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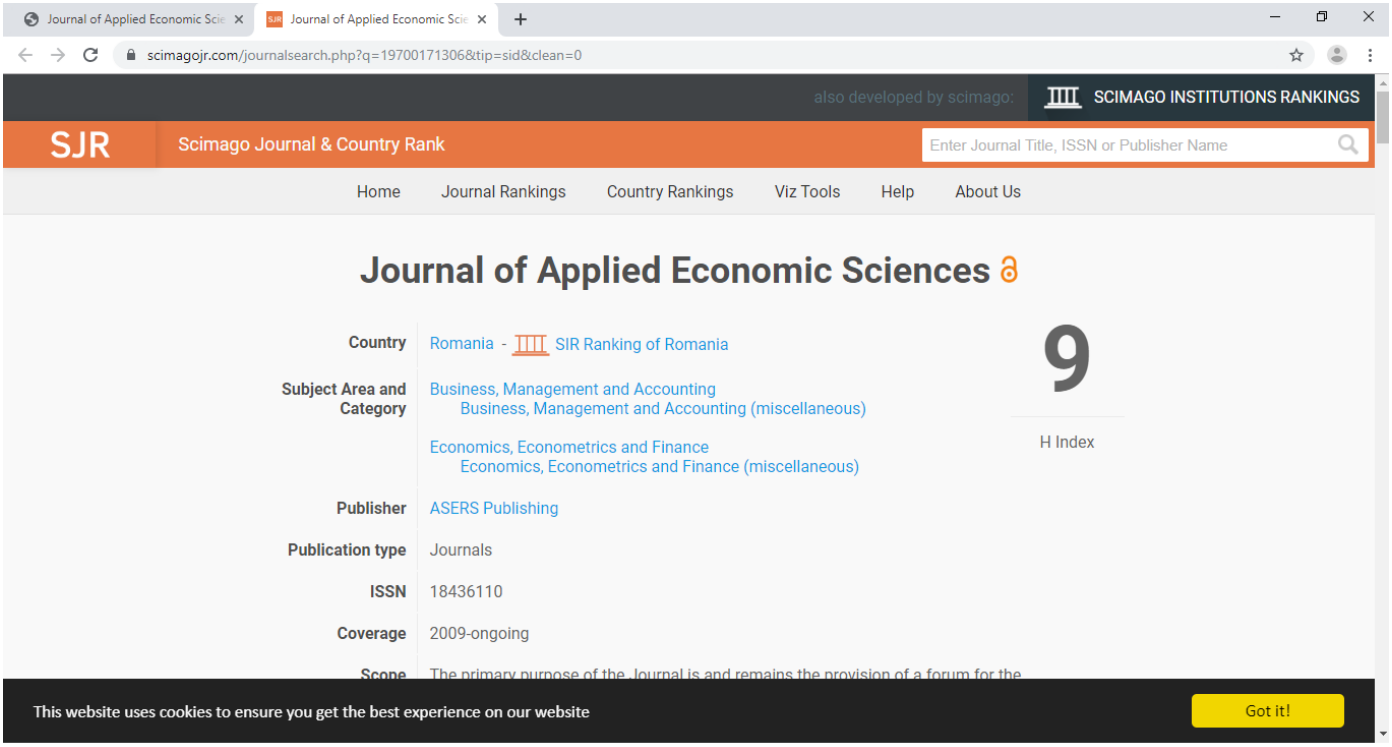
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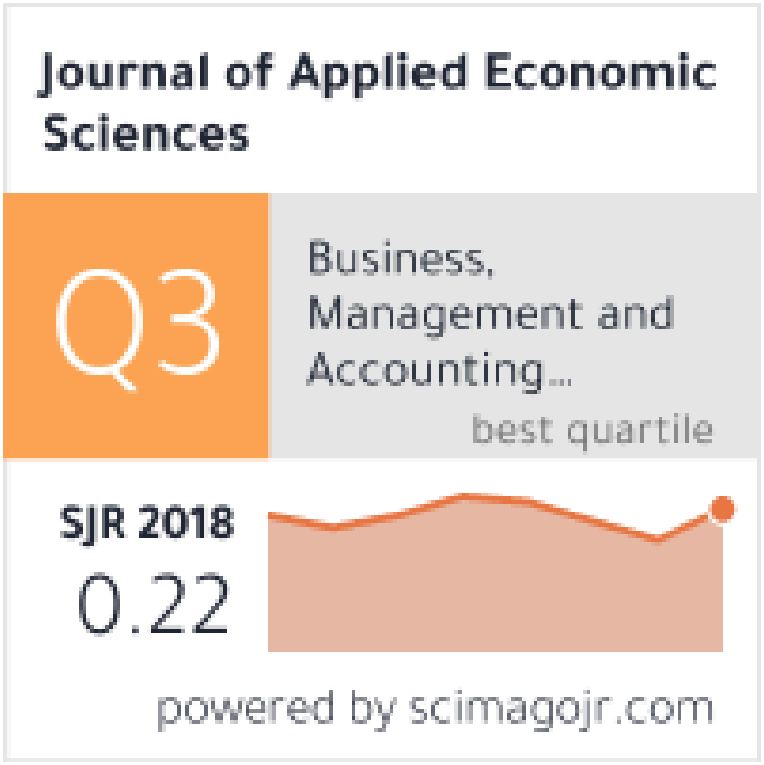
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Determinant of Exchange Rate with Hybrid Model: Empirical Evidence from Indonesia

