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# Symmetric and Asymmetric Approaches to Money Demand Determination in Indonesia: Is Divisia Money Relevant?*

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## Abstract

This study aims to examine whether symmetric effects or asymmetric effects of exchange rates exist in determining the money demand in Indonesia. Simple-sum money and Divisia money were included in different models for comparison due to the financial developments in Indonesia. This study uses time-series data from 1996Q1 to 2019Q4 for the estimation. The nonlinear autoregressive distributed lag (NARDL) model is utilized to verify the asymmetric effects of exchange rates on money demand. The Augmented Dickey-Fuller and Phillips-Perron unit root tests were performed to verify the order of integration of the variables. The findings of this study revealed that the exchange rate is one of the most important determinants of money demand in Indonesia and the effect is asymmetric. The findings further indicated that money demand function, which incorporates Divisia monetary aggregate is parsimonious. Monetary targets such as money supply and interest rates are critical for monetary policy conduct to achieve inflation levels set by government. As the adoption of an inflation targeting framework needs to be in keeping with the flexible exchange rate system, the asymmetric effect of exchange rate changes can be used in exchange rate policy conduct to achieve financial system and price stability.

**Keywords:** Asymmetric, Nonlinear, Divisia, Money Demand, Exchange Rate

**JEL Classification Code:** C10, E41, E52, G00

## 1. Introduction

The stability of money demand has been widely researched, both theoretically and empirically, due to its importance in the conduct of monetary policy that accentuates the influence of monetary aggregates on output, interest rates, and prices (Simorangkir, 2002). The Keynesian IS-LM model indicates that monetary policy strategies can be based on: (1) the money supply rules that require stable money demand to target the growth rate of money; (2) interest rate rules that require a stable Investment-Saving relationship (Alsamara & Mrabet, 2019). Therefore, the money demand function is relevant in the conduct of optimal monetary policy. However, explanatory variables are found to be unrelated to the shift in money balances holdings, which can be due to financial market developments (James, 2005). Worldwide innovation in financial services covers service delivery or access to financial markets as well as organizational functions and service delivery (Fasnacht, 2009). As financial deregulation contributes to financial innovation, the association between real money balances and interest rates has been weakened by these innovations (Gurley & Shaw, 1960). The relationship between money and nominal income is also weakened by the action of lifted financial market controls, as the relationship is established based on quantity rationing that takes place during the contractionary periods while this rationing is relaxed during expansionary periods (Simorangkir, 2002). Financial innovations have contributed to perpetual shifts in real monetary balances (Adil, Hatekar, & Sahoo, 2020).

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Many developed countries have shifted to inflation targeting due to unstable money demand (Bhatta, 2013).

Indonesia is a country of interest in the study of money demand. Bank Indonesia has adopted an inflation targeting framework since 2005, in keeping with the free-floating exchange rate system. Price and financial system stability are achieved via the operation of exchange rate policy to minimize huge volatility in exchange rates. Consequently, Bank Indonesia has the authority to conduct monetary policy using monetary targets in terms of money supply and interest rates to attain the inflation level set by the government. Due to the financial development and the relevance of money supply in the monetary policy design, the derivation of a money demand function that is stable will be crucial for Indonesia. The source of instability in the money demand function would be interesting to investigate.

Financial developments have an influence on monetary transmission mechanisms and have altered the components of monetary aggregates (Jung, 2016). With the deepening of financial innovation, many monetary assets are developed with different frequencies of transaction. However, the conventional or simple-sum monetary aggregate assumes that the weightage for monetary assets with different frequencies of transaction is the same, which might not be consistent with the acceleration of financial innovation. Thus, the alternative monetary aggregate, Divisia money, is proposed in the estimation of money demand in Indonesia. The Divisia monetary aggregate initiated by Barnett (1980) is derived from the frequency of transactions involving monetary assets, and these assets are assigned different weights. In view of developments in financial markets, it is important to explore different types of monetary aggregates that can contribute to the derivation of a stable money demand. Therefore, the Indonesian Divisia monetary aggregate was constructed and is used to compare against conventional money supply or simple-sum monetary aggregates in the money demand function estimation for Indonesia.

