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FORECASTING INDONESIAN MONEY DEMAND FUNCTION WITH AUTOREGRESSIVE DISTRIBUTED LAG (ARDL)MODEL

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ABSTRACT

This study analyzes the demand for money in Indonesian economy using autoregressive distributed lag (ARDL) cointegration model. The determinant variables used in this study are real income, inflation, exchange rates, and dummy variables for capturing financial shocks in domestic economy. The empirical results show that the coefficient of the determinants provide a significant and expected result; in the M1 money demand model exists a significant evidence of cointegration relationship between M1 and its determinant variables. M1 Model passes necessary diagnostic and stability test and show a satisfied forecasting result with small deviation from its actual value. On the other hand, M2 money demand model shows no evidence of long-run relationship and fail to pass the stability test. This results show the empirical evidence that M1 is more reliable to use as a money demand variable to design an effective monetary policy in Indonesia.

Studi ini menganalisis permintaan uang di Indonesia dengan menggunakan model kointegrasi autoregressive distributed lag *(ARDL). Variabel determinan yang digunakan adalah pendapatan riil, inflasi, nilai tukar, dan variabel* dummy *untuk mengakomodasi* financial shocks *dalam ekonomi domestik. Hasil studi empirik membuktikan bahwa variabel-variabel determinan menunjukkan hasil sesuai dengan yang diharapkan dan cukup signifikan; pada model permintaan uang M1 terdapat hubungan kointegrasi yang cukup signifikan antara M1 dan determinannya. Model M1 telah lulus uji* diagnostic *dan uji stabilitas serta menunjukkan deviasi yang kecil antara angka prakiraan dengan angka aktualnya. Disisi lain, model permintaan uang M2 tidak menunjukkan keberadaan hubungan jangka panjang dan tidak dapat melalui uji stabilitas dengan baik. Hasil tersebut merupakan bukti empirik yang mengindikasika bahwa untuk merancang kebijakan moneter yang efektif, M1 lebih handal untuk digunakan sebagai variabel permintaan uang di Indonesia.*

1. INTRODUCTION

Money demand can be used as an important indicator for economic growth in a country. The ability to determine money demand is one significant factor to perform optimum monetary policy. When the output of one economy is increasing, money demand is also increasing due to the increase of the transaction and consumption. On the other hand, when interest rate is increasing, people are more willing to hold other asset that gives return instead of money that has zero return.

The demand for money depends on the choices made by the economic actors on their portfolio problem. This problem can be solved by choosing optimum allocation of wealth either on money or on non-monetary assets. Both have their own positive and negative aspects. Money has the liquidity to perform transactions, but it does not earn any interest, while non-monetary asset is on the other way round. In other words, the decision to hold money depends on how much people value liquidity over return.

Several studies have been conducted on money demand on different economy. Studies conducted on developed economy such are: United States (Hafer and Jansen (1991), McNown and Wallace (1992)); Germany (von Hagen (1993), Hansen and Kim (1995)), Bahmani-Oskooee and Bohl (2000)); United Kingdom (Adam (1991) and Johansen (1992)); Japan (Bahmani-Oskooee and Shabsigh (1996)). However, there are also studies on developing economy such are: Iran (Bahmani-Oskooee (1996)), Shrestani-Renani (2007); Rusia (Bahmani-Oskooee and Barry (2000)); Yugoslavia (Frenkel and Taylor (1993)); Cambodia (Samreth (2008)), and China (Hafer&Kutan (1994)). The silver lining of the finding on those studies is the existence of cointegration relation between broad money (M2) with interest rate and income using Johansen (1988) and Johansen and Juselius (1990) cointegrating techniques.

As for Indonesian economy, several studies have been conducted with different results. Price and Insukindro (1994) conducted Engle-Granger, Johansen, and error correction (ECM) on periode 1969Q1-1987Q4 and found that the existence of cointegration relationship is different with different methods. Lestano, Jacobs and Kuper (2009) used autoregressive distributed lag (ARDL) model using period 1980Q1-2004Q2 and found that narrow money (M1) is more stable than broad money (M2) using real domestic income, nominal domestic interest rate, nominal foreign interest rate, and real exchange rate as the independent variables. Achsani (2010), in his study on stability of money demand in Indonesia for period 1990Q1-2008Q3, performed vector error correction model (VECM) and ARDL model using real income, interest rate, and error term as the independent variables. He found that ARDL model is more appropriate in predicting Indonesian money demand (proxies by M2).

The objectives of this study are: 1) to reveal the cointegrating relationship of both M1 (narrow money) and M2 (broad money) with their determinant variables such as real income, inflation rate and exchange rate with ARDL model, 2) to determine the stability of M1 and M2 model, 3) to find the effect of exchange rates in domestic money demand, and 4) to forecast the amount of M1 and M2.

The significance of this paper is to fill in the gap of previous studies on Indonesian money demand. There are 2 (two) distinguished features introduce in this study; the first is the inclusion of inflation rate (as the proxy for opportunity cost) as one of the independent variable instead of interest rate as previously used in other studies of money demand in Indonesian economy; the second is providing forecast results of each model for money demand in Indonesian economy with its determinant variables.