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Abstract:
The purpose of this study is to examine the determinants of the exchange rate in Indonesia by using a hybrid model which is a combination of macroeconomic model with a model of the microstructure. Furthermore, hybrid models are estimated using an error correction model of Domowitz El-Badawi. The results show that five macro variables (money supply, interest rates, inflation, output growth, and capital flow) and a variable microstructures (inventory) has a significant influence on the determination of the exchange rate.

Keywords: exchange rate, hybrid model, microstructure model, macroeconomic model, error correction model.

JEL Classification: E44, F31

1. Introduction

Lately we have seen the value of the rupiah against the US dollar fluctuates with the trend of diminishing value. At the end of 2012 the value of the rupiah against the US dollar is still below 10,000 per dollar, but in October 2013 has been above 11,000 per dollar and in December 2014 reached 12,700 rupiah. Even in August 2015 already over 14,000. Fluctuations in the exchange rate of rupiah per US dollar are reflected in Figure 1.

Given the impact of currency exchange rate fluctuations on the economy is huge, the efforts to maintain the stability of the rupiah exchange rate is very important. Parties are entrusted to keep the exchange rate in Indonesia is Bank Indonesia (BI), this is in accordance with the basic tasks of BI is to maintain the stability of the exchange rate good for the price of goods in general and against foreign currencies. Of course, to keep the stability of the currency exchange rate, previously had known beforehand the factors that affect the level of the rupiah.

Broadly speaking, the determination of the exchange rate can be grouped into three models, namely macroeconomic models, microstructure models and hybrid models. Meese and Rogoff (1983) asserted that unsatisfactory macroeconomic models are less satisfying to explain the determinants of the exchange rate. Frankel and Rose (1995) are same as Meese and Rogoff (1983), they showed the weak evidence that macroeconomic variables have an influence on the exchange rate, except in special conditions such as when hyperinflation. Bailliu and King (2005) also underline that models the determinants of the exchange rate based on the fundamental data of macroeconomic are less successful to explain or predict the exchange rate. The statement is very important because most of the research on the determinants of the exchange rate in Indonesia using macroeconomic models. Research on the exchange rate in Indonesia, including by Edwards and Sahminan (2008), Pratomo (2008), Cahyono (2008), Hsieh (2009) Abudalu and Elgazoli (2013), Heriqbaldi, et al (2014), Hsing (2015).