Indonesia is also one of the East Asia Pacific countries exposed to the world economy via flows of goods, services, labor and capital (The World Bank, 2020c). This international exposure indicates the importance of determining exchange rate behavior. Depreciation and appreciation of exchange rates could induce different effects on money demand (Bahmani-Oskooee & Bahmani, 2015). Exchange rate changes show asymmetric effects on money demand, which have been found in the studies of Bahmani-Oskooee, Bahmani, Kutan, and Xi (2019a); Bahmani-Oskooee, Xi, and Bahmani (2019b); and Haider, Ganaie, and Kamaiah (2017). Therefore, the purpose of this study is to investigate the symmetric and asymmetric effect of exchange rates on money demand by comparing the performance of the simple-sum monetary aggregate and the Divisia monetary aggregate in Indonesia. The comparison is done by using linear as well as nonlinear autoregressive distributed lag approaches to money demand determination in Indonesia.

## 2. Literature Review

### 2.1. Financial Development in Indonesia

As the largest economy in Southeast Asia (The World Bank, 2020a), Indonesia has undergone financial liberalization, in which the reforms cover local and capital account liberalization as well as alteration in prudential controls (James, 2005). There were five phases of financial system development in Indonesia (Hamada, 2003), namely, the formative period (1966 to 1972); the policy-based finance period (1973 to 1982); the financial reform period (1983 to 1991); the expansion period (1992 to 1997); and the financial restructuring period (1998 onwards). During the COVID-19 pandemic, acceleration in the speed of innovation has been found in the fintech industry and Bank Indonesia continues to move forward to its 2025 payment system road maps such as the creation of BI-Fast (Dzulfiqar, 2020). A loan of US$300 million was approved by the World Bank for the implementation of financial reforms in Indonesia (The World Bank, 2020b). The strengthening of financial sector resilience is backed by Indonesia's COVID-19 emergency response and is also supported by the World Bank.

### 2.2. Exchange Rate as a Determinant of Money Demand

Unstable money demand has also driven researchers to reveal important fundamentals that determine money demand. Structurally unstable economies can be a source of shift in the velocity of real money balances. For example, the practice of currency substitution, which tends to increase the velocity of local money stock in many emerging economies (Guidotti & Rodriguez, 1992). Currency substitution refers to conducting transactions using a foreign currency. The wealth effect explains that when a local currency depreciates, the local currency value of foreign assets increases (Arango & Nadiri, 1981). If local residents treat this increase as an upsurge in their wealth, their consumption increases and therefore increases the demand for money. Conversely, if local residents expect further appreciation in foreign currency that induces the adjustments of portfolios by substituting local currency with foreign currency when local currency depreciates, then the expectation effect (Bahmani-Oskooee, Halicioglu, & Bahmani, 2017) or the substitution effect (Bahmani-Oskooee & Baek, 2017) take place. Thus, the demand for money falls. Therefore, the presence of currency substitution effect or wealth effect possesses different changes in exchange rate and the inclusion of exchange rate in the money demand estimation will be worthwhile for the investigation. The importance of exchange rate also has been highlighted by Asadullah, Bashir, and Aleemi (2021); Fathima Thahara, Fathima Rinosha, and Fathima Shifaniya (2021); and Nguyen, Nguyen, Vo, and Tran (2021).

### 2.3. Divisia Monetary Aggregate

The stability of the money demand function in Indonesia was investigated by Bahmani-Oskooee and Rehman (2005) and Sianturi, Tanjung, Leong, Puah, and Brahmana (2017). Sianturi et al. (2017) revealed that using the Divisia monetary aggregate consistently with financial market developments is important in deriving a stable money demand function in Indonesia. Divisia monetary aggregate is also in line with economic theories such as consumer demand theory as well as theory of economic aggregation (Thornton & Yue, 1992). The Divisia monetary aggregate was considered more superior compared to the simple-sum monetary aggregate in the examination of asymmetric effects of exchange rate changes on money demand in Malaysia (Leong, Puah, Lau, & Shazali, 2019). There is a lack of study using Divisia monetary aggregate in testing the asymmetric effects of exchange rate on money demand in Indonesia and thus provides an avenue for investigation.

