Asymmetric effects of exchange rate changes on the demand for divisia money in Malaysia

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Abstract. Financial liberalisation has advanced the transformation of the financial market as more interest-bearing financial derivatives are introduced. Performance of the equal-weighted monetary aggregates has been affected and therefore disrupted the stability of money demand. Effectiveness of monetary policy is a concern as stability of money demand is required for a stable velocity derivation. Thus, the aim of this study is to derive a stable money demand function by considering the type of monetary aggregate included for estimation and the missing determinants of money demand. First, the divisia monetary aggregate is employed for money demand estimation in Malaysia. Second, the exchange rate is included as a determinant of money demand by employing the nonlinear autoregressive distributed lag approach to capture the asymmetric effects from exchange rate changes. The results indicate that all the variables are bound together in the long run and the model is stable. Asymmetric effects exist in the short run for both appreciation and depreciation. Long-run asymmetric effects only hold in currency appreciation in which a substitution effect exists between

exchange rate and money demand. A stable money demand function contributes to formulation of monetary policy in Malaysia.

Keywords: financial liberalization, divisia monetary aggregate, exchange rate, asymmetric, money demand.

JEL Classification: C41, E52

1. INTRODUCTION

Financial liberalisation has led to financial-sector transformation in emerging economies such as Malaysia, which is also a leading global Islamic finance hub. Malaysia underwent financial liberalisation as early as 1978 with liberalisation in deposit and lending rates. A remarkable change was seen between 1988 and 1993 when the money market-London interbank offered rate (LIBOR) differential rose and boosted foreign capital inflows (Dekle & Pradhan, 1997). The key evolution in the financial sector from 1997 to 2010 involved the financial sector diversification that was achieved by a deep and liquid debt securities market, consolidation and rationalisation in the banking industry and better market orientation (Bank Negara Malaysia, 2011). Cost-effective hedging was used to promote deep and liquid interest rate derivatives in financial institutions and corporations (Bank Negara Malaysia, 2011). The framework for the Financial Sector Blueprint (2011-2020) further enhanced financial liberalisation, including the introduction of innovative channels such as agent banking, mobile banking and some other innovative products and services like flexible micro-financing, micro-savings products and micro-insurance or takaful, among others. With this significant financial development in Malaysia, government policies are important to ensure continuous economic growth.

Along with passive fiscal policy, active monetary policy is critical for domestic equilibrium determination (Tsuzuki, 2016). Money neutrality is one of the important issues for monetary policy (Wlodarczyk, 2014). In addition, the choice of target for monetary policy as well as the variables used to monitor the monetary conditions can be affected by financial liberalisation as the central bank normally employs quantity variables, such as broad money, as targets (Dekle & Pradhan, 1997). Stability of monetary aggregates has been affected due to financial liberalisation. As a result, money demand has become unstable. Under monetary targeting, a stable money demand function is critical for predicting future inflation and output, in which supply of liquidity must correspond to the demand for money to prevent excess money supply that will prompt inflation. Consequently, Malaysia shifted from monetary targeting to interest targeting in November 1995. The focus of policies changed to short-term interest rates while monetary authority monitors money and credit growth in the decision-making process (Dekle & Pradhan, 1997). The ability to estimate the money demand function is still the key concern of policymakers as the combination of money demand and money supply is used to determine interest rates, which can affect the ultimate goal of monetary policy (Kamaruddin & Khalid, 2016).

Instability of the conventional monetary aggregate can be due to the approach used for its construction. With rapid liberalisation in interest rates in Malaysia, the ability of conventional monetary aggregate to incorporate the change is unknown. The conventional money supply is derived by simple summation of all monetary components to form money, in which all monetary aggregates are perfectly substituted. Therefore, monetary assets have identical opportunity costs and are assigned equal weights (Drake & Fleissig, 2004). As various monetary assets possess different opportunity costs, lack of microeconomic foundation supports the perfect substitution assumption. If additional monetary assets are included in the construction of money, the perfect substitution assumption of monetary assets is inappropriate (Thornton & Yue, 1992). Thus,