2. LITERATURE REVIEW AND HYPOTHESIS

2.1. Money Demand Function

On macroeconomic theory, money demand depends on several factors such are income and the allocation of wealth faced by people in holding money or other monetary assets. The function of money demand is:

$$\frac{M^d}{P} = \frac{y}{P} L(i) \text{ ---} \qquad (1)$$

Money demand increases with nominal income and negatively depends on the interest rate. Where〖M〗^d is money demand; P is the price level; Y is real income; i is the opportunity cost or nominal interest rate.

For open economy, factor such as exchange rates must also considered to analyze the effect of the volatility of exchange rates on money demand. It is first suggested by Mundell (1963, p.487) and recently has been commonly included in the money demand function. The money demand function for open economy is:

$$\frac{M^d}{\mathrm{P}} = Y\ L(i, XR) \qquad (2)$$

Where XR is the nominal exchange rates. The increase (decrease) in XR is interpreted as depreciation (appreciation) of domestic currency against foreign currency.

2.2. Asset Market Equilibrium And The LM Curve

Let's assume that all assets can be classified into two categories, which are money and non-monetary asset. Money includes currency and accounts that has two main characteristics, which are zero interest rate $(i^m = 0)$ and fixed supplied at M. Non-monetary assets include bonds and securities pays interest rate ($i = r + \pi^e$) and fixed supplied at NM. So, the aggregate demand for assets will be: $\mathrm{M^d} + \mathrm{NM^d}$ that reflects the aggregate nominal wealth.

On the other hand, the aggregate supply of asset is M+NM that also represents the aggregate nominal wealth. Hence, market clear condition on asset market will be:

$$\mathrm{M^d} + \mathrm{NM^d} = \mathrm{M} + \mathrm{NM}$$
$$(\mathrm{M^d} - \mathrm{M}) + (\mathrm{NM^d} - \mathrm{NM}) = 0 \qquad (3)$$

The equilibrium on the financial market reached when $(\mathrm{M^d} = \mathrm{M})$, the interaction of $\mathrm{M^d}$,$\mathrm{M^s}$, and y leads to the determination of interest rate as shown in figure 1 on the appendix. Point A is the original equilibrium with Y rate of nominal income; $\mathrm{M^d}$ amount of real money demand; $\mathrm{M^s}$ amount of fixed money supplied by central bank, and with irate of interest. When output/income increases from Y to Y', people like to hold more money, at a given interest rate, and then pushes $\mathrm{M^d}$ curve move to $\mathrm{M^d}\,'$, with fixed amount of money supply M^s . The new equilibrium point is now A' with new interest rate i', and *i'>i*.

Interest or return regarded as the incentives for people to hold non-monetary assets instead of money. If the demand of money is increasing because of the increasing in income while money supply is fixed, interest rate must increases for people to hold less money. Interest rate continues to increase until money demand once again equals to money supply in the new financial market equilibrium.

LM-curve is the curve that shows LM relation. LM relation is the relation between output and interest rate, mainly because when output/income increases, money demands also increases, and then resulting in higher equilibrium interest rate. This relation is showing by the upward sloping LM-curve.

2.3. Monetary Policy And The LM-Curve

As previously mentioned, LM relation demonstrates the relationship between output/income with interest rate. LM-curve also use to show different monetary aspects such are; the sensitivity of money demand to interest rate and output (movement along/tangent of the LM curve) and the central bank monetary policy (monetary expansion and monetary contraction by examining the shifting of LM curve).

When large increase in y only results in small increase of iand as the result LM curve is flatter. The flat LM curve is a condition known as liquidity trap. It happens when monetary policy fails to pull one economy out of recession because people are willing to hold as much money (at any given interest rate) as the central bank is willing to supply. Change in money supply moves LM curve back and forth, and it has no effect on interest rates nor output; monetary policy will be ineffective. The LM curve is so flat, it means that M^d is totally interest inelastic at a very low interest rate. The interest rate is very close to zero, and people are indifferent between holding money and non-monetary assets. In this condition, fiscal policy becomes so powerful, while the monetary policy is ineffective. It is exactly what happened in Canada in the great depression and Japan on the late 1990's.

In an economy, the monetary authority lies in the hands of the central bank. The central bank uses monetary policy instruments to provide a structure for monetary policy decision-making. The monetary policies perform by the central bank can be categorized as follows: monetary targeting, exchange rate targeting, inflation targeting and implicit nominal anchor. This paper focuses only on money targeting policy which emphasizes on the growth rate of a chosen monetary aggregate.

If central bank decides to increase the nominal money supply form M to M' (by buying securities/government bonds from open market) given fixed P, it drives the increasing of real money and shifts the LM curve down from LM to LM' (presented by Figure 2 on the appendix). At any Y, interest rate is decreasing to meet its new financial market equilibrium (monetary expansion policy). If the central bank decides to decrease money supply (by selling securities/government bonds to open market), LM curve shifts up and interest rate is increasing (monetary contraction policy). It is also known as an open market policy.

2.4. Money Demand And Exchange Rate

Robert Mundell (1963) proposed that exchange rate is an important determinant of money demand in an open economy and must be included in the money demand function. It shows in the Mundell-Fleming model as an extension to the IS-LM model. Since then, some researchers also found different effects of exchange rate on money demand.

