KINERJA Volume 27, No. 1, 2023 Page. 148-162

The Role of Expectations on Exchange Rate Determination in Indonesia

Rogatianus Maryatmo

Development Economics Study Program, Faculty of Business and Economics, Universitas Atma Jaya Yogyakarta

r.maryatmo@uajy.ac.id

Abstract

There are two purposes of this paper. Firstly, it deals with expectation formation. Secondly, it will be tested whether the expectation has a significant role in determining the current exchange rate in the case of Indonesian currency against the US dollar and Euro. This research will compare two kinds of expectation formation. Firstly, the expectation built from the fundamental economy is known as rational expectation formation. Secondly, the expectation formulated from past time series information, the Auto Regressive Moving Average (ARMA) model, is utilized. The steps to prove the role of expectation are stationary process, degree of integration, co-integration, and U-Theil's Inequality Coefficient Test (UTIC). It is found that both kinds of expectation formation have essential roles in determining the current exchange rate in Indonesia. However, according to UTIC criteria, a rational expectation better explains both current exchange rate movements.

Keywords: rational expectation, expectation formation, exchange rate, interest differential

JEL : F31, F37, G41

DOI : 10.24002/kinerja.v27i1.6926

Received : 02/07/2023 Reviewed: 02/25/2023 Final Version: 03/02/2023

1. INTRODUCTION

According to the Rational Expectation Hypothesis, if all agents use all available information, the economic agents will not make a systematic error. Consequently, what agents expect in the past will generally be an unbiased predictor of current events (Holden, Peel, and Thompsons, 1985; Kallianiotis, 2018). On the other hand, if agents' expectation is biased and rational, they will incorporate the bias into their expectations and therefore eliminate it (Harvey and Quinn, 1997; Tfaily, 2018). A considerable amount of studies, especially in the field of International Finance, show that the expectation of agents on the exchange rate is a biased predictor of the actual exchange rate (Hamzaoui and Regaieg, 2016) (Maitra, 2016). Miah, Hassan and Alam (2004) studies on the causes of the bias found that there are two categories of sources of the bias. The first bias is time varying risk premium (Fama, 1984), and the second is the failure of rational expectations by the agents (Kallianiotis, 2018; Arlt and Mandel, 2017).

One possibility to reveal the cause of the bias is a study using a data survey. Since time varying risk premium is due to time series data, a study using data survey is free risk premium bias. So if the study reveals the bias, the bias must be due to rational expectation formation (Miah, Hassan and Alam, 2004). A study using data survey done by Krasker (1980) failed to prove the cause of the bias. The failure to prove the bias could be because of the "peso problem." Peso problem is actually a statistical problem because of the small sample. Since Shareef and Shijin (2016) revealed that the short-term interest rate and past value of the spread between short-term and long term exchange rate cause the bias in the case of the expectation hypothesis in India. Moon (2018) proves that the model utilized to generate the rational expectation variable itself breeds the bias. According to Gujarati and Porter (2009), a small sample tends to result in high variances. The smaller the sample size, the smaller the denominator is, so the average variances tend to be high.

There are two kinds of behavior in expectation formation. They are adaptive and rational expectations. In adaptive expectation is assumed that economic agents use only past exchange rate data to predict future exchange rates (Kallianiotis, 2017). Otherwise, in the rational expectation formation, it is assumed that economic agents consider all information available in their decision-making for trading foreign currencies. This paper it is going to prove which kind of expectation is closely related to the realization of exchange rate behavior in Indonesia. If economic agents use all information available, they are rational. On the other hand, if economic agents use only past data of foreign exchange, they are called irrational.

2. LITERATURE REVIEW

2.1. Theoretical Background

Several studies revealed the relationship between the spot exchange rate and the expected exchange rate through the theory of interest parity (Harvey, 2006; Bhargava, Dania, and Malhotra, 2011; Arlt and Mandel, 2017; Ishioro, 2014). The studies stated that the return of assets worldwide must be identical once expected exchange rate movements are considered. The statement could be formulated mathematically such as;

$$RC_t(1+id_t) = \left(\frac{RC_t}{ER_t}\right)(1+if_f)E_t(ER_{t+1}) \qquad (1)$$

The left side of the equation is the interest-bearing assets domestically, and the right side is the interest-bearing assets in a foreign currency. RC is the nominal value of the asset in terms of domestic currency, and id_t is the domestic interest rate. The notion of $\left(\frac{RC_t}{ER_t}\right)$ is the nominal value of the assets in foreign currency, where ER_t is the spot exchange rate; if_t is the foreign interest rate, and E_t (ER_{t+1}) is the expected exchange rate in time t when the assets are on maturity.

If the return on interest-bearing assets domestically is higher than that in a foreign country, then there are capital flows from the foreign country to the domestic country. Reversely, if the return on interest-bearing assets domestically is lower than that in a foreign country, there is capital outflow. If the return of interest-bearing assets of both countries is equal, then the equilibrium of the capital market is reached. There is no tendency for capital movement. The equilibrium condition is represented by equation (1). Equation (1) mathematically could be reformulated into equation (2).

$$ER_t = \left(\frac{1+if_t}{1+id_t}\right)E_t(ER_{t+1}) \quad (2)$$

When people expect future exchange rate tends to increase, people will borrow money and buy foreign currency. The foreign currency will be deposited, and set the deposit's due date in time t+1 when they need the foreign currency. Therefore, the domestic interest rate and spot rate tend to increase. When people expect the future exchange rate increases, the spot rate tends to increase.