## 3. Data Description and Methodology

Based on the standard money demand function (Goldfeld, 1973), the money demand function in Indonesia is as follows:

$$\mathrm{Md}_t = \beta_0 + \beta_1 y_t + \beta_2 r_t + \beta_3 er_t + e_t \qquad (1)$$

where $\mathrm{Md}_t$ represents real money demand, $y_t$ is real income, $r_t$ designates the interest rate and $er_t$ denotes the exchange rate. The effects of exchange rate fluctuations will be tested using linear and nonlinear autoregressive distributed lag.

The cointegration relationship between the variables is estimated using the transformed Equation (1) in a restricted linear autoregressive distributed lag (ARDL) model as follows:

$$\begin{aligned}\Delta\mathrm{Md}_t &= \alpha + \textstyle\sum_{i=1}^{p} \tau_{1i}\Delta\mathrm{Md}_{t-i} + \sum_{i=0}^{q_1} \tau_{2i}\Delta y_{t-i} \\ &+ \textstyle\sum_{i=0}^{q_2} \tau_{3i}\Delta r_{t-i} + \sum_{i=0}^{q_3} \tau_{4i}\Delta er_{t-i} + \delta_0\mathrm{Md}_{t-1} \\ &+ \delta_1 y_{t-1} + \delta_2 r_{t-1} + \delta_3 er_{t-1} + u_t\end{aligned} \qquad (2)$$

where $\Delta$, $\alpha$ and $u_t$ stands for the first difference operator, drift component and white noise residual, respectively. The null hypothesis is tested using the Pesaran, Shin, and Smith's (2001) asymptotic distribution of the *F*-statistic. A null hypothesis of no cointegration will be rejected if the computed *F*-statistic value is larger than the upper critical value. In contrast, if the computed *F*-statistic value is smaller than the lower critical value, the same hypothesis cannot be rejected. Inconclusive inference is made if the computed *F*-statistic value falls between the upper and lower critical values.

Short-run dynamics of the estimated variables is identified using the reduced form of Equation (1) derived from the ARDL error-correction model. The equation is expressed as:

$$\begin{aligned}\Delta\mathrm{Md}_t &= \alpha + \textstyle\sum_{i=1}^{p} \tau_{1i}\Delta\mathrm{Md}_{t-i} + \sum_{i=0}^{q_1} \tau_{2i}\Delta y_{t-i} \\ &+ \textstyle\sum_{i=0}^{q_2} \tau_{3i}\Delta r_{t-i} + \sum_{i=0}^{q_3} \tau_{4i}\Delta er_{t-i} \\ &+ \sigma\mathrm{EC}_{t-1} + \mu_t\end{aligned} \qquad (3)$$

where the estimated cointegration model in Equation (2) is used to derive the lagged correction term or $EC_{t-1}$. The $EC_{t-1}$ which is statistically significant indicates that a long-run causality from explanatory variables to dependent variable is confirmed. The parameter of $\sigma$ denotes the speed of adjustment of short run deviations to restore long-run equilibrium.

The nonlinear autoregressive distributed lag (NARDL) model recommended by Shin, Yu, and Greenwood-Nimmo (2014) is utilized to verify the asymmetric effects of exchange rates on money demand. NARDL model provides long-run and short-run estimation under the same vector autoregressive framework. Therefore, the equation in the long run is written as:

$$\mathrm{Md}_t = \alpha_0 + \alpha_1 y_t + \alpha_2 r_t + \alpha_3 er_t^+ + \alpha_4 er_t^- + e_t \qquad (4)$$

where the real money demand, the real income and the interest rate are represented by $\mathrm{Md}_t$, $y_t$, and $r_t$, respectively. $er_t^+$ and $er_t^-$ designate the partial sums of positive and negative changes for the nominal exchange rate. The cointegrating vector consists of the long-run parameters for estimation, which is $\alpha = (\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4)$. Therefore, the cointegration between explanatory variables and money demand is verified by the coefficients of $\alpha$. The $er_t^+$ and $er_t^-$ are computed from:

$$er_t^+ = \textstyle\sum_{i=1}^{t} \Delta er_i^+ = \sum_{i=1}^{t} \max(\Delta er_i, 0) \qquad (5)$$