monetary assets with different opportunity costs must be assigned different weights. Barnett (1980) introduced the concept of using different weights for various monetary assets with dissimilar returns in computing the monetary aggregate. The monetary aggregate constructed under this approach is called the Divisia monetary aggregate. The weightage is calculated based on the monetary services provided by monetary assets. As a result, the effect of change in opportunity costs among various monetary assets can be captured by the Divisia monetary aggregate. The computation approach is more consistent with the development of financial liberalisation, in which many new monetary assets are launched with various rates of return. For instance, Divisia monetary aggregate was found significant in explaining the exchange rate (Leong et al., 2018a; Leong et al., 2018b). With the innovation in monetary aggregate computation, this provides an alternative way to estimate the money demand function for Malaysia. Malaysia had undergone financial crises as well as implemented different exchange rate regimes but subsisted in the era of globalisation and export rivalry (Chan et al., 2019).

In addition, financial liberalisation also contributes to a more integrated financial market in Malaysia that may alter the money demand determinants. In Malaysia, the market share of global players in the banking sector is as high as an estimated 20% while the insurance and takaful sectors have an estimated two-thirds, which has promoted international trade and investment flows, new areas of economic development, employment and financial system diversification and development (Bank Negara Malaysia, 2011). Non-resident portfolio plays a role in foreign exchange market (Ministry of Finance Malaysia, 2018). Thus, fluctuations in the exchange rate affect policymakers, multinational firms, international traders and international investors. For instance, volatility of exchange rate was found affecting the real exports of Malaysia (Wong & Lee, 2016). Mundell (1963) was the pioneer in theoretically relating the exchange rate to money demand in addition to income and interest rate. Since then, exchange rate has been tested empirically to prove this hypothesis. The empirical studies relate exchange rate to money demand via the wealth effect and substitution effect. The wealth effect exists if depreciation in domestic currency or appreciation in foreign currency increases the value of foreign assets expressed in domestic currency, which are held by local residents and thus increase the demand for money (Arango & Nadiri, 1981). The substitution effect presumes that further appreciation (depreciation) in foreign (domestic) currency is expected when foreign (domestic) currency appreciates (depreciates) and, therefore, domestic residents demand more (less) for foreign (domestic) currency instead of local currency (Bahmani-Oskooee & Pourheydarian 1990; Haider et al., 2017). Succinctly, exchange rate is one of the key determinants of cash demand in the long run (Khatat, 2018).

The responses of the market players to changes in the exchange rate may not be identical. Most studies assume that the determinants of money demand have symmetric effects on the demand for money. McNown and Walace (1992), Civcir (2003) and Bahmani-Oskooee et al. (2013) found that the exchange rate has a symmetric effect on money demand. For Malaysia, Azali et al. (2000) and Leong et al. (2010) also estimated the money demand function by including the exchange rate as one of the determinants in a symmetric setting. However, Bahmani-Oskooee and Bahmani (2015) found that exchange rate changes had asymmetric effects on the demand for money in Iran. In a recent study, asymmetric effects of exchange rate changes were also found by Bahmani-Oskooee and Baek (2017) in Korea. In fact, asymmetric effects capture the unequal upswing and downswing changes in the exchange rate. Failure to consider this effect will result in invalid information regarding the cointegration between the variables.

Accordingly, the motivation of this study is to derive a stable money demand function for Malaysia. First, how stable is the money demand function using the Divisia monetary aggregate as the money supply? Second, are exchange rate changes the determinants of money demand and do they have asymmetric effects on money demand?

2. MODEL AND METHODOLOGY

The standard money demand function is specified following Goldfeld (1973) by including a scale variable and the opportunity cost of holding money. For the case of Malaysia, the exchange rate variable is included in the standard money demand model (Azali et al., 2000):

$$MD_t = \beta_0 + \beta_1 y_t + \beta_2 r_t + \beta_3 er_t + e_t \tag{1}$$

where MD_t is the real money demand, y_t designates the real income, r_t is the interest rate and er_t denotes the exchange rate.