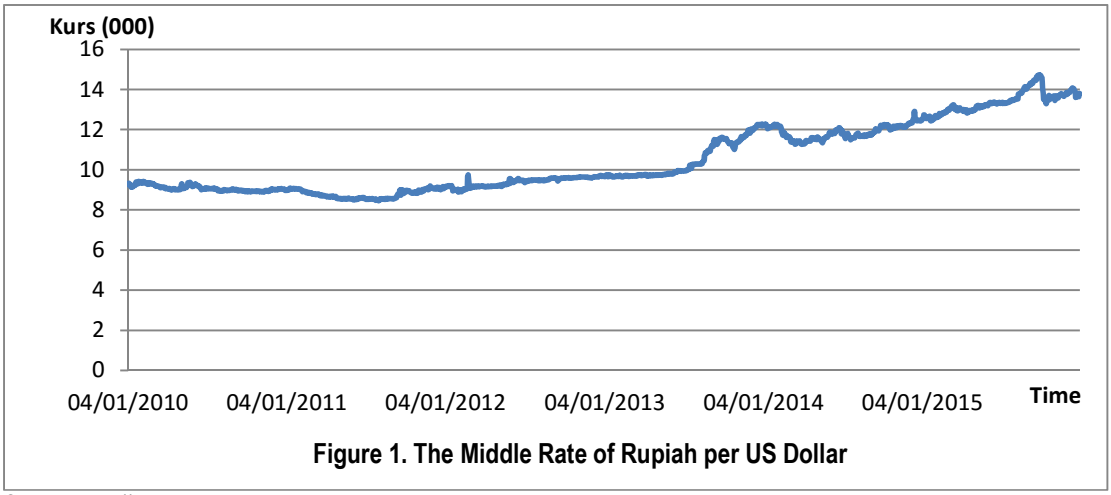

Figure 1. The Middle Rate of Rupiah per US Dollar

Source: http://pusatdata.kontan.co.id

Cheung et al (2005) and Abhyankar et.al. (2006) explain that a failure in projecting the exchange rate is generally caused by the models used. Most researchers generally rely on one model or the basic concepts only. Macroeconomic models give better results when in the long term, while the microstructure gives better results when used in the short term. Macroeconomic models give better results when in the long term, while the microstructure gives better results when used in the short term. Analysis of the determinants of the exchange rate in order to cover, short-term and long-term it is necessary to use a hybrid model. Evans and Lyons (2000) became a pioneer in analyzing the determinants of the exchange rate using a hybrid model. The model combines fundamental macroeconomic models with microstructures models. Payne (2003), Killeen et.al. (2006), and Rime et.al. (2007) have also implemented Hybrid model empirically. Their empirical studies do show better results, viewing from the abilities in explaining variations in the exchange rate. Therefore, this study will use a hybrid model.

2. Research methodology

The hybrid model is a model that combines macroeconomic variables and microstructure as variables that determine the exchange rate. In general, the hybrid model can be expressed as follows (Lyon, 2001):

$$E_t = f(i, m, z) + g(X, I, Z) + e_t$$

Where f (i, m, z) is a component of macroeconomic models and g (X, I, Z) is a component microstructures. Notation E shows the exchange rate, i is interest rate, m is the money supply, other macroeconomic variables z, X is order flow, I is net position or dealer inventory, Z are other micro variables, and e is the error.

Furthermore, to estimate the equation (1) it is done by using Error Correction Model Domowitz Elbadawi. The procedures are: 1) testing the data stationary by detecting the presence of unit root, 2) transforming the data into stationary, 3) conducting cointegration Dickey-Fuller test, 4) Estimating by using the error correction model.

Explicitly, a hybrid model using the Error Correction Model Domowitz Elbadawi can be written as follows:

$$\Delta LnE_t = \alpha_0 + \alpha_1 \Delta LnM_t + \alpha_2 \Delta I_t + \alpha_3 \Delta P_t + \alpha_4 \Delta Y_t + \alpha_5 \Delta LnTB_t + \alpha_6 \Delta LNCF + \alpha_7 \Delta LnOF_t + \alpha_8 \Delta LnINV_t + \alpha_9 LnM_{t-1} + \alpha_{10} I_{t-1} + \alpha_{11} P_{t-1} + \alpha_{12} Y_{t-1} + \alpha_{13} LnTB_{t-1} + \alpha_{14} LnCF_{t-1} + \alpha_{15} LnOF_{t-1} + \alpha_{16} LnINV_{t-1} + \alpha_{17} EC_t + \varepsilon_t \ldots\ldots\ldots\ldots (1)$$

