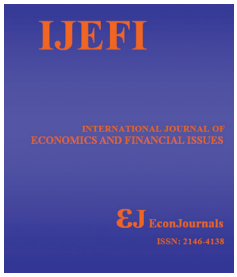

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A Model of the Dynamic of the Relationship between Exchange Rate and Indonesia's Export

Pasrun Adam[1,2]*, Rosnawintang[3], Ambo Wonua Nusantara[4], Abd Aziz Muthalib[5]

[1]Department of Mathematics, Universitas Halu Oleo, Kendari, Indonesia, [2]Department of Economics, Universitas Halu Oleo, Kendari, Indonesia, [3]Department of Economics, Universitas Halu Oleo, Kendari, Indonesia, [4]Department of Economics, Universitas Halu Oleo, Kendari, Indonesia, [5]Department of Economics, Universitas Halu Oleo, Kendari, Indonesia.
*Email: adampasrun@gmail.com

ABSTRACT

This study aims to investigate the effect of Rupiah/US dollar exchange rate on the volume of Indonesia's export. It analyzes monthly data spanning from January 2001 to November 2015. An econometric model used to analyze the data is the difference equation model. Result of analysis found that in the long term the exchange rate of rupiah/US dollar affects export. This long-term influence is negative, in that each 1% increase (decrease) in rupiah/US dollar is always followed by 0.24% fall (rise) in export. Furthermore, in the short term there is an effect of the exchange rate of rupiah/US dollar on export and the effect is also negative. Indonesian government needs to conduct a policy aimed at increasing industrial outputs that can boost exports. The government also needs to implement a monetary policy to ensure that the exchange rate of rupiah remains stable.

Keywords: Exchange Rate, Export, Difference Equation Model
JEL Classifications: F140, F310, G150

1. INTRODUCTION

In an open economy, the currency of a developed country such as the United States is a transaction tool commonly used in international trade, be it in real or financial sector. In the real sector, in particular, trade occurs through exporting and importing activities. Aggregate export and import of this activity is assessed by exchange rate, which is a currency price. Umnov (1984) defines the volume of exports of one kind of commodity as a multiplier of exchange rate and quantity of exported commodities. Export is the total volume of all commodities that are exported to all countries. Therefore, exchange rate and export quantity play important roles in the calculation of export, and, economically any changes in the exchange rates and export quantity can affect export.

We learn from the history of Indonesia's economy that in during the Asian financial crisis (1997-1998), the nominal exchange rate of rupiah/US dollar was depreciated, jumping from Rp 2403.27/US dollar in the first quarter of 1997 to Rp 10,460.77/US dollar in the second quarter of 1998. What weakened rupiah currency was the prices of imported goods, in particular those of industrial raw materials, which became very expensive, and as a result importing activities increased domestic inflation and at the same time decreased the output production of exported goods, which then caused export to fall. A combination of the depreciation of rupiah exchange rate and the rising inflation led to the fall of Indonesia's gross domestic product (GDP) by 15% in 1998, as compared to the country's GDP in the first quarter of 1997 (Lo, 2000). In the next period, particularly during the period of 2001:1-2015:11, the trend of both rupiah/US dollar exchange rate and Indonesia's export showed a fluctuation and an up-trend. However, the trends went to opposite direction at certain sub periods. For example, in sub period 2001:1-2002:2, the exchange rate of rupiah/US dollar rose from Rp 9497.00/US dollar in January 2001 to Rp 10,240.00/US dollar in February 2002, while export fell from $ 4,890,340,852.00 in January 2001 to $ 4,197,038,074.00 in February 2002. In sub period 2002: 2-2005:7, the exchange rate of rupiah/US dollar fell to Rp 9868.00/US dollar in July 2005, while export rose to $ 7,153,919,300.00 in July 2005. In sub period 2005:7-2008:9, the exchange rate fell to Rp 9,425.00/US dollar in September

2008, while the export rose to $ 12,277,178,043.00 in September 2008. In sub period 2008:9-2009:11, the exchange rate ies rose to Rp 9,527.00/US dollar in November 2011, while export fell to $ 10,775,361,672.00 in November 2011.