A study on money demand in Canada, United States, and United Kingdom by Arango and Nadiri (1981) found that level of fluctuation of foreign or domestic exchange rates affects the wealth of domestic residence through the value of foreign assets held and simultaneously it also affects the demand for money. Bahmani–Oskooee and Pourheydarian (1990) found a positive and significant relationship between money demand and exchange rates in their study on Canada and United States. It indicates that the depreciation of domestic currency increases money demand. Exchange rate depreciation may increase domestic money demand through wealth effect. When peoplevalued their assets on domestic currency, the depreciation of domestic currency means that the value of foreign assets held by domestic holders is increasing, where as the value of domestic assets hold by foreign holders are decreasing. This induces the increasing of domestic money demand. This condition known as the wealth effect of exchange rates

On the contrary, Bahmani and Oskooee (1996 & 2002) found that depreciation of domestic currency affects market expectation for further depreciation and people hold more foreign currency, and it will decrease money demand for domestic currency. This is known as the currency substitution effect. The net result completely depends on the magnitude of wealth effect compare to the currency substitution effect.

2.5. Hypotheses

This paper assumed the function of money demand following the Bahmani-Oskooee (1996) and Bahmani-Oskooee and Rehman (2005):

$$LM_t = \beta 0 + \beta 1\, INF + \beta 2\, LY + \beta 3\, LXR + \beta 4\, DUMMY + \mu t \qquad (4)$$

Theoretically, the hypotheses are as follows: the expected sign of the coefficient of inflation (β1) is negative; the expected sign of the coefficient of income (β2) is positive; and the expected sign of the coefficient of exchange rate (β3) is either positive or negative. If the depreciation of exchange rate affects the increase in wealth and finally increases money demand, β3 is positive. However, if the increase in exchange rate leads to the decrease in money demand as on the currency substitution effect, β3 is negative

3. RESEARCH METHODOLOGIES

3.1. Populasi dan Sampel

There are several common techniques use to estimate cointegrating relationship on money demand. There is an estimation based on residual approach such as Engle and Granger (1987)and also a maximum likelihood base such as Johansen and Juselius (1990) and Johansen (1992). Those methods required all of the variable has the same order of integration. When the variable contains different order of integration, the estimation cannot be accurate. To solve this problem,Pesharan et al. (1997) proposed an Autoregressive Distributed Lag (ARDL) cointegration method. ARDL cointegration method does not require the variables to have the same order of integration Other advantages of ARDL are: 1) it takes sufficient lags to capture data generating process in general to a specific modeling; 2) it generatesa dynamic error correction model through a simple linear transformation. The ARDL model analyzed using Microfit econometric software developed by Pesharan and Pesharan (Oxford University).

The money demand equation represented on ARDL model is estimated as follows:

$$\Delta LMREAL_t = \alpha_0 + \delta_0 \mathrm{T} + \sum_{i=1}^{n} \alpha_{1i} \Delta LMREAL_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\, \Delta INF_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\, \Delta LYREAL_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta XLR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta DUMMY_{t-i} + \theta 1 LMREALt-i + \theta 2 INFt-i + \theta 3 LYREALt-i + \theta 4\, \mathrm{L}XRt-i + \theta 5 DUMMYt-i + \varepsilon t \qquad (5)$$

LMREAL is the log of real money demand as dependent variable (the real value of M1 and M2 respectively); INF is the price level proxies by CPI; LYREAL is the log of real domestic income; LXR is the log of exchange rates of domestic currency to USD; DUMMY is the dummy variable; ε_t is the residual term or error term. In this paper, the unit root test is performed with Augmented Dickey Fuller method to show the different order of the variables.

Equation (5) represents cointegration ARDL (p, q_1, q_2, q_3, q_4) with intercept and time trend (T). For all possible values of $p = 0,1, \dots m$ and $q_1 = 0,1, \dots m$ and m is the maximum lag with k number of variables and sample period $t = m + 1, m + 2, \dots n$ there exist $(m + 1)^{k+1}$ ARDL estimations. Coefficient $\alpha_i = 1, \dots 5$ represent the short-run dynamics and $\theta_i = 1, \dots 5$ estimate the long-run relation or the error correction term on this model.

The ARDL procedures consist of two steps which are: First: determining the existence of long-run relationship among variables in the equation. The hypothesis testing of no-cointegration is as follow: $H_0 : \theta_i = 0\ forall\ i = 1, \dots,$ and $H_1 : \theta_1 \neq 0, \theta_2 \neq 0, \dots \theta_{15} \neq 0$ by estimating F-statistics based on Wald-test. The F-statistics distribution is a non-standard F-statistics irrespective the variable's order of integration. The critical value of F-statistics is provided by Pesharan and Pesharan (1995); Pesharan et al. (2001) for large sample and Narayan (2005) for small sample observation. The critical value consists of a range, the lower value is estimated as if the variables is stationary at the level I(0), and upper value is estimated as if the variables integrated at order one I(1). If the estimated value of F-statistics fallsbelow the lower bound, one is failed to reject H_0 , which means there is no cointegration between the variables; if it falls higher than the upper bound, H_0 is rejected, which means there exists a cointegration relation between variables; but if it falls within the range, the result is inconclusive.

Second:selecting the estimated F-statistics to support the existence of cointegration relation, byselecting the lag order variables using Schwarz Bayesian Criterion (SBC) to determine the true dynamics of the model.