and

$$er_t^- = \textstyle\sum_{i=1}^{t} \Delta er_i^- = \sum_{i=1}^{t} \min(\Delta er_i, 0) \qquad (6)$$

where $er_t^+$ indicates the increase in nominal exchange rate whereas $er_t^-$ designates the decrease in nominal exchange rate. If an appreciation (or a depreciation) in nominal exchange rate contributes to a rise (fall) in the money demand, a wealth effect presents. The signs of the coefficient are positive and negative for $er_t^+$ and $er_t^-$, respectively. On the contrary, the presence of a substitution effect signifies an appreciation in nominal exchange rate, leading to a decrease in money demand while a depreciation in nominal exchange rate contributes to an increase in demand for money. The signs of coefficient for $er_t^+$ and $er_t^-$ are negative and positive, respectively.

In the setting of the ARDL model (Pesaran & Shin, 1999; Pesaran et al., 2001), Equation (4) is then written as:

$$\begin{aligned}\Delta \mathrm{Md}_t &= \alpha + \sum_{i=1}^{p} \tau_{1i} \Delta \mathrm{Md}_{t-i} + \sum_{i=0}^{q_1} \tau_{2i} \Delta y_{t-i} \\ &+ \sum_{i=0}^{q_2} \tau_{3i} \Delta r_{t-i} + \sum_{i=0}^{q_3} (\tau_{4i}^{+} \Delta er_{t-i}^{+} + \tau_{4i}^{-} \Delta er_{t-i}^{-}) \\ &+ \delta_0 \mathrm{Md}_{t-1} + \delta_1 y_{t-1} + \delta_2 r_{t-1} + \delta_3 er_{i-1}^{+} + \delta_4 er_{i-1}^{-} + \mu_t \end{aligned} \quad (7)$$

where the short-run effect and long-run effects are captured by the coefficients of $\tau$ and $\delta$, respectively. The lag orders are denoted as $p$, $q_1$, $q_2$ and $q_3$. In order to obtain the long-run elasticities of exchange rate changes, either increases or decreases of money demand, the coefficients of $der$ ($\delta$) are divided by $\delta_0$. The short-run effects of an $er$ increase and decrease in money demand are determined by $\sum_{i=0}^{qj} \tau_{4i}^{+}$ and $\sum_{i=0}^{qj} \tau_{4i}^{-}$, respectively, where $j = 1, 2$ or 3.

Equation (7) is then assessed by utilizing the traditional ordinary least squares. The general-to-specific approach is used to eliminate the insignificant lags to form the final money demand specification based on the NARDL approach (Katrakilidis & Trachanas, 2012). The Wald F test is also used to verify the presence of long-run relationships or cointegration among the estimated variables. No cointegration among the variables (null hypothesis) is tested against the presence of cointegration among the variables (alternate hypothesis). The null and alternate hypotheses are expressed as:

$$\boldsymbol{H}_0: \boldsymbol{\theta}_0 = \boldsymbol{\theta}_1 = \boldsymbol{\theta}_2 = \boldsymbol{\theta}_3 = \boldsymbol{\theta}_4 = 0$$

and

$$\boldsymbol{H}_1: \boldsymbol{\theta}_0 \neq \boldsymbol{\theta}_1 \neq \boldsymbol{\theta}_2 \neq \boldsymbol{\theta}_3 \neq \boldsymbol{\theta}_4 \neq 0$$

If cointegration is present among the variables, the long-run and short-run asymmetry inferences can be made.

Quarterly data were used for the estimation. Due to the data availability of the three-month interbank rate, the period of estimation for all models started from 1996:Q1 and ended in 2019:Q4. The data used for estimation and Divisia money computation were obtained from the Census and Economic Information Centre (CEIC) database and were transformed to natural logarithms, except for the interest rate. Two models were tested using the ARDL approach, which were the simple-sum model and the Divisia model. For the simple-sum model, the real M2 money (LRSM2), real GDP (LRGDP), three- month interbank rate (IR) and nominal exchange rate in ringgit per United States term (LNER) were used for estimation. Meanwhile, the real M2 Divisia money (LRDM2), LRGDP, Divisia M2 money dual price (DPM2) and LNER were used for the Divisia model. On the other hand, simple-sum and Divisia models used identical variables under the NARDL approach, except for the exchange rate. The exchange rate comprised partial sums of positive exchange rate changes (LERPOS) and partial sums of negative exchange rate changes (LERNEG).