People's expectation in time t for the future exchange rate in time t+1 is not always precisely equal to the spot rate in time t+1 (Da Costa, Issler and Matos, 2015; Hamzaoui and Regaieg, 2016). According to rational expectation, if people have perfect information, even people's expectation of the exchange rate is not always equal to the spot rate. Still, on average, the expectations are correct. People make mistakes, but generally, people will make a correct prediction (Wickremasinghe, 2016).

Another study shows that the exchange rate could be explained by price differential among countries. The theory is so-called Purchasing Power Parity (PPP), which is usually associated with the idea of a Swedish economist, Gustav Cassel, in 1916 (Chacoliades, 1990). The theory is based on the idea that a bundle of money should purchase the same representative bundle of commodities in different countries. There are two theories of PPP. The theories are absolute and relative versions of PPP. In this paper, it is going to be quoted the relative version of PPP. The formulation of the relative version of PPP is as follows.

$$ER_t = \frac{(P_t / P_{t-1})}{(P_t^* / P_{t-1}^*)} ER_{t-1} \quad (3)$$

Equation (3) revealed that the current Exchange Rate (ERt) is determined by the price differential of both countries and by the previous Exchange Rate (ERt-1). Pt represents the current domestic price, and Pt* (Pt with star) represents the current foreign price. If inflation is higher domestically than of the foreign partner, the upper part of the left side of the equation will be higher than the lower part. With a certain value of the past exchange rate (ERt-1), domestic inflation will bring about import pressure. Demand for foreign currency will increase, so the current exchange rate tends to have deteriorated (ERt increases).

A similar situation happens. If the inflation of a foreign country is higher than that of a domestic country, the upper side of the left side of the equation is lower than that of the lower side. As a result, demand for export and supply of foreign currency increases. In return, the domestic currency is strengthened. On the right side of the equation, the current exchange rate (ERt) is lower than the past exchange rate (ERt-1). Equation (3) could be reformulated reversely into equation (4).

$$ER_{t-1} = \frac{\left(P_t^* / P_{t-1}^*\right)}{\left(P_t / P_{t-1}\right)} ER_t \qquad (4)$$

If the time dimension of equation (4) is shifted one period ahead, equation (4) could be reformulated, such as below.

$$ER_t = \frac{\left(P_{t+1}^* / P_t^*\right)}{\left(P_{t+1} / P_t\right)} E(ER_{t+1}) \qquad (5)$$

Equation (5) implies that the current exchange rate is determined by the expected price differential of both countries and by the expected exchange rate. For a certain value of the expected price differential of both countries, the current exchange rate tends to increase if the expected exchange rate increases.

From both theories, it could be concluded that both countries' interest and price differential determine the current exchange rate. Interest differential influences the current exchange rate through capital flow, and price differential affects the current exchange rate through the trade flow of both countries.

Throop (1993) developed the exchange rate theory, which combines both interest and price differential. He started with the theory of uncovered interest parity (UIP). He formulated that the current exchange rate is determined by price differential (P_t*-P_t), real interest rate differential (id_t-if_t*), and the real expected exchange rate E(RER_{t+1}). PR is risk premium.

$$ER_t = PR + \beta_1 (P_t^* - P_t) + \beta_2 \left(id_t - if_t^*\right) + \beta_3 E(RER_{t+1}) \qquad (6)$$

Since Troop's theory (Throop, 1993) is under Covered Interest Parity, the theory predicts that when the market mechanism is perfect, which is represented by perfect capital and commodity movement between trade partners, expected exchange rate will be a good predictor for the current exchange rate, except for the possible of risk premium (PR). According to the Sticky Price Monetary Model (Engel, 1999), the premium is associated with the price in the market for goods adjusting to disturbance more slowly than the price in the market of financial assets. In the light of the models, Purchasing Power Parity holds in the long run when prices are able to adjust fully. On the other hand, deviations from Purchasing Power Parity occur in the short run. The deviations, characterized by the premium, are associated with a temporary differential between the real interest rate at home and abroad.

2.2. Expectation Formation

In this section, it will be discussed the concept and formation of expectation. The purpose of expectation formation is to estimate the expectation variable and to prove that the variable has a significant role in determining the current exchange rate. Two types of expectations are going to be formulated in this section. They are adaptive and rational expectation models.