The relationship between exchange rate and export can occur in two directions. Exchange rate can affect export if importers in foreign countries consider the price of goods in exporting country cheaper. Therefore, if the exchange rate of the domestic currency is depreciated (assuming other variables do not change), then it can lead to increased purchase of domestic goods by other countries. In this situation, domestic exporters can sell domestic goods abroad, causing export to rise (Ali et al., 2014).

Conversely, when an increase occurs in the preference of people abroad who go for domestic goods in other countries, domestic goods will be sold abroad, albeit with high prices. In the next cycle, increasing demand for domestic goods may cause domestic exchange rate to be appreciated (Mishkin, 2004). The appreciation of domestic exchange rate can cause concern among exporters since it makes domestic products more expensive in the international market, and this can affect exports (Ramachandran et al., 2008) in that export may decrease.

A number of studies on the effect of exchange rate on exports in various countries have been conducted by Sukar (1998), Acaravci and Ozturk (2002), Kemal and Qadir (2005), Fountas and Aristotelous (2005), Marquez and Schindler (2007), Fang and Miller (2007), Shane et al. (2008), Dincer and Kandil (2011), Caglayan and Demir (2013), Cheung and Sengupta (2013), Sweidan (2013) and Hooy et al. (2015). Despite this bulk of research, however, there is no consensus regarding the results of the research. Some researchers, such as Hooy et al. (2015), Caglayan and Demir (2013), found that the effect of exchange rate on export was positive. Some others, such as Kemal and Qadir (2005), Marquez and Schindler (2007), Shane et al. (2008) and Cheung and Sengupta (2013), discovered that the effect of exchange rate on exports was negative. In fact, some researchers concluded from their research that in the long term there was no influence of exchange rate on exports (Fountas and Aristotelous, 2005; Fang and Miller, 2007; and Nyeadi et al., 2014). The difference in the results reported by those studies can be attributed to the economic conditions of a country in a given period. For example, Kemal and Kadir (2005) found that while in the long term exchange rate affected export in India, it did not have any significant effect on export in the short term. Sukar (1998) and Sweidan (2013) reported that while in the long term there was no influence of the exchange rate on exports, the influence occured in the short term. Dincer and Kandil (2011) conducted a research in Turkey and found that the effect of exchange rate on exports was positive prior to 2003, while after 2003 this influence was negative. Another factor causing the difference in the research results is the type of exported goods and export destinations. For example, Chi and Cheng (2016) examined the effect of real income, bilateral exchange, and volatility of exchange rate on Australian maritime-sector exports to its trading partners including China, India, Indonesia, Korean Republic, Taiwan, and Malaysia. They found that the effect of the exchange rate on Australian export to China, India, Indonesia, and Malaysia was positive, while the effect was negative to Korea. Furthermore, it is revealed from the literature that, in general, past researchers used disaggregate export as a dependent variable and volatility of exchange rate as an independent variable. In other words, the researchers paid less attention to aggregate export as the dependent variable.

The present study uses exchange rate as an independent variable and aims to examine the long-term effect of exchange rate on Indonesia's aggregate exports. An econometric model used to test the effect is the different equation model proposed by Enders (2015). In selecting the model, the underlying assumption is that the effect of exchange rate on export does not occur instantly; rather, it requires a certain time lag. In the meantime, Indonesian government has always been trying to stabilize the exchange rate of rupiah against foreign currencies by implementing related monetary policies. For this particular reason, information about changes in exchange rate in the past becomes very important. Furthermore, the influence of the signal is graphically illustrated by using a method described in Adam (2014) and Adam et al. (2016).

2. REVIEW OF LITERATURE

Theories about the relationship between exchange rate and export have been presented in the previous subsection with a view from demand-side effect where the relationship is positive. From the supply side, the appreciation (depreciation) of the exchange rate decrease (increase) the cost of imported raw materials (Duran, 2016) and increase (decrease) the supply of output for export (Kandil and Mirzae, 2002; Dincer and Kandil, 2011) and this may increase (decrease) exports. So, depreciation of exchange rate can affect export either positively or negatively.