$$EC_t = LnM_{t-1} + I_{t-1} + P_{t-1} + Y_{t-1} + LnTB_{t-1} + LnCF_{t-1} + LnInv_{t-1} + LnOF_{t-1} - LnE_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$LnE_t = \beta_0 + \beta_1 LnM_t + \beta_2 I_t + \beta_3 P_t + \beta_4 Y_t + \beta_5 LnTB_t + \beta_6 LnCF + \beta_7 LnOF_t + \beta_8 LnInv_t .....(3)$$

Equation (1) is a short-term equation and the equation (3) is a long-term equation. Where α_0 and β_0 are constants; α_i,and β_i are the coefficient; E_t is the rupiah exchange rate against the US dollar; M_t is the difference between the money supply Indonesia with the United States; I_t is the difference of interest rate between Indonesia and the United States; P_t is Inflation differences between Indonesia and the United States; Y_t is output growth differentials between Indonesia and the United States; TB_t is the trade balance; CF_t is capital flow; OF_t is order flow; INV_t is inventory; EC_t is an error correction term.

The data used in this research are monthly data covering the period 2010:1 to 2015:6. The data source is published by Bank Indonesia and the various editions of the Federal Reserve Statistical Release.

3. Empirical results

Based on the results of the calculation of unit root test on the data level, visible LnE_t, LnM_t, I_t, P_t, $LnTB_t$, $LnINV_t$ probability value are greater than 5 percent, it means that the data are not stationary at level. While variable Y_t, $LnCF_t$, $LnOF_t$ probability value of less than 5 percent, it means the data are stationary at level. Data transformation is then performed using the first difference. The results of calculations on the data first difference stationary seen all these variables (Table 1).

Table 1 - The Result of Unit Root Test

No	Variable	Level			1st difference		
		ADF Stat	Prob	Information	ADF Stat	Prob	Information
1	LnE_t	1.0499	0.9967	Not stationary	-6.71075	0.0000	Stationary
2	LnM_t	-1.7439	0.4047	Not stationary	-9.0453	0.0000	Stationary
3	I_t	-1.3477	0.6022	Not stationary	-4.5307	0.0000	Stationary
4	P_t	-2.0942	0.2470	Not stationary	-5.2443	0.0000	Stationary
5	Y_t	-8.7583	0.0000	Stationary	-8.7267	0.0000	Stationary
6	$LnTB_t$	-1.8593	0.3491	Not stationary	-9.9926	0.0000	Stationary
7	$LnCF_t$	-7.9474	0.0000	Stationary	-15.856	0.0000	Stationary
8	$LnOF_t$	-12.887	0.0000	Stationary	-17.000	0.0000	Stationary
9	$LnINV_t$	-0.6293	0.8560	Not stationary	-10.643	0.0000	Stationary

Source: Own Work

To perform cointegration tests with Eangle Granger (EG), it must be done from the regression equation models being tested. Then the residual is taken to be tested with Augmented Dickey-Fuller. If the value of the t statistic Augmented Dickey-Fuller (ADF) is greater than the critical value, the variables in the equation cointegrated each other or have a long-term correlation. Alternatively, it could be seen from the probability value (ρ-value). From table 2 shows that the value of the t statistic Augmented Dickey-Fuller (ADF) is greater than the critical value in all its α. The conclusion is variables in the equation cointegrated each other or have a long-term correlation.

Table 2 - The Result of Cointegration

ADF test statistic	Value
T- statistic	-3.9458
Critical Value Level 1%	-3.5349
Critical Value Level 5%	-2.9069
Critical Value Level 10%	-2.591
Prob.	0.003
Information	Cointegrated

Source: Own Work

Furthermore, the models estimate an error correction model (ECM) with the estimation results are presented in Table 3. From the table shows variable error correction (EC_t) demonstrated statistically significant results and is positive mark. This can be interpreted as a model specification Error correction model (ECM) Damowitz Elbadawi used in this study is valid and able to explain the dynamic variation. EC_t coefficient of 0.307504 means that the proportion of the determinant of the exchange rate in the previous period was adjusted in the current period is approximately 0.307504 percent.