The concept of the adaptive model is that the model of expectation formation involves only past values of the dependent variable. One of the critical approaches to the adaptive model is the Koyck model (Gujarati and Porter, 2009). There are at least three rationalizations of the Koyck model. They are Adaptive Expectation

Model, Stock Adjustment Model, and Partial Adjustment Model. The rationalization of the adaptive model is as below

$$ER_t = \alpha + \beta EER_t \quad + \varepsilon_t \tag{7}$$

Equation (7) reveals that the current exchange rate, ERt, is determined by the expected exchange rate (EERt). In the spirit model of adaptive expectation, the expected exchange rate is formed only by the past exchange rate value (Echavarria and Villamizar-Villegas, 2016; Arlt and Mandel, 2017; Harvey and Quinn, 1997) as below.

$$EER_t - EER_{t-1} = \emptyset\{ER_t - EER_{t-1}\} \tag{8}$$

The above equation shows the adaptive process of expectation. Expectations will change if there are biases in the past expectation. The coefficient of theta (θ) is the adjustment coefficient of the expectation. With simple mathematical manipulation, equation (8) is substituted into equation (7). The result could be formulated in equation (9) below

$$ER_t = \pi_0 + \pi_1 ER_{t-1} + u_t \tag{9}$$

Where π_0 and π_1 are composite of the coefficient of adjustment. Constant $\pi_0 = \frac{\alpha_0 - \emptyset}{1-\alpha\emptyset}$ and $\pi_1 = \frac{1-\emptyset}{1-\emptyset\alpha}$ (Gujarati and Porter, 2009).

The idea of a solution for adaptive expectation models is commonly using Auto-Regressive (AR), Moving Average, Auto-Regressive Moving Average, Auto-Regressive Integrated Moving Average, and Vector Auto-Regression (VAR) models (Gujarati and Porter, 2009). Choices for the solution of adaptive expectation are actually finding the best realization for the past data. Every data has its pattern of completion

The formulation for rational expectation is based on theory (Leitner and Schmidt, 2007). In this case, the solution for the formation of rational expectation will be called reduced form. In the case of rational expectation on the future exchange rate, equation (6) could be recalled. The exchange rate is determined by price and interest differential and by its expectation of the future exchange rate.

$$ER_t = PR + \beta_1(P_t^* - P_t) + \beta_2\left(id_t - if_t^*\right) + \beta_3 EER_{t+1}$$

Since it is assumed that there is long run one to one equilibrium in equation (6), so equation (6) could be reversed (Chiang and Wainwright, 2005). If the time dimension shifted back one period, the equation could be reformulated, such as in equation (10).

$$ER_t = -PR - \beta_1(P_{t-1}^* - P_{t-1}) - \beta_2\left(id_{t-1} - if_{t-1}^*\right) + \phi ER_{t-1} \tag{10}$$

Equation (10) is a first-degree of difference equation. The general solution for the difference equation will be as presented in equation (11) (Maryatmo, 2005).

$$ER_t = -\sum_{i=0}^{i=\infty}\phi^i PR - \sum_{i=0}^{i=\infty}\beta_1\phi^i(P_{t-i}^* - P_{t-i}) - \sum_{i=0}^{i=\infty}\beta_2\phi^i\left(id_{t-i} - if_{t-i}^*\right) \tag{11}$$

Equation (11) is a reduced form. The reduced form could be used to estimate the expected exchange rate, formulated by the Interest and Purchasing Power Parity theory. The expected value of equation (9) is a good predictor for future expectations of the exchange rate as it is predicted by economic theory.

3. METHODOLOGY

The purpose of this study is to prove that expectation of the future exchange rate is a good predictor of the current exchange rate. Besides co-integration approaches, which researchers on financial economics commonly use, It is introduced an informal-statistical way to prove that expectation on the future exchange rate is a good predictor for the current exchange rate. An informal-statistical method introduced is U-Theil's Inequality Coefficient (UTIC) (Pindyck and Rubinfeld, 1991).

In this paper, there are fourteen variables involved. The variables are the Rupiah to USD and Euro exchange rate, interest rate, inflation, economic growth of both countries, and created variables expected exchange rate of USD and Euro to rupiah. The quarterly data for the period from 2001: 1 to 2018:1 were downloaded from the Official website of Bank Indonesia (BI, 2018).

In this research, time series data are employed. Since the research deals with time series data, before the co-integration method can be applied, it is required to run the stationary test and to find the degree of integration of the series. Therefore, the augmented Dickey Fuller (ADF) test is utilized to test the stationary of the series. ADF test is actually the development of Dickey Fuller (DF) test, which ensures that the residual is not auto-correlated by adding as much lag of the first difference terms. The model of ADF is as follows (Gujarati and Porter, 2009).

$$\Delta y_t = \alpha + \beta_0 t + \beta_1 y_{t-1} + \beta_{2+i} \sum_{1}^{i} \Delta y_{t-i} + \mu_t \qquad (12)$$

To test the stationary of the series (y_t), it will be applied the hypothesis as suggested by Hill, Griffiths and Lim (2008) that,

$H_0 : \beta_1 = 0,$

$H_a : \beta_1 \neq 0$

If $\beta_1 = 0$, since $\beta_1 = (\rho - 1)$, it is implied that the coefficient of autocorrelation, $\rho = 1$, or it is said the series is unit root. If $\beta_1 \neq 0$, it is implied that the series is stationer. A variable is called degree of integration one, if non-stationer variable is stationer after it is differenced once. If a variable is differenced twice to be stationer, the variable has degree of integration two.