Jian (2007) examined the effect of real exchange rate misalignment of RMB on China's export using annual data in the period 1978-2005. Result of analysis using error correction model (ECM) indicated that the real exchange rate negatively affected export. Thorbecke and Kato (2012) investigated the effect of exchange rate of the Yen on the export of consumable goods to the following countries: United States, People's Republic of China, Russian Federation, Taipei, China, Germany, Australia, Canada, South Korea, United Kingdom, France, Belgium and Luxembourg, Spain, Hong Kong, China, Italy, Netherlands, Saudi Arabia, Mexico, and Singapore using annual data in the period 1988-2009. Result of testing by using Dols model showed that an increase in the exchange rate of Yen led to a significant increase in the value of China's exports. Li et al. (2015) examined the response of Chinese exports to the RMB exchange rate movements. In their analysis, they used multiple regression and found that the reaction of exporters towards the exchange rate movements were very minimum. Dekle and Ryoo (2007) tested the correlation between fluctuations of exchange rate and Japanese export quantity using simultaneous structural models. Based on the result of the tests, they found that exports volume at company level was significantly affected by the fluctuations of exchange rate. They also found that financial constraints played an important role in affecting the sensitivity of exports to the fluctuations of exchange rate.

Jaussaud and Rey (2012) examined the effect of exchange rate and the volatility of exchange rate on Japan's exports of each of the following sector (foods, textiles, metal products, chemicals, non-metal products, and machinery and equipment) to China and the USA, and using annual data in the period from 1971 to 2007. Results of analysis using vector ECM models indicated that an appreciation of Yen exchange rate and an increase in exchange rate volatility decreased Japan's exports. Cheung and Sengupta (2013) examined the effect of real exchange rate of Indian rupee on the export of Indian companies in the non-financial sector using annual data in the 2000-2010 period. Test result using multiple regression showed that there was a strong negative impact of the appreciation of the exchange rate and exchange rate volatility on exports.

Some previous researchers also examined the effect of exchange rate and earnings on exports. Sukar (1998) investigated the influence of the real exchange rate and revenue on the volume of US exports to its trading partner countries including Australia, Canada, the UK, Belgium, France, Germany, Italy, Netherlands, Japan, Hong Kong, Korea, Singapore, and Mexico, using quarterly data in the 1975Q1-1993Q2 period. Test result using ECM model showed that while in the long run the real exchange rate affected exports, in the short term, it had no effect on exports. Thorbecke and Zhang (2009) studied the effect of the exchange rate of RMB, foreign income, and the capital stock on Chinese commodities (clothing, furniture and Footwear) that were exported to Argentina, Australia, Austria, Belgium, Bangladesh, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Italy, Japan, Malaysia, the Netherlands, New Zealand, Norway, Poland, Saudi Arabia, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, Turkey, the UK and the USA. Result of analysis using Dols models showed that an increase in foreign income and capital stock, as well as the appreciation of the RMB exchange rate on competing exporting countries, raised the value of China's exports of the country. Cheung (2005) examined the effect of foreign exchange rates and foreign countries' opinion about exports to the US, Hong Kong, Japan, and other countries. Overseas income was proxied by the country's production index of the US and Japan. Result of analyzing monthly data spanning from 1991 to 2001 showed that the rate of state revenues of the US and Japan had a very strong and positive effect on exports.