Goodness of fit tests and diagnostic tests are taken to confirm the model's performance.Stability test suggested by Brown et al. (1975) conducted (CUSUM test and CUSUMSQ) in this study to make use the cumulative sum and cumulative sum square of recursive residuals based on the first t observations and updates recursively and plotted against break points. The stability of money demand is necessary to have a predictable and stable relationship between money and its determinant variables. The stability of the long-run relation between variables is used to form the short-run or the error correction term in juxtaposition with the short-run dynamics. Laidler (1993, p.175) and Bahmani-Okooee (2001, p.3) noted that instability problem could occur from inadequate modeling of the short-run dynamics to characterize the departures from its long-run relationship..

Finally, this study also forecast the money demand using ARDL model. Forecasting model precision test is measured by the deviation of forecasted value compare to its actual value.

4. RESULTS AND FINDINGS

Data for this study is taken from Bank Indonesia and Indonesia National Statistics Board database in quarterly basis from 1993Q1 to 2013Q3. Money demand proxies by real M1 (narrow money) and realM2 (broad money) respectively, and adjusted from its nominal value with price index; Y proxies by GDP and converting to real GDP by using customer price index (CPI); INF proxies by the inflation rate; XR proxies by exchange rate of IDR to USD; and DUMMY is to represent Asian economic crisis that takes value 1 over the period 1998Q1–1998Q4 and 0 elsewhere. Time trend is included to capture changes in the financial systems through technology of transaction as suggested by Dekle and Pradhan (1999) or to smooth the impact of the new financial technology overtime as suggested by James (2005). All variables are in natural log form except for INF and DUMMY.

The order of cointegration is tested using Augmented Dickey Fuller unit root test, and the results are presented on table 1 on the appendix. It shows different order of integration among variables. Graphical representation for all variables presented in figure 3 on the appendix.

The first stage of ARDL model is to determine the existence of long-run relationship of money demand and its determinants. The error correction model uses both M1 and M2 respectively as the dependent variables to act as the proxies for money demand with lags one to ten on the first difference of each determinant variable. The value of F-statistics for joint significance of each variable also estimated. The results compare with the F-statistics critical value bound test provided by Narayan (2005, p.1987-1990). Since the sample in this paper is small, F-statistics provided by Pesaran, Shin, and Smith (1997, 1999) is not relevantfor this estimation because F-test is sensitive to the number of lags imposed. Table 2 on the appendix provides the estimated F-statistics for each lag order. Based on the estimated F-statistics, we reject the null hypothesis of no long-run relation between M1 and its independent variables on lag 1 to lag 10 with difference significance level. While on M2, we reject the null on lag two, four, six, and seven, while we failed to reject the nullwith other lags.

The second step, the estimation of the long-run relationship on equation and the error correction (for short-run relationship) by using above results and chooses the optimum lag by the value SBC with Microfit 4.1. The result of each equation will be presented on two different sub-sections which are4.1 for money demand with M1-model; and 4.2 for money demand with M2-model.

4.1. Money Demand $M1$-Model

The long-run estimation for money demand with M1 as the dependent variable presented in table 3 and the short-run result in table 4 respectively on the appendix. SBC selection criteria select maximum lags to 6 and it also helps us to save the degree of freedom. Microfit estimates ARDL (5,0,0,5,1) along with goodness of fit and diagnostic test.

In the long-run, all determinant variables are significant at 1% level except for the dummy variable. The value of income elasticity is 0.37 and highly significant. The sign for income is positive as expected in theory; it means that the effect of real income will lead to the 37% per quarter increase in money demand. The coefficient of the inflation is negative and highly significant although the coefficient is quite small.

The coefficient of exchange rate is negative and highly significant, which is quite interesting. It shows that in the long-run, depreciation of currency decreases demand for domestic money. This result shows that the currency substitution effect through expectation outweigh the wealth effect in Indonesian money demand for the long-run.

Positive and significant sign of time trend indicates that the advance of financial technology in financial sector increases the velocity of narrow money (M1). Financial technologies such as automatic teller machine (ATM), electronic and/or mobile banking, and credit card makes it easier to convert money substitutes to money (Dekle&Pradhan 1999).

The error correction model described in table 4 on the appendix represents the short-run relation between M1 money demand and its determinants. Almost all of the determinant variables are significant. The contemporaneous change of real income and inflation shows the expected and significant sign aligning with the long-run estimation. The sign of exchange rates is quite contrary compared to the long-run estimation. It may be concluded that in the short-run, the wealth effect dominates the currency substitution effect. When money demand adjusts to its long-run value, the currency substitution effect prevails. In the short-run, the dummy variable has a positive and significant sign. It shows that, in the short-run, financial shock has a significant impact in the short-run, while it has no impact in the long-run.The most important thing is the sign of the ecm(-1) variable that is negative and significant at 1% level. This is the evidence of the existence of cointegration relationship among variables on this M1 money demand model. The coefficient is -0.7; the negative sign shows that the current state of the money demand falls below its long-run equilibrium and it will adjust upward to meet its long-run equilibrium. The absolute value of 0.7 presents the speed of adjustments to its long-run equilibrium value following the short-run adjustments. It implies that 70% of the disequilibrium in the real M1 demand is offset by short-run adjustment quarterly. The level of significance presents that almost all of the disequilibrium value caused by previous adjustment converges back to its long-run equilibrium.

The error correction equation is:

ecm = *LM1REAL -.36867*LYREAL + .1452E-3*INF +.50971*LXR -.038720*DUMMY- 21.3265*C -.021068*T*

The performance of the model is tested by: the overall goodness of fit presented on table 3. It implies that the model can explained about 99.7% of its observations. It is confirmed by high R-bar-squared value and low standard error. The value of DW-statistics of 2.5 (which around 2) presents that there is no serial correlation of the residual of the model and it is confirmed by the diagnostics test.