If all variables are stationer with degree of integration zero, the model of (9) and (11), representing the expectation formation, could be done. If the variables are not stationer, they could be differenced to be stationer. If the variables are not stationer and have degree of integration one, so co-integration approach could be applied (Engle and Granger, 1992). If the variables are not stationer and have different degrees of co-integration, Auto Regressive Distributed Lag (ARDL) could be applied (Hill, Griffiths and Lim, 2008).

The equation to test the co-integration mathematically could be written as follow.

$$ER_t = \beta_0 + \beta_1 EER_{t+1} + \varepsilon_t \quad (13)$$

Where ER_t is the current exchange rate, EER_{t+1} is the expectation of future exchange rate, and β_0 is expected equal to zero, and β_1 is expected equal to one. The first step is proving that the above equation is co-integrated (Kozul, 2013; Harvey and Quinn, 1997).

If variables ER_t and EER_{t+1} are co-integrated, the residual of the above equation will be stationary. To prove that the residual of the above equation is stationer, Augmented Dickey Fuller Test (ADF) could be employed (Pindyck and Rubinfeld, 1991). The general form of ADF could be performed by running the formula below.

$$\Delta\varepsilon_t = \varphi_0 + \varphi_1 \varepsilon_{t-1} + \sum_{i=1}^{i=n} \varphi_{1-i} \Delta\varepsilon_{t-i} + \mu_t \quad (14)$$

With hypothesis : $H_0 : \phi_1 = 0$

$H_a : \phi_1 \neq 0$

Where $\phi_1 = \rho - 1$, and ρ is coefficient of autocorrelation.

From the above equation, ε_t is considered as unit root, if $\phi_1 = 0$. Since $\phi_1 = (\rho - 1)$ and $\phi_1 = 0$, ρ, which is the coefficient of the autocorrelation function of error, is equal to one or unit (1). If $\rho = 1$, ε_t will tend to be higher or lower than ε_{t-1} because off the random shock, μ_t. So if $\phi_1 < 0$, ρ will be less than a unit ($-1 < \rho < 1$). If ($-1 < \rho < 1$) ε_t tends to be equal to ε_{t-1} or the condition is stable. The condition that ε_t tends to be stable is called the condition of stationary. If ε_t is stationary, equation (13) is co-integrated. Consequently, it can be proved that expectation on the future exchange rate, EER_{t+1}, is a good predictor of current exchange, ER_t, if in equation (14) $\beta_0 = 0$, and $\beta_1 = 1$.

Because there are two expectation variables derived, it could be raised a question of which kind of expectations well-explain the current exchange rate. This paper introduces U-Theil's Inequality Coefficient (UTIC) to judge which kind of expectation explains better current exchange rate. The concept of UTIC is comparing between actual and forecasted series. The better the fit expectation variable to actual data, the lower the difference, and the smaller the value of UTIC. The formula of UTIC, as suggested by Pindyck and Rubinfeld (1991), could be written as follow

$$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^s - Y_t^d\right)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^s\right)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^d\right)^2}} \quad (15)$$

T is the number of observations, Y^s and Y^d both consecutively are actual and forecasted data. The value of U will always fall between O and 1. If U = 0, the actual and forecasted data are close. If U =1, the actual and forecasted data do not fit.

4. RESULT AND DISCUSSION

There are four steps for confirming that expectation has an important role in determining the exchange rate in Indonesia. The first step is finding the degree of integration and stationer of the series involved in the study. The second step is the expectation formation of the exchange rate in Indonesia. The third step is testing the role of the expectation through the co-integration test. The final step is testing the role of the expectation through the informal statistical test U Theil's Inequality Coefficients.

4.1. Stationary Test and Degree of Integration

There are eight variables involved in this study. Three of them are stationary on the level. Five of them have degree of integration one.

Table 1. Stationary Test and Degree of Integration

No	Variable Name	Model	t Statistic of rho (ρ)	Conclusion
1	ER_t	With trend and drift	-2.154504	Unit Root
	D(ER_USD)	None	-2.292098***	Stationary on first difference
2	INFL_US	With trend and drift	-2.983663*	Stationer on Level
3	IR_US02	None	-1.138877	Unit Root
	D(IR_US02)	None	-6.358453****	Stationary on first difference
4	GR_US	None	-1.234698	Unit Root
	D(GR_US)	None	-6.696613	Stationary on first difference
5	IR_INDBU	With drift	-3.661518***	Stationary on level
6	GR_INDO	With drift	-3.674169****	Stationary on level
7	EER1t+1	With trend and drift	-2.522005	Unit Root
	D(EER1t+1)	None	-6.974132****	Stationary on first difference
8	EER2t+1	With trend and drift	-2.452595	Unit Root
	D(EER2t+1)	None	-7.516528****	Stationary on first difference
9	ER_EUROt	With trend and drift	-2.553771	Unit Root
	D(ER_EURO)t	None	-8.070161*	Stationary on first difference
10	INF_EUROt	With Drift	-3.031457	Unit Root
	D(INF_EURO)t	None	-6.672056****	Stationary on first difference
11	IR_EUROt	None	-1.581840	Unit Root
	D(IR_EURO)t	None	-4.775683****	Stationary on first difference
12	GR_EUROt	None	-3.237611****	Stationary on level
13	$ARER\_EUROFt_{+1}$	With trend and dritf	-2.354632	Unit Root
	$D(ARER\_EUROF)t_{+1}$	None	-7.263625****	Stationary on first difference
14	RE_EUROFt_{+1}	With trend and drift	-2.407211	Unit Root
	$D(RE\_EUROF)t_{+1}$	None	-7.826485****	Stationary on first difference

Note: The sample period is spanned from 2001:1 to 2018:1. Symbols of *, ***, and **** indicate that the statistics are significant at the risk of 0.15, 0.05, and 0.01 levels, respectively. Source: Bank Indonesia (2022).