Some other factors that may affect export have also been investigated by researchers in the field of economics and finance. Edwards and Alves (2006) examined determinants of exports in African countries. They found that exports were affected by real exchange rate, cost infrastructure, export profits, tariff rates, and labor skills. Majeed and Ahmad (2006) examined determinants of exports in developing countries. Some economic variables that could be identified were foreign direct investment, GDP, national savings, direct taxes, real exchange rate, industry value added, the total labor force, the number of television per 1000 people, and the number of telephones per 1000 people. Result of testing using fixed effects panel model showed that the economic variables under investigation did affect export. Saikia (2013) examined the determinants of export performance of India. Several variables were identified as determinants of export performance including GDP, income of foreign countries, real exchange rate, index of trade liberalization, and foreign direct investment. The researcher used the autoregressive distributed lag (ADL) models to examine the effect of those economic variables. Test result showed that there were both long- and short-term effects of the economic variables on exports. The effect of GDP, trade liberalization index, and exchange rate was positive, whereas the effect of foreign state revenue and foreign direct investment was negative. Based on these research findings, the researcher recommended that Indian government should improve the quality of local products and implements a policy to reduce production costs.

3. DATA AND METHODOLOGY

3.1. Data

This study uses monthly time series data spanning from January 2001 to November 2015. Two types of time series data are analyzed: time series data of exchange rate and time series data of Indonesia's export. There are 16 Indonesian commodities of exports, and some of 13 commodities (oil products, tuna, rubber, plywood, crabs, paper and paper products, computers, coffee, crude oil, coconut oil, apparel, tea, tobacco, and shrimp) that are exported to the United States. Besides that generally the US dollar is used as a tool of trade transactions. Therefore, in order to the analysis is not biased, then this study uses the exchange rate of rupiah/US dollar as the time series data, and the unit of export is US dollar.

The source of data about the exchange rate of rupiah/US dollar is the Bank of Indonesia (www.bi.go.id), and the source of data about export is the Central Bureau of Statistics (www.bps.go.id). Time series data that are obtained from both sources is expressed in for exchange and EXP^0 for aggregate exports. For the purpose of data analysis, the econometric model uses ECR as an independent variable and EXP as a dependent variable, where $ECR = \log(ECR^0)$ and $EXP = \log(EXP^0)$.

3.2. Methodology

Several models can be used to analyze the influence of independent variables on a dependent variable, among others: Vector autoregression (VAR), Granger causality, and ADL. The VAR adopts the concept of Granger causality. Granger causality is a simplified model of ADL, namely the ADL model (Koop, 2006) or the ARDL model (Pesaran and Shin, 1997). The model is selected to suit with the characteristics of the underlying data and research assumption. This study takes time lag into account since an exchange rate requires a certain time lag to affect aggregate exports and since the Indonesian government has implemented monetary policy to stabilize prices and the exchange rate of rupiah, so that information about the exchange rate in the past can be vital in the implementation of the monetary policy. Based on these considerations, the following model is used:

$$EXP_t = a_0 + \sum_{i=1}^{n} a_i ECR_{t-i} + bECR_{t-p} + \epsilon_t \quad (1)$$

Where, n and p are time lag, a_i ($i = 0, 1,\ldots,n$), and b are regression parameters with $|a_i| < 1$, ($i = 1,2,3,\ldots,n$) and t represents time in

month unit, ε_t is white noise with $E(\varepsilon_{ti}\varepsilon_{tj}) = 0, i \neq j, E(ECR_t \varepsilon_{t-i}) = 0$ in model (1), it is assumed that both *ECR* and *EXP* variables are stationary (or stationary at level). If *ECR* is stationary at first difference, then (1) becomes:

$$D(EXP_t) = a_0 + \sum_{i=1}^{n} a_i D(EXP_{t-i}) + bD(ECR_{t-p}) + \epsilon_t \quad (2)$$

Where, $D(EXP_t) = EXP_t - EXP_{t-1} = EXP - EXP(-1)$ is the first difference form of *EXP*.

Model (1) is proposed and used by Enders (2015), and he names the model (1) as a special model of the ADL model. Agung (2009) and Adam et al. (2015) refer to the model (1) as a special model of the lagged variable autoregressive (LVAR). Model (1) is a form of difference equation with explanatory variables or variable pressure process $bECR_{t-p}$ and it is called the difference equation model (Enders, 2015). Model (1) can also be referred to as a special case of the Granger causality model.

