inflow remains increasing by maintaining global and domestic risk by watching how market mechanism works. The challenge of Rupiah movement is influenced by external factors such as tax reformation policy by the US, geopolitics and increase in oil price.

5. CONCLUSION

The stability of macroeconomy is crucial factors for economy development. The global economy dynamics provides implication to an importance of an effort to strengthen macroeconomy fundamental of a particular country to stabilize the exchange rate. Based on the analysis, it can be concluded that:

1. In long term, money supply variable or monetary aggregate affects negative relation by the movement of exchange rate where the increase on money supply or monetary aggregate causes the exchange rate depreciation. Short term shock does not affect the exchange rate.
2. The rapidity of exchange rate response toward macroeconomy fundamental variable is permanent where price variability and money supply still contribute greatly to the movement of exchange rate. Foreign exchange rate provides smaller impact compared to economy fundamental variable.
3. Dornbusch hypothesis on exchange rate overshooting is not proven in Indonesia during observation period.

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