The variables are the Exchange Rate of rupiah to US dollar (ER_t), US inflation rate (INFL_US), US interest rate (IR_US), US economic growth (GR_US), Domestic Interest Rate of Indonesia (IR_INDOBU), Domestic Economic Growth of Indonesia (GR_IND), Adaptive Expectation ($EER1_{t+1}$), Rational Expectation Variable ($EER2_{t+1}$), Exchange Rate of rupiah to Euro (ER_EURO_t), Inflation Rate of European Countries (INF_EURO_t), Interest Rate of European Countries (IR_EURO_t), Economic Growth of European Countries (GR_EURO_t), Adaptive Expectation for EURO exchange rate ($ARER\_EUROF_{t+1}$), and Rational Expectation for EURO (RE_EUROF_t). Variable

INFL_US, GR_IND, IR_INDOBU, and GR_EURO are stationary on level. Since the other variables have degree of integration one, the result of the ADF test can be accessed in Table 1.

4.2. Expectation Formation

There are two different approaches to expectation formation. The first is that expectation is formulated through only past data, commonly known as adaptive expectation. Through econometrically-sound theory, the influence of the series of past data on USD and EURO could be formulated to Adaptive Expectation Model (AEM). For the empirical approach, Model ARMA is utilized. Basically ARMA model is a model that the value is determined only by its owned past value. All variables involve in ARMA are stationers. The estimation result of ARMA model can be presented in Table 2.

Table 2. Estimation Result for ARMA Expectation Formation of US Dollar and Euro to Rupiah Exchange Rate

US DOLLAR			**EURO**		
Indep Vars	**Coefficients**	**t stats**	**Indep Vars**	**Coefficients**	**t stats**
C	13.26209	1.253906	C	200.6463	2.948889***
D(ER(-1))	0.446910	4.132450***	D(ER_EURO(-1))	-0.456048	-4.531332***
D(ER(-2))	-0.023610	-1.277731	D(ER_EURO(-2))	-0.528742	-5.306906***
EROR	0.936159	49.20610***	RESEURO	0.499472	7.527401***
EROR(-1)	-1.389153	-12.93397***	RESEURO(-4)	-0.504710	-7.625800***
EROR(-2)	0.454761	4.374675***			
R Squares	0.976244		**R Squares**	0.560448	
DW	2.077632		**DW**	2.012606	
F Statistic	5316.071***		**F Statistic**	19.12564***	

Note: The sample period is spanned from 2001:1 to 2018:1 *, ** and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively. Source: Bank Indonesia (2022).

The estimation results are well fit with R Squares 0.976244 and 0.560448 consecutively. Both models are soundly free of autocorrelation problems. Durbin Watson's statistics are 2.077632 and 2.012606. Overall, the models of expectation are good, with the F test statistically significant both in $\alpha = 0.01$ %. The model is the best fit, meaning that the data is well-forecasted by the model. The weakness is that the models are determined by their own past values. The forecast is biased upward when the trend is downward, and they are biased downward when the trends are upward. In the long run, since the environment of the economy change, the models which are determined by their past value could not follow the change in the trend. However, the co-integration test proves that both residuals of the model are stationer.

The second expectation formation is the rational expectation approach. In the scheme of rational expectation, it is assumed that all agents decide to buy or sell foreign currencies using all information available when the decision is made. It is assumed that information is perfect. In the sense of rational expectation in the exchange rate, it is assumed that all economic agents know the economic structures which determine the exchange rate. Using equation (11), the rational expectation of the exchange rate could be estimated. Since several variables involved have different degrees of integration, so one possible estimation approach is the ARDL model (Hill, Griffiths and Lim, 2008). The results are presented in Table 2.

The estimation result of rational expectation formation for the exchange rate of the US dollar to rupiah is well fit with R^2= .93. The statistic of Durbin Watson is 2.020251, which implies that there is no autocorrelation in the exchange rate. The value of the F statistic is 111.3099, which is statistically different from zero. It could be concluded that economic agents utilize past and recent information to form their expectations of future exchange rates.

The predictor variables for US dollar exchange rate are INFL_US, IR_US02(-2), GR_US(-3), IR_INDBU(-4), GR_INDO, and GR_INDO(-4). INFL-US is inflation in the US. IR_US02(-2) is the nominal interest rate in the US with a time lag of two (2) quarters. GR_US(-3) is the economic growth rate in the US with three (3) a quarters time lag. IR_INDBU(-4) is the nominal interest rate of a three-month time deposit in public banks in Indonesia with a time lag of four quarters or one year behind. GR_INDO and GR_INDO(-1) are current and past economic growth rates consecutively.