Two important steps need to be taken before estimating model (1), namely: stationarity test and cointegration test. The augmented Dickey-Fuller test (ADF test) is used for stationarity test. The equation used to test the stationarity of time series data of *EXP*, for instance, is:

$$D\left(EXP_t\right) = \alpha + \beta t + \rho EXP_{t-1} + \sum_{i=1}^{n} \theta_i D(EXP_{t-i}) + \varepsilon_t \quad (3)$$

Where, α, β, ρ and θ are parameters, and *t* expresses trend. In model (3), the parameter that must be examined is the significance of parameter ρ based on a formula of hypothesis H_0: ρ = 0 versus H_1: ρ < 0. If hypothesis H_1 is accepted (H_0 rejected), then *EXP* is stationary (Koop, 2006). Based on ADF test, *EXP* is stationary if the absolute value of the test statistic associated with ADF test is higher than the absolute value of the critics value at a significance level of 1% or 5%. The next step is to test the cointegration of both time series data of *EXP* and *ECR*. The cointegration test is performed by using the Engle-Granger two-step cointegration test. This cointegration test is run if both *EXP* and *ECR* are integrated of order one, I(1), or stasionary at first difference. If *EXP* and *ECR* are found to be integrated order one, I(1), the next step is to estimate the simple regression equation between *ECR* and *EXP*, and then to keep the residue with *RES*, to come up with:

$$RES_t = EXP_t - \alpha - \beta\, ECR_t \quad (4)$$

Where, α and β are the constant obtained from the previous estimation of the simple regression equation. If *RES* is stasionary or integrated of order zero, I(0), then *ECR* and *EXP* are said to be cointegrated (Heij et al., 2004), and the model obtained is a model of error correction. If *RES* is nonstasionary time series, then a model of relationship between *ECR* and *EXP* is obtained like (2). Model (1) and (2) have a long-term relationship with the multiplier effect of *ECR* on *EXP* being $\delta = \frac{b}{1 - \sum_{i=1}^{n} a_i}$, whereas the short-term multiplier effect is *b*. If δ > 0 then the long-term effect of *ECR* on *EXP* is positive. In contrast, if δ < 0, then the long-term effect of *ECR* on *EXP* is negative (Heij et al., 2004). The same case is applied to coefficient *b*.

To examine the effect of exchange rates on aggregate exports (*EXP*), the ordinary least square method is used to estimate regression parameters of model (2). In testing the significance of the parameters, the testing criteria used are the P value criteria, both t-statistics and F-statistics. A regression parameter is significant if the P value of the statistical test is smaller than the P value of critique at the significance level of 1% or 5%. When the significance test finds more than one *b* parameter that is significant, then *b* parameter with the smallest Akaike information criterion value is selected. Durbin–Watson (*DW*) statistical value is used to check whether or not the estimated model is false. If DW is larger than the coefficient of determination R^2, it can be concluded that the model is not a spurious regression.

4. RESULTS AND DISCUSSION

4.1. Results

The results of the stationary test of time series data using ADF test is summarized in Table 1:

As shown in Table 1, the absolute value of the test statistic associated with ADF test of the *EXP* variable (0.509726) is smaller than the absolute value of the critics value (3.437122) at the significance level of 5%, thus *EXP* is not stationary. *ECR* is not stationary either, since the absolute value of the test statistic associated with ADF test (2.186946) is smaller than the absolute value of the critics value (4.011352). The absolute value of the test statistics of *D*(*EXP*) variable is 18.94326, which is higher than the absolute value of the critics value (4.01394), thus *D*(*EXP*) is stationary. *D*(*ECR*) is also stationary because the absolute value of the test statistic (11.29237) is higher than the absolute value of the critics value (4.013946).

RES is the time series obtained from Equation (4). The estimation result related to a cointegration test is summarized in Table 2.