The diagnostic test result on this model passes all three tests (serial correlation test (on 10% significant level); functional form test; heterokedasticity test). The results confirmthat the residuals of this model are not serially correlated; the model is appropriately specified; and the residuals are homokedasticrespectively.

To test the stability of this model, CUSUM (cumulative sum of recursive residual test) and CUSUMSQ (cumulative sum of square of recursive residual test) proposed by Brown et.al (1975) were performed. CUSUM test is a residual test based on the cumulative sum of the residuals based on the first n-observations by updating recursively, and then to be plotted against the break points. If the CUSUM plot stays within the 5% significance level (shows by two straight lines as the critical value lines, the estimated coefficient is stable.

Similar measure also apply on CUSUMSQ test which based on the square of the recursive residuals. The graphical presentation of M1 for CUSUM and CUSUMSQ describe on figure 4 on the appendix. Both graphs confirm that M1 stays within the critical value lines, and then it can be conclude that M1 money demand is stable.

The forecast of M1 money demand model performed by ARDL is shown on table 5 on the appendix. Forecast value of M1 money demand for period 2013Q1-2013Q3 respectively show 1%, 6%, and 5% deviation from its actual value. It confirms that the model is quite accurate for forecasting the value of M1 money demand. Figure 5 on the appendix presents the dynamic forecast power of the forecast model through the whole observation. The forecast value and actual value fluctuate around the same line across the sample population.

4.2. Money Demand $M2$-Model

Estimation results in table 1 on the appendix confirms that SBC selection criteria choose lag seven as the maximum lag for M2 money demand model. Microfit estimation obtained ARDL (4,2,3,1,1). Long-run estimation for M2 money demand model describes in table 6 on the appendix.

In the long-run, on M2 money demand model, none of the determinant variable shows significant sign. It presents on table 5 on the appendix and confirms on table 7on the appendix. The sign of the ecm(-1) variable is also not significant. It means that there is no cointegration relation between M2 and its determinants. The lack of cointegration relationship between M2 and its determinant variables concludes that M2 is not appropriate to model the money demand in Indonesian economy.

To test the stability of M2 money demand, CUSUM and CUSUMSQ test are performed. The result describes on figure 6 on the appendix. The graphical presentation, shows that the plot of CUSUMSQ statistics of M2 crosses the 5% critical value lines. It indicates the instability ofM2. According to Renani (2007, p.6), a stable and predictable relationship between the money demand and its determinants variable is a necessary condition to formulate necessary monetary policy strategy. Since the M2 money demand estimates that there is noevidence to prove long-run relation between M2 money demand and its determinant variables and there exist an instability in M2, it is safe to conclude that M2 is not an appropriate model for forecasting money demand in Indonesian economy.

5. CONCLUSIONS

Monetary policy is an important policy in one economy to maintain a sustainable growth. Due to this significant matter, there have been many studies conducted on money demand across countries using both $\boldsymbol{M1}$ and/or $\boldsymbol{M2}$. This study of Forecasting Indonesian money demand model is conducted with ARDL model.

On the result, M1 money demand model presentsa significant evidence of long-run relationship between M1 and its determinant variables. Coefficient of real income and inflation confirm the hypotheses. The exchange rate coefficient shows that in the long-run, in Indonesian economy, currency substitution effect dominates wealth effect. An expected and significant signs also show on the short-run. In the short-run, dummy variable shows that Indonesian money demand is sensitive to financial crisis. M1 also shows a satisfied result on the performance test such as goodness of fit, diagnostic, and stability test. Based on this, this study forms a forecasting model and checks it with the actual available data. The forecasting value is very close to the actual data across the observation sample.

On the contrary, estimation with M2 shows that there is no evidence of long-run relationship between M2 and its determinant variables, since all of the long-run coefficients are not significant. It is also supported by the insignificant coefficient of ecm (-1) on the error correction model. M2 variable failed the CUSUMSQ test that indicates that there is an instability in the M2 money demand model. Furthermore, there is no need to establish a forecasting model for M2. Based on the aforementioned results, it may be concluded that M1 served as a better money demand variable to design optimum monetary policy by the central bank compare to M2. The findings of this study incate that Indonesian Monetary authority (Bank of Indonesia) should control M1 as the monetary aggregate to forecast the domestic money demand.

6. IMPLICATIONS AND LIMITATIONS

This study has implications for monetary economy policy and future research. This study reveals the existence of cointegration relationship between M1 and its determinant variables. It is not necessarily the same with M2. This study also sheds some lights of the exchange rates effect to money demand in Indonesian economy. The inclusion of other monetary variables i.e. domestic and/or foreign interest rate, development in financial industry, or any element of balance of payment can be included for further study using the same or different estimation method with expanding data series.

It is important to bear in mind that due to the short period data availability, the findings in this paper should be carefully interpreted. Nevertheless, this study provides some insights on Indonesian money demand determinant.