## 4. Results and Discussion

The ARDL approach allows the estimation of variables with a mixed order of $I(0)$ and $I(1)$. However, the existence of the $I(2)$ variable will have an effect on the validity of the computed $F$-statistics postulated by Pesaran et al. (2001). The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were performed to verify the order of integration of the variables. All variables used for estimation were stationary at first difference and thus there was no $I(2)$ variable (see Table 1). In other words, the model comparison based on the ARDL and NARDL approaches can be conducted.

The Akaike Information Criterion (AIC) is used for lag order selection, in which the optimal lag for estimation is 6. The ARDL estimation results for simple-sum and Divisia models are presented in Table 2. In Panel C, the results of the bound test for linear cointegration estimation indicate that the estimated F statistic values of 17.1707 in the simple-sum model and 51.6941 in the Divisia model are greater than the 95 percent upper bound based on the 3.23 lower bound and 4.35 upper bound of Pesaran et al. (2001).

The findings provide grounds for the estimation of the relationship of money demand dynamics to real GDP, interest rate and exchange rate. The presence of long-run relationships among the variables in both models is reconfirmed as the signs of the coefficients for EC terms are negative and the terms are significant. The derived models were also checked by using a battery of diagnostic tests. The simple-sum model suffered from serial correlation and misspecification problems. The Divisia model also suffered from serial correlation, misspecification and heteroskedasticity problems.

However, all of the models are stable, which is checked via the CUSUM and CUSUM of squares tests that represent the cumulative sum of recursive residuals test and the

**Table 1:** Unit Root Test Results

| Variables | Level | | First Difference | |
|---|---|---|---|---|
| | Intercept | Trend & Intercept | Intercept | Trend & Intercept |
| **Augmented Dickey-Fuller (ADF) Test** | | | | |
| LRSM2 | –0.1705 (1) | –1.4517 (1) | –12.6139 (0)*** | –12.5500 (0)*** |
| LRDM2 | –0.4276 (1) | –2.9564 (1) | –13.5852 (0)*** | –13.5112 (0)*** |
| LRGDP | –0.1936 (5) | –2.6955 (4) | –3.6813 (4)*** | –3.2710 (3)* |
| IR | –2.0771 (8) | –2.4081 (8) | –5.4643 (7)*** | –5.4745 (7)*** |
| DPM2 | –3.1960 (0)** | –3.5357 (0)** | –6.6978 (2)*** | –6.6662 (2)*** |
| LNER | –3.5950 (1)*** | –4.8377 (3)*** | –5.8361 (3)*** | –6.0985 (3)*** |
| LERPOS | –4.9132 (0)*** | –3.5389 (0)** | –2.8644 (4)* | –3.2517 (4)* |
| LERNEG | –2.8780 (2)* | –2.4634 (2) | –4.7323 (1)*** | –5.1962 (1)*** |
| **Phillips-Perron Test (PP)** | | | | |
| LRSM2 | –0.4764 (9) | –1.8167 (4) | –12.6391 (4)*** | –12.5873 (4)*** |
| LRDM2 | –0.4710 (1) | –4.0630 (4)*** | –16.3202 (9)*** | –16.2480 (9)*** |
| LRGDP | –0.4669 (11) | –1.8040 (7) | –9.9596 (10)*** | –9.9004 (10)*** |
| IR | –2.5422 (4) | –3.3082 (4)* | –6.6317 (1)*** | –6.5947 (1)*** |
| DPM2 | –3.4261 (3)** | –3.7878 (3)** | –8.8288 (12)*** | –8.7498 (12)*** |
| LNER | –3.2844 (0)** | –3.1902 (0)* | –7.2699 (1)*** | –7.3599 (0)*** |
| LERPOS | –3.9128 (3)*** | –3.2047 (2)* | –4.9065 (2)*** | –5.3944 (1)*** |
| LERNEG | –2.7306 (4)* | –1.8167 (4) | –8.0102 (4)*** | –8.3946 (4)*** |

cumulative sum of squares of recursive residual test, respectively. Based on the long-run relation results of the simple-sum model in Panel B, only real GDP is found to be statistically significant at the 1 percent level of significance. Conversely, only interest rate is statistically significant at the 1 percent level of significance in the Divisia model.