The coefficient of determination to find out the percentage change in the variation of the independent variables could explain the change in the dependent variable. The coefficient of determination of 0.812968 (see Table 3) meaningful 81.2968 percent of the independent variables in the model are able to explain the variation changes in the exchange rate, while the remaining 18.7032 percent set of variables outside of the model.

Changes in money supply in Indonesia are relative to the United States (D(LnM)) and changes in inventory dollars in commercial banks (D(LnINV)) showed significant and marked positive. While the variables were not significant were the relative change in interest rate of Indonesia to the United States (D(I)); changes in capital flows (D(LnCF)); changes in the trade balance (D(LnTB)); changes in Indonesia's inflation relative to the United States (D (P)); changes in the growth of Indonesia's output relative to the United States (D(Y)); and changes the order flow in Indonesia (D(LnOF)).

For variable lag is significant lag first of the interest rate relative (I_{t-1}), lag first of capital flow ($LnCF_{t-1}$), the lag first on the trade balance (LnTBt-1), lag first of inflation relative (P_{t-1}), lag first from the output growth of the manufacturing sector in Indonesia and the United States (Y_{t-1}), lag first of inventory dollars in commercial banks ($LnINV_{t-1}$), and lag first of order flow ($LnOF_{t-1}$). All variable lags have significant a negative sign or a negative direction. While the variable lag which is not significant is the lag of the money supply relative between Indonesia and the United States (LnM_{t-1}).

Table 3 - Hasil Estimasi Error Correction Model

Variable	Coefficient	t-Statistic	Prob.
C	0.881924	3.668235	0.0006
D(I)	-0.006506	-0.651995	0.5176
D(LnCF)	-0.004814	-0.761320	0.4503
D(LnM)	0.599784	7.835529	0.0000
D(LnTB)	-0.000313	-0.012277	0.9903
D(P)	0.002190	1.003959	0.3205
D(Y)	6.56E-05	0.143264	0.8867
D(LnINV)	0.093436	3.916014	0.0003
D(LnOF)	-0.000325	-0.104731	0.9170
I_{t-1}	-0.313714	-5.006040	0.0000
$LnCF_{t-1}$	-0.317710	-4.957612	0.0000
LnM_{t-1}	-0.046964	-1.251962	0.2168
$LnTB_{t-1}$	-0.314579	-4.217183	0.0001
P_{t-1}	-0.306949	-4.977543	0.0000
Y_{t-1}	-0.308147	-4.977031	0.0000
$LnINV_{t-1}$	-0.174891	-4.428775	0.0001
$LnOF_{t-1}$	-0.307324	-4.954952	0.0000
EC_t	0.307504	4.971161	0.0000
R square 0.812968			

Source: Own Work

To determine the significance of long-term coefficients can be done by comparing the value of the t statistic with a value of t table (see Table 4). The table shows that the absolute value of the t statistic is greater than t table is C (constant), the difference money supply in Indonesia and the United States (LnM) with the positive direction, the difference in interest rates in Indonesia and the United States (I) with negative direction, the difference in inflation in Indonesia and the United States (P) with the positive direction, the difference in the growth of output of the manufacturing sector in Indonesia and the USA (Y) with a negative direction, capital flow (LnCF) with a negative direction, inventory dollars in commercial banks (LnINV) with a positive direction. While the variables that are not significant are the order flow (LnOF) and the trade balance (LnTB)

In the long term effect of the money supply relative between Indonesia and the United States (LnM) exchange rates had a positive direction. Meaning the greater the money supply in Indonesia relative to the United States will respond with the rising value of the rupiah against the dollar (rupiah depreciated). In harmony with the long-term effects of changes in money supply in Indonesia relative to the United States on the exchange rate in the short term also has a positive direction. Means the greater the money supply in Indonesia relative to the United States will result in the weakening rupiah currency (rupiah depreciated) or the US dollar strengthened.