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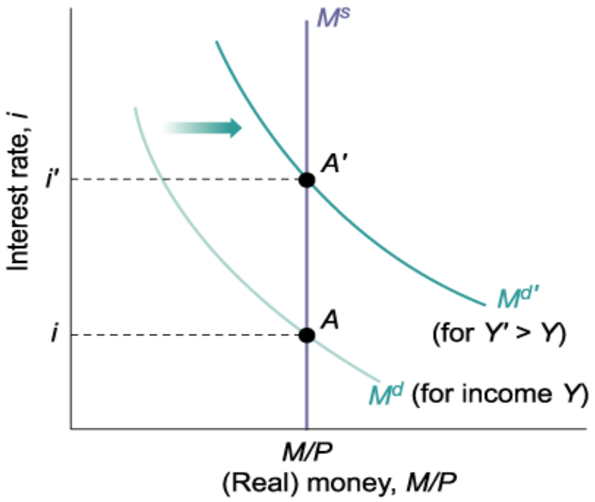
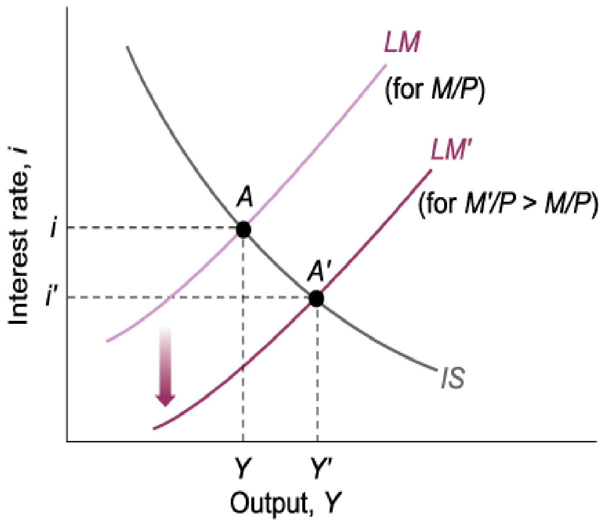
APPENDIX

Figure 1. Money demand and interest rate



Source: Macroeconomics by Oliver Blanchard (sixth edition)

Figure 2. Shift of LM-Curve



Source: Macroeconomics by O.Blanchard (sixth ed)

Figure 3. Variables in level

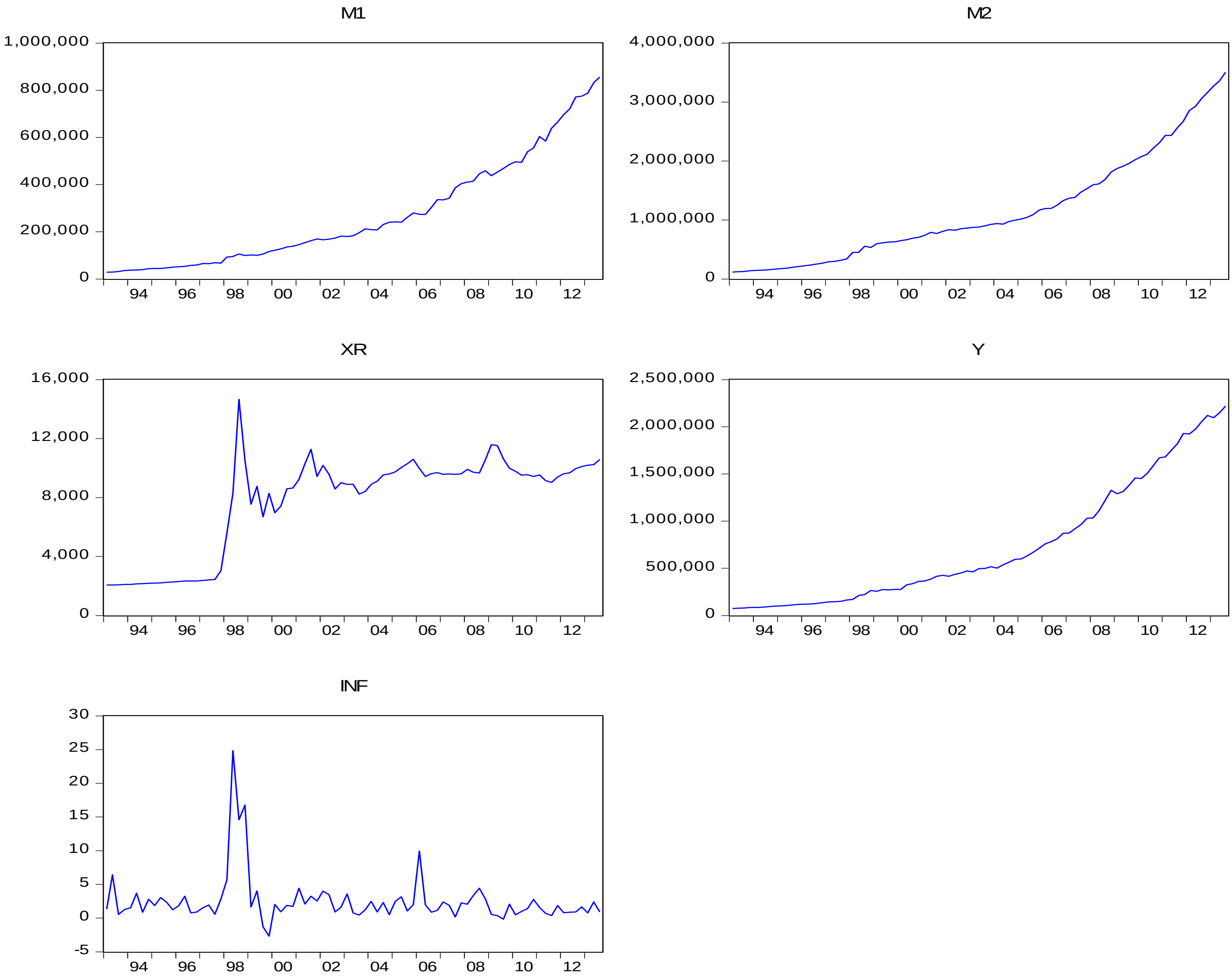
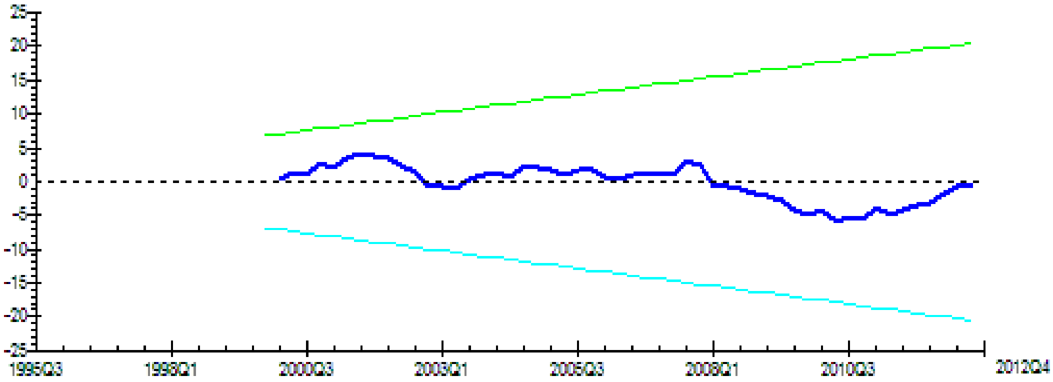