Table 3. Estimation Result For Rational Expectation Formation For Exchange Rate of US Dollar and Euro to Rupiah

	US DOLLAR			EURO	
Indep Vars	**Coefficients**	**t stats**	**Indep Vars**	**Coefficients**	**t stats**
C	1163.407	0.935633	**C**	3914.610	3.066792***
IR_US02(-2)	-90.24222	-1.661085	**INFL_IND(-4)**	-99.41059	-2.429107**
INFL_US	-19.37031	-0.311448	**INF_EURO**	-323.9106	-1.842579*
GR_US(-3)	53.58744	1.392397	**IR_INDBU**	-102.2105	-1.805678*
GR_INDO	-94.90192	-0.721679	**GR_EURO(-3)**	81.58715	1.821499*
GR_INDO(-1)	127.3770	1.156354	**IR_EURO(-1)**	279.3778	2.057876**
IR_INDBU(-4)	-18.66039	-0.504300	**ER_EURO(-1)**	0.825378	13.02324***
ER(-1)	0.928612	17.62961***			
R Squares	0.931832		**R Squares**	0.897604	
DW	2.020251		**DW**	2.065503	
F Statistic	111.3099***		**F Statistic**	84.73797***	

Note: The sample period is spanned from 2001:1 to 2018:1 *, ** and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively. Source: Bank Indonesia (2022).

The predictors for the Euro exchange rate are domestic inflation, INF_IND(-4), inflation in Euro countries, INF_EURO, domestic interest rate, IR_INDBU, economic growth of European countries, GR_EURO(-3), the interest rate of European countries (IR_EURO), and past time lag of Euro exchange rate (ER_EURO(-1).

4.3. Co-integration Approach for Rationality Test

After the expectation variables are formulated, the test for rationality through the co-integration approach could be processed. Variables exchange rate (ER) and adaptive expectation on the exchange rate (EER1 and EER2) have degree of integration one. Employing equation (13), the co-integration approach for the rationality test could be executed. The result of the co-integrated equation of the current exchange rate on adaptive expectation variables can be presented below.

The model in Table 4 indicates that the current exchange rate (ERt) is explained by the expectation of future exchange rates (EER1t+1 and $AREUROF3_{t+1}$)) which are formulated through adaptive expectation process. According to the estimation result in Table 4, the expectation variable explains the actual exchange rate well. Constanta (C) is not significant, and coefficient of the expectation of future exchange rate is significantly different from zero, and the value of the coefficient of expectation is close to one. The R squares are relatively high.

As expected, the test of the rationality of the expectation model hold. The coefficient of expectation of future exchange rate is close to one, but the constant (C) is not significantly different from zero as it is theoretically predicted for both cases of the exchange rate, US dollar and Euro. If economic agents expect future exchange rate increases, current exchange rate will also increase by close to one or precisely are 0.93244 for US dollar exchange rate, and 0.984253 for Euro exchange rate, respectively. The Augmented Dicky Fuller (ADF) test also settled that the residuals of both model are stationary.

Table 4. Co-integration Approach for Rationality Test Using ARMA(1) Expectation Formation

	US DOLLAR			**EURO**	
Indep. Vars	**Coefficients**	**t stats**	**Indep. Vars**	**Coefficients**	**t stats**
C	639.8141	1.750664	**C**	94.06659	0.220540
$EER1_{t+1}$	0.932444	26.89247***	**$AREUROF3_{t+1}$**	0.984253	30.11471***
R Squares	0.918700		**R Squares**	0.933120	
DW	1.730346		**DW**	1.008734	
F Statistic	723.2047***		**F Statistic**	906.8955***	

Note: The sample period is spanned from 2001:1 to 2018:1 *, ** and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively. Source: Bank Indonesia (2022).

Harvey and Quinn (1997) argue that future expectation, which is adaptive expectation explains well the variation of current exchange rate because there is two ways causality between current and future expected exchange rate. Hadad and Pancaro (2010), as reported in Perry and Juhro (2016), testify that the rupiah depreciation is followed by the worsening the balance of payment, so it triggers further depreciation as predicted by Marshal-Lerner theory (Jafari, Ismail and Kouhestani, 2011). Tasseven (2017) claims that bubbles possibly happen in the short run and in the long run it will reach equilibrium.

The second co-integration approach uses exchange rate expectation variable, which formation uses all information available in the economy. Such formation of expectation is called rational expectation. The result of the estimation can be reported below.

Table 5. Co-integration Approach for Rationality Test Using Rational Expectation Formation

	US DOLLAR			**EURO**	
Indep. Vars	**Coefficients**	**t stats**	**Indep. Vars**	**Coefficients**	**t stats**
C	-62.08771	-0.400369	**C**	-581.5126	-1.915507*
EER_{t+1}	1.001007	67.98127***	**ER_EUROF3_{t+1}**	1.035557	44.85031***
R Squares	0.986551		**R Squares**	0.969632	
DW	0.650628		**DW**	0.705834	
F Statistic	87.02484***		**F Statistic**	2011.550***	

Note: The sample period is spanned from 2001:1 to 2018:1 *, ** and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively. Source: Bank Indonesia (2022).