Impact of increase in the supply of a currency (when demand remaining) will have an impact on the money supply curve shifts to the right, the money supply curve shifts cause the balance of supply and demand for money decreases, so the value of money and the currency depreciated appreciated partner. Empirically many previous studies support these findings as Civcir (1998), Groen (2000), Atmadja (2002), Nucu (2011), Morley (2009), Saeed, et.al (2012), and Uddin, et.al (2013).

Table 4 - Long Term Coefficient and t Statistics

Variable	Coefficient	t-statistics	t-table
C (Constant)	2.868008	8.451E+00	1,96
I	-0.02019	-8.08E+00	1,96
LnCF	-0.03319	-5.72E+00	1,96
LnINV	0.431256	104.39316	1,96
LnM	0.847274	165. 1557	1,96
LnOF	0.000585	0.237936	1,96
LnTB	-0.02301	-1.099899	1,96
P	0.001805	2.1542618	1,96
Y	-0.00209	-3.031990	1,96

Source: Own Work

Based on the estimation equation long term, interest rate relative (I) effect on the exchange rate of the rupiah. The direction of the effect of these two variables is negative. It means when the interest rate Indonesia increases relative to US interest rates causes the rupiah against the dollar down (the rupiah appreciated). These findings are consistent with previous studies, including Civcir (1998), MacDonald, et.al. (2003), Hacker, et.al. (2009) showed that there is a tendency of a negative correlation between the interest rate and the spot rate is relatively nominal (the domestic rate minus the foreign interest rate) and the spot exchange rate. In the short term, first variable lag of interest rates relative Indonesia compared to the US (I_{t-1}) had an influence on the currency exchange rate negative direction too. It means in the short term, if there is an increasing the interest rate relative Indonesia, it will respond with a decreasing rate (rupiah appreciated).

These findings are in accordance with the theory of asset demand. All investors will expect a high return of investment instruments including currency chosen. When capital can move flexibly between countries and when assets perfect substitutes, then the capital will lead to currency assets that have a greater return. In this case the rise in interest rates in Indonesia responded to the flow of funds to Indonesia so that ultimately have an impact on the strengthening of the rupiah against the dollar.

The impact of relative inflation between Indonesia and the United States (P) against the exchange rate of the rupiah is the positive effect. The higher the relative inflation in Indonesia with the United States will increase the rupiah exchange rate against the dollar (the rupiah depreciates). Similarly, in the short term, the lag of inflation relatively Indonesia with the United States (P_{t-1}) depreciated impact on the rupiah against the dollar. The research was supported by the results of the findings of the Civcir (1998) who discovered the existence of a positive influence between inflation with currency exchange rates. Canales-Kriljenko (2004) found the Consumer Price Inflation (CPI) effect significantly positive direction against the exchange rates of currencies in various countries (cross section). Hsing (2009) also declared positive influence between inflation with currency exchange rates in New Zealand.

These findings are consistent with the theory of Purchasing Power Parity. A commodities should have the same price either in Indonesia or United States when expressed in the currencies of the same one, so the purchasing power of both currencies (rupiah and United States dollars) is at parity. If there is a price difference will occur the arbitration will adjust the price in both countries, so that finally the price is the same.

In the long term growth of the relative output between Indonesia and the United States (Y) has a negative influence against exchange rates. This means that the higher output growth would further strengthen the exchange rate of the rupiah against the dollar. In the short term, the lag from the relative output growth between Indonesia

and the United States (Y_{t-1}) influential with negative direction. It means that in the short term the relative output growth in Indonesia and the Americas the previous period affects the rupiah exchange rate. If output continues to grow normally aligned with the accession opinions. Rising incomes will increase needs money so encouraged currency appreciate. In addition, increasing output Growth will increase optimism that it will have an impact on the appreciation of the rupiah. The empirical results are aligned with the results of this research include performing by Groen (2000) reveals that there are empirically influenced with negative direction between real income (Y) and currency exchange rates. The research of MacDonald, et.al. (2003) also found that the increase in real GDP relative to the amount of 1 percent of the trading partner will have an impact on the appreciation of the real effective exchange rate of 0.2 per cent.