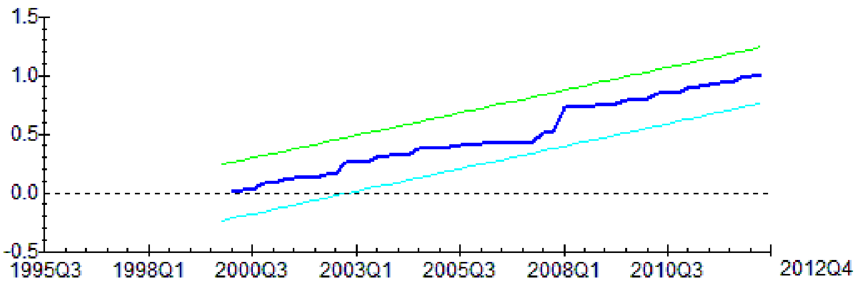
Figure 4. CUSUM and CUSUMSQ Plot of M1

Plot Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Plot Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Figure 5. Dynamic forecasts for *M*1

Dynamic forecasts for level of LM1REAL

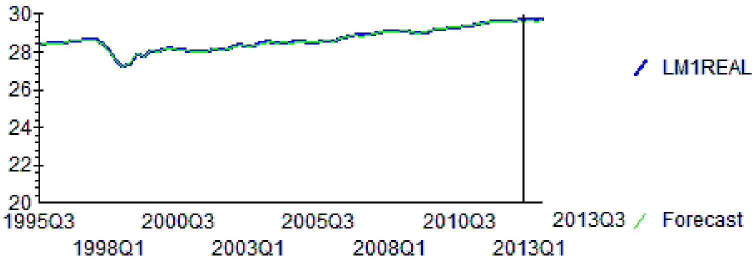
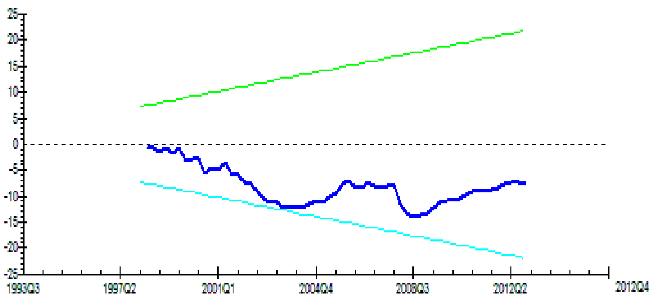


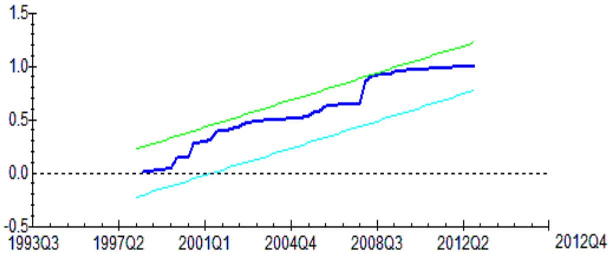
Figure 6. CUSUM and CUSUMSQ Plot of *M*2

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Source of Figure 3. – Figure 6. : Author's estimation results with Microfit 4.1

Table 1. Augmented Dickey Fuller critical value

Variables	Critical value I(0)	Critical value I(1)	Order
INF	-4.844321***		I(0)
M1REAL	1.904218	-7.432705	I(1)
M2REAL	1.787751	-4.282734***	I(1)
XR	-1.950756	-8.915432***	I(1)
YREAL	1.780534	-6.769754***	I(1)