Table 2 shows that the absolute value of the test statistics of *RES* is 2.191048, while the absolute value of the critics value at level 1% is 3.469933. The absolute value of the test statistics is lower than the absolute value of the critics value at the level of 1% (also 5%), thus the *RES* is not stasionary. Therefore, the time series of both exchange rate (*ECR*) and aggregate exports (*EXP*) are not cointegrated. Based on the results of the cointegration test, then model (2) is used to test the effect of the exchange rate on aggregate export.

Table 1: The estimation result of stationary test of time series data

Variable	t-statistics	1% critical value	5% critical value	P*
EXP	−0.509726	−4.014288	−3.437122	0.9823
D(*EXP*)	−18.94326	−4.013946	−3.436957	0.0000
ECR	−2.186946	−4.011352	−3.435708	0.4935
D(*ECR*)	−11.29237	−4.013946	−3.436957	0.0000

*MacKinnon (1996) one-sided P values

The result of estimating the regression parameter of model (2) using ordinary least square method is summarized in Table 3.

It can be seen in Table 3 that coefficient $D(EXP_{t-1})$ is −0.370253 at the significance level of 1% since the P value t-statistics is 0, and this P value is lower than 1%. Coefficient $D(ECR_{t-3})$ is −0.331984 at the significance level of 5%, since the P value of the t-statistic is 0.0436, and the P value is lower than 5%. Thus, there is an effect, both in long and short term, of the exchange rate on Indonesia's export. This influence is negative, since, every 1% increase (decrease) in the exchange rate of rupiah/US dollar causes exports in units of US dollars to go down (up) by 0.24%. The short-term effect of the exchange rate of rupiah/US dollar on the exports is also negative. An equation regression model that shows the effect of rupiah/US dollar exchange rate on the export of Indonesia is:

$$EXP_t = EXP_{t-1} - 0.370253\ D(EXP_{t-1}) - 0.331984\ D(ECR_{t-3}) \quad (5)$$

The exchange rate of rupiah/US dollar requires a time lag of 3 months to affect the aggregate exports of Indonesia. In a process signal, this effect is illustrated in Figure 1, which shows that the trend of Equation (5) does not start from the 1st month.

Table 2: The estimation result of the stationary test of *RES*

Variable	ADF t-statistics	1% critical value	5% critical value	P*
RES	−2.191048	−3.469933	−2.878829	0.2104

*MacKinnon (1996) one-sided P values. ADF: Augmented Dickey-Fuller

Table 3: Estimation results of the relationship test (dependent variable: *EXP*)

Variables	Coefficient	t-statistic	P	Others statistics
D(*EXP*(-1))	-0.370253	-5.284386	0.0000	R^2: 0.149286
D(*ECR*(-3))	-0.331984	-2.033265	0.0148	DW: 1.952186
				AIC: -2.337913

DW: Durbin–Watson, AIC: Akaike information criterion

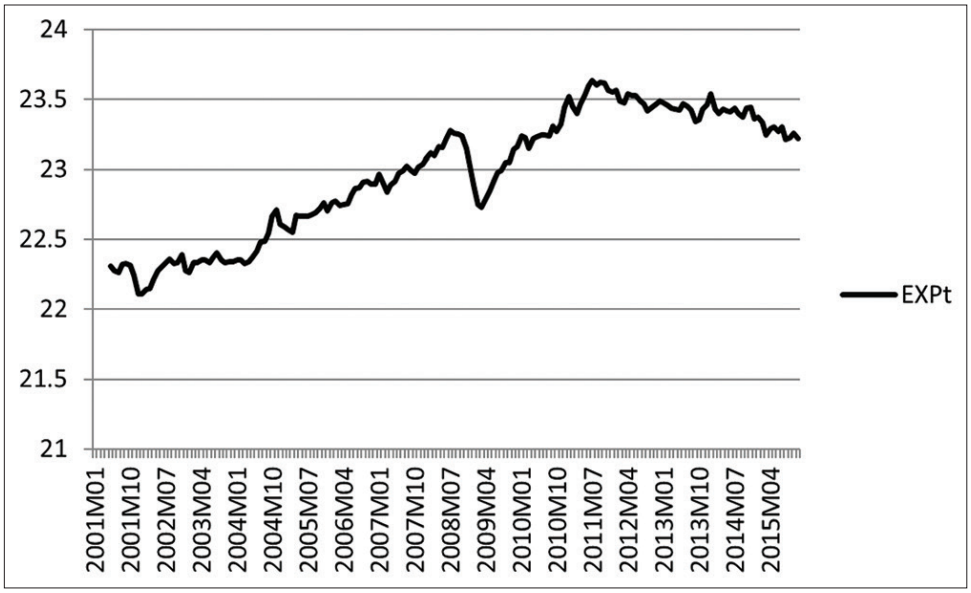
Indonesia's export is also influenced by the export in the previous months, namely $D(EXP_{t-1})$. The total of the effect of the rupiah/US dollar exchange rate and the effect of export prior to the current export is 14.93%, meaning that the exports of Indonesia is affected by other factors by 85.17%.