The insignificance of the explanatory variables such as exchange rate in both models motivates the use of the nonlinear ARDL approach to estimate the money demand function using simple-sum and Divisia money. In the nonlinear ARDL model, partial sums of positive and negative nominal exchange rate changes were computed. The results of the estimation are presented in Table 3. Panel A, B and C presents the results of short-run estimates, long-run estimates and diagnostic statistics, respectively.

With the 95 percent lower bound of 2.86 and the upper bound of 4.01, the estimated $F$ statistic values of 24.4857 in the simple sum model and 10.4347 in the Divisia model are greater than the upper bound. In other words, nonlinear cointegration exists among the variables in each model. The EC terms for simple-sum and Divisia models that are negative and significant verify long-run relationships present among the estimated variables in the models. The coefficients of EC terms also represent the speed of adjustments of the variables to restore equilibrium. The speed of adjustment for the simple sum model is around seven quarters while the Divisia model is approximately two quarters. Thus, the speed of adjustment for the Divisia model is faster than for the simple-sum model.

The results of the long-run estimated model (Panel B) for simple-sum money show that real GDP, interest rate and depreciation in exchange rate are statistically significant related to money demand. The sign of coefficients for all explanatory variables are consistent with the *a priori* theory. The estimation results further provide the diagnostic statistics of the model. The simple-sum money demand function is stable but suffers from model misspecification and heteroskedasticity. The same estimation procedure is applied to the Divisia money demand model. The long-run coefficients in the analysis of the Divisia model show that all explanatory variables, namely real GDP, the interest rate as well as the increase and decrease in exchange rates, are significant. The sign of coefficients is consistent with the *a priori* theory and the size of coefficients is plausible. The Divisia money demand model does not display serial correlation, misspecification, normality and

**Table 2:** ARDL Estimation Results for Simple-Sum and Divisia Models

| Independent Variables | Simple-sum Model | | Divisia Model | |
|---|---|---|---|---|
| | Coefficient | *p*-value | Coefficient | *p*-value |
| **Panel A: Short-Run Estimated Model** | | | | |
| ∆LRGDP | –0.2230 | 0.0824 | 0.0010 | 0.9509 |
| ∆LRGDP(–1) | 0.4687 | 0.0000 | – | – |
| ∆LRGDP(–1) | –0.2395 | 0.0045 | – | – |
| ∆IR | –0.0034 | 0.0021 | – | – |
| ∆IR(–1) | –0.0023 | 0.0116 | – | – |
| ∆DPM2 | – | – | 0.0397 | 0.0899 |
| ∆LNER | 0.1844 | 0.0000 | 0.2499 | 0.0000 |
| **Panel B: Long-Run Estimated Model** | | | | |
| Constant | 4.2686 | 0.0001*** | 0.1617 | 0.1104 |
| LRGDP | 0.8482 | 0.0000*** | 0.0001 | 0.9509 |
| IR | –0.0071 | 0.2408 | – | – |
| DPM2 | – | – | –0.0333 | 0.0060*** |
| LNER | –0.2302 | 0.1031 | –0.0128 | 0.3299 |
| **Panel C: Diagnostic Statistics** | | | | |
| *R*-squared | 0.6768 | | 0.7809 | |
| *F*-Statistics | 17.1707 | | 51.6941 | |
| $EC_{t-1}$ | –0.0944 | 0.0020*** | –1.4452 | 0.0000*** |
| Serial Correlation | 15.4408 | 0.0000*** | 3.9237 | 0.0234** |
| Functional Form | 5.5242 | 0.0212** | 2.1479 | 0.0345** |
| Normality | 0.2612 | 0.8776 | 0.9262 | 0.6293 |
| Heteroskedasticity | 2.5987 | 0.1105 | 3.6313 | 0.0599* |
| CUSUM | Stable | | Stable | |
| CUSUM of Squares | Stable | | Stable | |

Notes: The upper bound critical value of the *F*-statistic at the 5% significance level is 4.01 based on Pesaran et al. (2001). Serial correlation is checked using the Lagrange multiplier (LM) test of residual serial correlation. The functional form is confirmed by conducting the Ramsey's RESET test. The Jarque-Bera normality test is used to test the normality of data. The presence of autoregressive conditional heteroskedascity is tested by using ARCH test. The stability of the model is validated through cumulative sum of recursive residuals test (CUSUM) and cumulative sum of squares of recursive residual test (CUSUM of squares).
Source: Compiled by the authors.

heteroskedasticity problems. The results of CUSUM and CUSUM of squares indicate that the derived money demand function is stable.