The estimation results show that constants are not significantly different from zero with α = 0.05, and the coefficient of expectation of exchange rate is statistically equal to one. Both statistic tests indicate that the expectation of future exchange rate for US dollar ($EER2_{t+1}$) and Euro ($AREUROF3_{t+1}$) well explain the current exchange rate (ER_t). Both expectations are well fit with the current exchange rate. Both expectations are co-integrated with the current exchange rate. In order to judge which kind of expectation is better to predict the current exchange rate, UTIC criteria will be utilized.

4.4. U-Theil's Inequality Coefficients (UTIC)

The estimation result revealed that the constant is not significantly different from zero, and the coefficient of expectation of exchange rate is statistically equal to one. Both statistical tests indicate that the expectation of future exchange rate (EER2t+1) well explains the current exchange rate (ERt). Therefore, both expectations are well-explaining the current exchange rate. Moreover, both expectations are co-integrated with the current exchange rate. To judge which kind of expectation is better, UTIC criteria are applied.

Basically, UTIC calculates the gap between the actual and the predicted variables. UTIC not only judges the closeness of the predicted to the actual but also considers the ability of a model to follow the turning point of the actual data. Theoretically, the rational expectation will follow the turn better than the adaptive expectation that will always be late in reacting to the turning point of the actual data. From the calculation, the result of the UTIC is as follows. From the UTIC result, it could be concluded that the rational expectation variable is a better well-fit and follows the turn of the actual exchange rate than the adaptive expectations.

Table 6. U-Theil's Inequality Coefficients

No	Expectation Variables	U-Theil's Coefficient	
		US Dollar	Euro
1.	Adaptive Expectation	0.029993	0.039671877
2.	Rational Expectation	0.022516	0.015015384

Source : Bank Indonesia (2022)

5. CONCLUSION

The expectation is an unobservable variable. For the purpose of this research, the expectation variables are created and formulated. There are two forms of expectation variables. They are adaptive expectations and rational expectations. The adaptive expectation is estimated using Auto Regressive Moving Average (ARMA) Model. The Rational Expectation Model is estimated using variables involved in Interest Parity and Purchasing Parity Theories. Both forms of expectation variables are statistically well-estimated.

From the two forms of expectation, the adaptive expectation and the rational expectation variable of exchange rate are both co-integrated with the current exchange rate. Since economic agents are rational, the expected rate of exchange rate will equal the future of the current exchange rate. On the other hand, if economic agent expectation is adaptive, the expectation is influenced by the current exchange rate, so there is a two-way causality relationship between the current exchange rate and the adaptive expectation on the exchange rate.

Both expectation variables are well-fit and follow the turn of the actual exchange rate. The UTIC result shows that the rational expectation surpasses the adaptive expectation variables in explaining the variation of the current exchange rate. Indonesian economic agents are still rational in formulating their expectations on exchange rates.

The domination of rational expectation in determining the current exchange rate is the one explanation for the continuous depreciation of the rupiah and appreciation of the dollar since the formation of rational expectation is dominated by the past value of the exchange rate. When the current exchange rate of the rupiah is weakening, economic agents tend to buy more strong currencies such US dollar and Euro. As a result, the US dollar and Euro are further strengthened. This is because the US dollar and Euro are the strongest foreign currency in Indonesia. Agents tend always to buy strong currencies such as the US dollar and Euro because the US dollar and Euro are one of the safest assets for Indonesian economic agents.

The conclusion that the rational expectation on the future exchange rate is better in explaining the variation of the current exchange rate using UTIC is not a formal test. Therefore, the conclusion could not be generalized. The next research agenda should develop a formal test to get the conclusion of which expectation is better in explaining the variation of current exchange rate.

REFERENCES

Arlt, J. and Mandel, M., 2017. An empirical analysis of relationships of forward exchange rates and present and future spot exchange rates: Example of CZK/USD and CZK/EUR. *Finance a Uver - Czech Journal of Economics and Finance*, 67(3), pp. 199–220.

Bhargava, V., Dania, A. and Malhotra, D.K., 2011. Covered interest rate parity among BRIC nations. *The Journal of Business and Economic Studies,* 17(1), p.37-81.

Bank Indonesia, 2018. *Statistik Ekonomi dan Keuangan Indonesia.* Available at: http://bi.go.id/statistik/statistik keuangan/statistik ekonomi dan keuangan Indonesia/SEKI.

Chacoliades, M., 1990. *International Economics*. Internatio. Singapore: McGraw-Hill Publishing Company.

Chiang, C. A. and Wainwright, K., 2005. *Fundamental Methods of Mathematical Economics*. 4th ed. New York: McGraw-Hill.

Da Costa, C. E., Issler, J. V. and Matos, P. F., 2015. A note on the forward and the equity premuim puzzles: Two symptoms of the same illness?. *Macroeconomic Dynamics*, 19(2), pp. 446–464. doi: 10.1017/S1365100513000400.