Note:
1) ADF test statisics 2.59, 2.89, 3.51 respectively for significant level at 10%, 5%, and 1%
2) *, **, *** respectively for significant level at 10%, 5%, and 1%

Table 2. F-statistics for long-run relation with intercept & trend

	1	2	3	4	5	6	7	8	9	10
M1	4.71*	5.75**	5.14**	5.29**	4.63*	4.96**	5.86**	5.33**	5.01**	5.37**
M2	3.12	4.35*	3.24	4.94**	2.96	4.57*	4.59*	4.25	3.28	4.00

Note:
1. F-statistics of bound test by Narayan (2005) for k=4 with intercept & trend at 90% significance level is 3.160 - 4.230; 95% is 3.678 - 4.840; 99% is4.890 - 6.164;
2. *, **, *** respectively for significant at 10%, 5%, and 1%

Table 3. Estimated long-run coefficients using the ARDL pproach (dependent variable = M1)

Dependent variable is LM1REALUS ARDL(5,0,0,5,1)		
Regressor	Coefficient	T-Ratio[Prob]
LYREAL	.36867	2.9868[.004]***
INF	-.1452E-3	3.7611[.000] ***
LXR	-.50971	-5.2259[.000] ***
DUMMY	.038720	1.5897[.118]
C	21.3265	4.9602[.000] ***
T	.021068	4.4161[.000] ***

R-Bar-Squared	**.99751**
S.E. of Regression	.028211
DW-statistic	2.5202

Diagnostic Tests	
Serial Correlation	F(4, 49)= 2.4103[.062]
Functional Form	F(1, 52)= .55407[.460]
Heteroscedasticity	F(1, 68)= .79908[.375]

Note:
1) *, **, *** respectively for significant at 10%, 5%, and 1%
2) Number in [ ] are the p-value

Table 4. Error Correction Representation for the Selected ARDL Model results (dependent variable = M1)

Dependent variable is LM1REALUS ARDL(5,0,0,5,1)		
Regressor	Coefficient	T-Ratio[Prob]
dLM1REAL1	.21026	1.7251[.090]*
dLM1REAL2	.16448	1.4874[.143]
dLM1REAL3	.0029025	.029513[.977]
dLM1REAL4	.37084	4.3494[.000]***
dLYREAL	.26081	2.7229[.009] ***
dINF	-.1027E-3	-4.7215[.000] ***
dLXR	-.54767	-5.5826[.000] ***
dLXR1	.22334	1.8191[.074]*
dLXR2	.24459	2.2651[.027] ***
dLXR3	.012245	.12779[.899]
dLXR4	.34465	3.9008[.000] ***
dDUMMY	.093163	4.9229[.000] ***
dC	15.0870	3.8772[.000] ***

Dependent variable is LM1REALUS ARDL(5,0,0,5,1)		
dT	.014904	3.5591[.001] ***
ecm(-1)	-.70743	-6.3581[.000] ***

Note:
1) *, **, *** respectively for significant at 10%, 5%, and 1%
2) Number in [ ] are the p-value

Table 5. Dynamic forecasts for the level of LM1REAL

ARDL(5,0,0,5,1) selected using SBC Dependent variable in the ARDL model is LM1REAL included with a lag of 5			
Observation	Actual	Prediction	Error
2013Q1	29.6689	29.6588	.010141
2013Q2	29.7040	29.6429	.061042
2013Q3	29.7136	29.6632	.050438

Table 6. Estimated long-run coefficients using the ARDL approach (dependent variable = M2)

Dependent variable is LM2REAL		
Regressor	Coefficient	T-Ratio[Prob]
LYREAL	1.8954	.44136[.661]
INF	.0018207	.47105[.639]
LXR	-1.9837	-.37849[.707]
DUMMY	.070908	.095415[.924]
C	-6.6625	-050051[.960]
T	.0032457	.022072[.982]

R-Bar-Squared	**.99828**
S.E. of Regression	.019843
DW-statistic	2.3323

Diagnostic Tests	
Serial Correlation	F(4,52)= 1.4213[.240]
Functional Form	F(1,55)= .62856[.431]
Heteroscedasticity	F(1,71)= 2.6272[.109]

Note:
1) *, **, *** respectively for significant at 10%, 5%, and 1%
2) Number in [ ] are the p-value

Table 7. Error Correction Representation for the Selected ARDL Model results (dependent variable = M2)

Dependent variable is LM1REALUS		
Regressor	Coefficient	T-Ratio[Prob]
dLM1REALUS1	-.33213	-5.0075[.000]***
dLM1REALUS2	-.079007	-2.7585[.008] ***
dLM1REALUS3	-.048628	-1.9750[.053]*
dLYREALUSD	.029741	.34182[.734]
dLYREALUSD1	.24833	3.8925[.000] ***
dINF	-.1084E-3	-7.6001[.000] ***
dINF1	-.5953E-4	-4.1714[.000] ***
dINF2	-.6364E-4	-5.9599[.000] ***
dLXR	-.79180	-8.6521[.000] ***
dDUMMY	.042435	3.2212[.002] ***
dC	-.11927	-.050502[.960]
dT	.5810E-4	.022180[.982]
ecm(-1)	-.017902	-.48884[.627]

Note:
1) *, **, *** respectively for significant at 10%, 5%, and 1%
2) Number in [ ] are the p-value

Source of Table.1 – Table.7 : Author's estimation results with Microfit 4.1