When comparing two models, a parsimonious money demand function is developed by utilizing Divisia money and by including the effect of exchange rate changes. The positive sign of the coefficient for real GDP and the negative sign of the coefficient for dual price are consistent with the *a priori* theory. When there is a one percent increase in real GDP, Divisia money demand will increase by 0.89 percent. Conversely, a one percent increase in interest rate will lead to a 0.10 percent reduction in money demand.

An asymmetric effect exists as the LERPOS and LERNEG are significantly related to money demand. The signs of coefficients for LERPOS and LERNEG are positive, which indicates the presence of the expectation effect. The results are consistent with the findings of Puah and Hiew (2010). The positive sign of the coefficient for LERPOS

**Table 3:** Nonlinear ARDL Estimation Results for Simple-Sum and Divisia Models

| Independent Variables | Simple-Sum Model | | Divisia Model | |
|---|---|---|---|---|
| | Coefficient | *p*-value | Coefficient | *p*-value |
| **Panel A: Short-Run Estimated Model** | | | | |
| Constant | –0.1640 | 0.2226 | 0.5704 | 0.0041 |
| LRSM2(–1) | –0.1481 | 0.0000 | – | – |
| LRDM2(–1) | – | – | –0.4476 | 0.0000 |
| LRGDP(–1) | 0.2039 | 0.0000 | 0.3979 | 0.0000 |
| IR(–1) | –0.0047 | 0.0000 | – | – |
| DPM2(–1) | – | – | –0.0431 | 0.0069 |
| LERPOS(–1) | –0.0168 | 0.4690 | 0.0656 | 0.0703 |
| LERNEG(–1) | 0.0975 | 0.0656 | 0.1523 | 0.0019 |
| ∆LRSM2(–1) | –0.5046 | 0.0000 | – | – |
| ∆LRSM2(–2) | –0.3459 | 0.0002 | – | – |
| ∆LRSM2(–3) | –0.4122 | 0.0000 | – | – |
| ∆LRDM2(–5) | – | – | –0.3900 | 0.0000 |
| ∆LRGDP(–2) | –0.2206 | 0.0085 | – | – |
| ∆LRGDP(–3) | – | – | –0.2863 | 0.0201 |
| ∆LRGDP(–4) | –0.2394 | 0.0017 | –0.4046 | 0.0011 |
| ∆LRGDP(–6) | – | – | –0.3827 | 0.0024 |
| ∆IR(–1) | –0.0039 | 0.0005 | – | – |
| ∆IR(–6) | –0.0025 | 0.0025 | – | – |
| ∆DPM2(–6) | – | – | –0.0417 | 0.0269 |
| ∆LERPOS(–1) | 0.1145 | 0.0809 | – | – |
| ∆LERPOS(–4) | –0.0981 | 0.0191 | –0.1392 | 0.0246 |
| ∆LERPOS(–5) | – | – | 0.2619 | 0.0002 |
| ∆LERPOS(–6) | – | – | –0.1985 | 0.0008 |
| ∆LERNEG | – | – | 0.7815 | 0.0000 |
| ∆LERNEG(–1) | –0.2572 | 0.0030 | – | – |
| **Panel B: Long-Run Estimated Model** | | | | |
| Variables | | | | |
| Constant | –1.1077 | 0.2828 | 1.2743 | 0.0002*** |
| LRGDP | 1.3768 | 0.0000*** | 0.8889 | 0.0000*** |
| IR | –0.0320 | 0.0001*** | – | – |
| DPM2 | – | – | –0.0963 | 0.0162** |
| LERPOS | –0.1138 | 0.5099 | 0.1466 | 0.0352** |
| LERNEG | 0.6584 | 0.0308** | 0.3402 | 0.0003*** |