Echavarria, J. J. and Villamizar-Villegas, M., 2016. Great expectations? evidence from Colombia's exchange rate survey. *Latin American Economic Review*. Springer Berlin Heidelberg, 25(1), pp. 1–27. doi: 10.1007/s40503-016-0033-2.

Engel, C., 1999. On the Foreign Exchange Risk Premium in Sticky-Price General Equilibrium Models. *International Tax and Public Finance*, 6, pp. 491–505.

Engle, R. F. and Granger, C. W. J., 1992. *Long Run Economic Relationships:Readings in Co-integration*. New York: Oxford University Press.

Fama, E. F., 1984. Forward and Spot Exchange Rates. *Journal of Monetary Economics*, 14.

Gujarati, D. N. and Porter, D. C., 2009. *Basic Econometrics*. 9th ed. Singapore: McGraw-Hill.

Hamzaoui, N. and Regaieg, B., 2016. Exploration of the foreign exchange forward premiums and the spot exchange return: A multivariate approach. *International Journal of Economics and Financial Issues*, 6(2), pp. 694–702.

Harvey, J. T., 2006. Modelling Interest Rate Parity: A System Dynamics Approach. *Journal of Economic Issues*, XL(2), pp. 395–403. Available at: http://dx.doi.org/10.1016/j.jaci.2012.05.050.

Harvey, J. T. and Quinn, S. F., 1997. Expectations and rational expectations in the foreign exchange market. *Journal of Economic Issues*, 31(2), pp. 615–622. doi: 10.1080/00213624.1997.11505953.

Hill, R. C., Griffiths, W. E. and Lim, G. C., 2008. *Principles of Econometrics*. 3rd ed. New York: Willey and Son.

Holden, K., Peel, D. A. and Thompsons, J. L., 1985. *Expectations: Theory and Evidence*. New York: St.Matin'Es Press.

Ishioro, B. O., 2014. The dynamics of exchange rate expectations formation: The Nigerian perspective', *Ekonomska Misao I Praksa-Economic Thought and Practice*, 23(2), pp. 431–460.

Jafari, Y., Ismail, M. A. and Kouhestani, M. S., 2011. Determinants of trade flows among D8 countries: Evidence from the gravity model. *Journal of Economic Cooperation and Development*, 32(3), pp. 21–38.

Kallianiotis, I., 2017. Exchange Rate Movement: Efficiency in the Foreign Exchange Market. *International Research Journal of Applied Finance*, VIII(4), pp. 429–443.

Kallianiotis, I., 2018. Exchange rate expectations. *Journal of Applied Finance & Banking*, 2(2018), pp. 101–134.

Kozul, I., 2013. Co-integration analysis of purchasing power parity in Republic of Croatia. *UTMS Journal of Economics*, 4(3), pp. 253–268.

Krasker, W. S., 1980. The "peso problem" in testing the efficiency of forward exchange markets. *Journal of Monetary Economics*, 6(2), pp. 269–276. doi: 10.1016/0304-3932(80)90031-8.

Leitner, J. and Schmidt, R., 2007. Expectation formation in an experimental foreign exchange market. *Central European Journal of Operations Research*, 15(2), pp. 167–184. doi: 10.1007/s10100-007-0024-0.

Maitra, B., 2016. Monetary, real shocks, and exchange rates variations in India. *Journal of Economic Development*, 41(1).

Maryatmo, R., 2005. *Dampak Moneter Kebijakan Defisit Anggaran Pemerintah dan Asa nalar Dalam Simulasi Model Makro-Ekonomi Indonesia*. Yogyakarta: Penerbit Universitas Atma Jaya Yogyakarta.

Miah, F., Hassan, M. K. and Alam, S. M. I., 2004. Testing the rationality of exchange rate expectation: Evidence from survey data. *American Business Review*, 22(1), pp. 11–20.

Moon, S., 2018. Foreign exchange return predictability: Rational expectations risk premium vs. expectational errors. *SSRN Electronic Journal*, 22(4), pp. 467–505. doi: 10.2139/ssrn.3309048.

Perry, W. and Juhro, S. M., 2016. *Kebijakan Bank Sentral Teory dan Praktek*. Jakarta: PT Raja Grafindo Persaja.

Pindyck, R. S. and Rubinfeld, D., 1991. *Econometric Models and Economic Forcasting*. 3rd ed. New York: McGraw Hill.

Shareef, H. and Shijin, S., 2016. Expectations hypothesis and term structure of interest rates: An evidence from emerging market. *Asia-Pacific Financial Markets*. Springer Japan, 23(2), pp. 137–152. doi: 10.1007/s10690-016-9212-z.

Tasseven, Z., 2017. Bubbles in the Middle East stock markets. *International Journal of Economic Perspective*, 11(3), pp. 304–314.

Tfaily, A., 2018. Economic fundamentals over long and short horizons. *Review of International Comparative Management*, 19(2), pp. 167–174. doi: 10.24818/rmci.2018.2.167.

Throop, A. W., 1993. A generalized uncovered interest parity model of exchange rates. *Economic Review*, 2, pp. 3–16.

Wickremasinghe, G.B., 2016. Efficiency of foreign exchange market of Sri Lanka: some empirical evidence. *Economics, Management, and Financial Markets,* 11(4), pp.49-60.