4.2. Discussion

Given the results of statistical inference on the "result section," there is a significant effect of the exchange rate of rupiah/US dollar on Indonesia's export. This finding is consistent with what were found by some previous studies, except for the results reported by Fang and Miller (2004), Fountas and Aristotelous (2005), and Nyeadi et al. (2014). This difference could be attributed to several factors, including the economic conditions of the exporting countries in a certain time period (Sukar, 1998; Kemal and Kadir, 2005; Dincer and Kandil, 2011; Sweidan, 2013), and the economic conditions of export destinations (Hooy et al., 2015). The first reason is related to data collection in a period of time, and the second reason is associated to the strategies adopted by a country for selecting its export commodities and export destinations.

The finding of this study indicates that both in the long term and in the short term the effect of the exchange rate of rupiah/US dollar on Indonesia's export is negative. These results are consistent with the trending phenomenon of rupiah/US dollar exchange rate and Indonesia aggregate export within the time period 2001:1-2016:11, where the trend of rupiah/US dollar exchange rate and aggregate exports fluctuated and went toward opposite directions. This result is also supported by the theory proposed by Kandil and Mirzae (2002) and Dincer and Kandil (2011) that in terms of the supply side, the depreciation of the exchange rate may depress exports. This can be due to the use of imported raw materials for industries, such as crude oil, given that Indonesia has been a net importer

Figure 1: A signal of the effects of exchange rates on Indonesia's exports based on Equation (5)



Source: Own processing

of oil since 2003 (Wang et al., 2013). Therefore, when rupiah is depreciated, the prices of industrial raw materials in Indonesia become expensive and this condition can decrease production output, causing the supply of exported good to drop and the price of the goods to rise.

Furthermore, the result also shows that the effect of exports in the past and the exchange rate of rupiah/US dollar on the exports of Indonesia is only 14.93%, whereas the remaining 85.17% is influenced by other factors. Those other factors are, among others: The income of importing countries (Thorbecke and Zhang, 2009), tariff rate, labor skills (Edwards and Alves, 2006), and foreign direct investment (Saikia, 2013). However, the influence of these factors needs to be further investigated.

5. CONCLUSION AND POLICY IMPLICATIONS

This study aims to investigate the influence of the exchange rate of rupiah/US dollar on Indonesia's exports. The data used are the monthly data spanning from January 2001 to November 2015. An econometric model used to test the effect is the different equation model.

Test results show that the time series data of both exchange rate (*ECR*) and export of Indonesia (*EXP*) are integrated in order one, I(1). Result of a cointegration test indicates that *EXP* and *ECR* are not cointegrated. Furthermore, result of testing the effect shows that the exchange rate of rupiah/US dollar affects the export of Indonesia, not only in the long term but also in the short term. This influence is negative. In the long term, each 1% increase (decrease) in the exchange rate of rupiah/US dollar causes the exports of Indonesia in units of US dollars to go down (up) by 0.24%.

The Indonesian government needs to implement policies in order that a depreciation of the exchange rate does not suppress production output. The government also needs to increase the effectiveness of its monetary policy in order to maintain the stability of rupiah exchange rate.

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