**Table 3:** Continued

| Independent Variables | Simple-Sum Model | | Divisia Model | |
|---|---|---|---|---|
| | **Coefficient** | ***p*-value** | **Coefficient** | ***p*-value** |
| **Panel C: Diagnostic Statistics** | | | | |
| *R*-squared | 0.7808 | | 0.7610 | |
| *F*-Statistics | 24.4857 | | 10.4347 | |
| $EC_{t-1}$ | –0.1481 | 0.0000*** | –0.4476 | 0.0000*** |
| Serial Correlation | 0.0719 | 0.9307 | 0.0761 | 0.9268 |
| Functional Form | 12.7748 | 0.0006*** | 1.2845 | 0.2608 |
| Normality | 0.1088 | 0.9471 | 1.5313 | 0.4650 |
| Heteroskedasticity | 4.3321 | 0.0404** | 0.2920 | 0.5903 |
| CUSUM | Stable | | Stable | |
| CUSUM of Squares | Stable | | Stable | |

Notes: The upper bound critical value of the *F*-statistic at the 5% significance level is 4.01 based on Pesaran et al. (2001). Serial correlation is checked using the Lagrange multiplier (LM) test of residual serial correlation. The functional form is confirmed by conducting the Ramsey's RESET test. The Jarque-Bera normality test is used to test the normality of data. The presence of autoregressive conditional heteroskesdascity is tested by using ARCH test. The stability of the model is validated through cumulative sum of recursive residuals test (CUSUM) and cumulative sum of squares of recursive residual test (CUSUM of squares).
Source: Compiled by the authors.

shows that when there is a further appreciation of the Dollar, people expect the Rupiah to depreciate and therefore they hold fewer Rupiah. If there is a one percent depreciation of the Rupiah, money demand will be reduced by 0.15 percent. For LERNEG, the positive sign of the coefficient shows that when there is a depreciation of the Dollar, the expectation of further depreciation of the Dollar causes the Rupiah to appreciate and people will hold more Rupiah. A one percent appreciation of the Rupiah will cause a 0.34 percent increase in the demand for Rupiah. Thus, Dollar depreciation has a greater impact on domestic money demand compared to Dollar appreciation.

## 5. Conclusion

Financial liberalization has altered the relationship between economic fundamentals and money demand. The change of monetary components in monetary aggregates could be the source of unstable money demand. The alternative money supply, the Divisia monetary aggregate, is proposed to capture the alteration of monetary components. In addition, the insignificance of explanatory variables such as exchange rate in previous research could be due to the presence of an asymmetric effect from exchange rate changes. Therefore, both symmetric and asymmetric approaches are used for the estimation of money demand functions by incorporating simple-sum monetary aggregates as well as Divisia monetary aggregates for Indonesia. The linear approach used in deriving the money demand functions shows that some variables are insignificant. The important variables become significant when the asymmetric approach is used for estimation. Furthermore, when Divisia money is incorporated in the estimated money demand model, the model does not suffer from serial correlation, model misspecification, normality, and heteroskedasticity problems. As a result, a plausible model is derived by using the asymmetric approach as well as by employing Divisia monetary aggregates for the estimation. The findings regarding the characteristics of a stable money demand function in Indonesia, such as the presence of asymmetric effects of exchange rates and the significance of Divisia money, provides useful indication for policymakers.

The derivation of stable money demand strengthens the role of monetary targets in monetary policy conduct in Indonesia. A stable money demand function indicates that money supply and interest rates are the monetary targets that could be used to achieve the government's predetermined inflation level. Besides, the asymmetric effect of the exchange rate in Indonesia is also critical for the exchange rate policy formulation in achieving stability of prices and the financial system. Foreign currency depreciation has a stronger effect on domestic real money demand compared to foreign currency appreciation. Furthermore, the authorities could consider the construction of the Divisia monetary aggregate as the alternative money supply in Indonesia as monetary targets are critical to the conduct of inflation targeting in Indonesia. The stable money demand derived also provides consideration of monetary targeting as the alternative of inflation targeting in Indonesia.

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