In the long term, the correlation capital flow in Indonesia with the exchange rate of the rupiah against the dollar has a negative direction. It means that more capital flow in Indonesia will strengthen the exchange rate of rupiah (dollars appreciate). Some of the studies that are same as these findings is Opoku-afari, et.al. (2004) did a study with the results of capital inflow has a tendency will encourage the appreciation of real exchange rates. Macdonald, et.al. (2003) suggested that the increase in the net foreign asset 1 percent would apply to the appreciation of the real effective exchange rate by 1 percent. Similarly, in the short term, the lag of capital flow ($LnCF_{t-1}$) also has an impact on the exchange rate of rupiah with the negative direction.

According to Levi (2004) foreign investment in a country represents the demand for the country's currency when the investment is made. It means that an investment in Indonesia stock exchange from foreign parties represents the demand for the rupiah, so it will shift the demand curve against the rupiah currency to the right. The amount of investment flowing into the country, usually depends on the level of relative advantage compared to the level of benefits in other countries. Capital inflow indicates domestic asset purchases by foreigners. The purchase of domestic assets will raise the price of the domestic currency (Dua and Ranjan, 2013).

In the long term, it is finding a positive correlation between inventory dollars in commercial Banks (LnINV) and exchange rates. It means, the larger the inventory, it will have an impact on the weakening of the exchange rate of the rupiah or dollar values rise. It is found also in the short term, where dollar inventory changes in commercial bank will be responded with an increase in the exchange rate of the rupiah against the dollar (rupiah depreciated).

Moulton (2008) stated *a market maker* would decrease the prices to decrease their *inventory* when considered it had exceeded the level of inventory that would be achieved and would raise the price when their inventory positions was low (below the level of the expected inventory). Activities adjust the inventory of foreign exchange could be linked to the opportunity cost of holding liquid assets. This opinion of Becker and Amadou (2005), stating the cost of holding liquid assets appears when it was compared with holding the assets instrument liquidless, so they need to manage liquid asset inventory (currency) to respond selling and buying orders by setting the *ask price* and the *bid price*.

Conclusions

The purpose of this research is to analyze a determinant of currency exchange rates Indonesia by using hybrid models. The hybrid model is combining a macroeconomic model and a microstructures model. The results of this reseach are valid with a high coefficient of determination.

Macroeconomic variables that affect the exchange rate is the money supply, interest rates, inflation, output growth is relative, and capital flow. The increase in Money supply relative between Indonesia and America will be responded with a rise in the exchange rate (rupiah depreciated). The increase in money supply will shift the money supply curve to the right, it causes the balance of the money market decreases, eventually the exchange rate of the rupiah depreciates. The increase in the relative interest rate in Indonesia is compared with the United States will decrease the exchange rate of the rupiah against the dollar (rupiah appreciates). Every investor certainly will expect a high return on selected investment; it is corresponding to the theory of demand assets.

The higher the relative inflation in Indonesia compared United States, the higher the exchange rate of the rupiah against the dollar (rupiah depreciated). This is corresponding to the theory of *purchasing power parity*, the point is the increasing the inflation in the country would cause the domestic currency depreciates against the partner. The increasing the output relative growth in Indonesia will have an impact on the decrease in the exchange rate of the rupiah against the dollar (dollar appreciates). The growth of output, closes to the increasing the revenue, and increasing incomes will result in an increase in the demand for money, will further encourage the currency appreciates. In addition, the growth in output will also increase optimism the market participants and will strengthen the value of the currency. The higher the capital flow, it will have an impact on the decrease of the exchange rate

of the rupiah against the dollar (dollars appreciated). The purchase of domestic assets in Indonesia stock exchange by foreigners will push the rupiah currency appreciates.

Microstructures variables that affect the exchange rate is inventory. The greater inventory, the higher the exchange rate of the rupiah against the dollar (rupiah depreciated). Dealers will adjust dollar inventory in accordance with the desired target level. Dealer will increase the price of the dollar when it wants the increase in inventory.

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