The nonlinear autoregressive distributed lag (NARDL) model proposed by Shin et al. (2011) is used to estimate the asymmetric effect of the exchange rate in the long run and short run within the vector autoregressive (VAR) framework. The long-run equation to account for the asymmetric effect is expressed as (Shin et al., 2011):

$$MD_t = \alpha_0 + \alpha_1 y_t + \alpha_2 r_t + \alpha_3 er_t^+ + \alpha_4 er_t^- + e_t \tag{2}$$

where MD_t is the real Divisia money demand while *yt*, *rt* and *ert* are the real income, interest rate and nominal exchange rate, respectively. The cointegrating vector is $= (\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4)$, which comprises the long-run parameters for estimation, and er_t^+ and er_t^- are the partial sums of positive and negative changes for the nominal exchange rate, which are derived from the following equations:

$$er_t^+ = \sum_{i=1}^{t} \Delta er_i^+ = \sum_{i=1}^{t} max(\Delta er_i, 0) \tag{3}$$

and

$$er_t^- = \sum_{i=1}^{t} \Delta er_i^- = \sum_{i=1}^{t} min(\Delta er_i, 0) \tag{4}$$

where er_t^+ represents the increase in er_t while er_t^- indicates the decrease in er_t. The coefficient of $\boldsymbol{\alpha}$ is used to identify the long-run relationship between er_t^+ (or er_t^-) and money demand. For instance, a 1% appreciation in the currency increases the money demand by 2%, but a 1% depreciation may not reduce the money demand by 2% based on expectations (Bahmani-Oskooee & Baek, 2017). A wealth effect exists if an appreciation (depreciation) in foreign currency leads to an increase (decrease) in the demand for domestic currency. Conversely, an appreciation (depreciation) in foreign currency leads to a decrease (increase) in the demand for domestic currency, which denotes the presence of the substitution effect. To summarise the wealth or substitution effect of nominal exchange rates, the expected signs of the coefficients for both er_t^+ and er_t^- are presented in Table 1.

Table 1

Expected signs of coefficients

	er_t^+	er_t^-
Wealth effect	+	-
Substitution effect	-	+

Equation (2) is then transformed to the autoregressive distributed lag (ARDL) framework of Pesaran and Shin (1999) and Pesaran et al. (2001), expressed as:

$$\Delta MD_t = \alpha + \sum_{i=1}^{p} \gamma_{1i}\Delta MD_{t-i} + \sum_{i=0}^{q_1} \gamma_{3i}\Delta y_{t-i} + \sum_{i=0}^{q_2} \gamma_{4i}\Delta r_{t-i} + \sum_{i=0}^{q_3}(\gamma_{2i}^{+}\Delta er_{t-i}^{+} + \gamma_{2i}^{-}\Delta er_{t-i}^{-}) +$$

$$+ \theta_0 MD_{t-1} + \theta_1 y_{t-1} + \theta_2 r_{t-1} + \theta_3 er_{i-1}^{+} + \theta_4 er_{i-1}^{-} + \mu_t \qquad (5)$$

where the coefficients of γ and θ are used to capture the short-run and long-run effects, respectively. On the other hand, p, q_1, q_2 and q_3 are the lag orders. The long-run elasticities of the exchange rates increase and decrease on money demand is calculated by dividing the coefficients of *der* (θ) by θ_0. The short-run effect of a *er* increase on money demand is measured by $\sum_{i=0}^{q_j} \gamma_i^{+}$ while $\sum_{i=0}^{q_j} \gamma_i^{-}$ is used to compute the short-run effect of a *er* decrease on money demand, where $j = 1$, 2 or 3.

The standard ordinary least squares (OLS) method is used to estimate Equation (5). The insignificant lags are eliminated by utilising the general-to-specific procedure to derive the ultimate specification of the NARDL money demand model (Katrakilidis & Trachanas, 2012). Next, the presence of cointegration among the variables is tested using the Wald F test. The null hypothesis of no cointegration among the variables is stated as follows:

$$H_0: \theta_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$$

which is tested against the alternate hypothesis of the existence of cointegration among the variables. The alternate hypothesis is:

$$H_1: \theta_0 \neq \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq 0.$$

The inferences on long- and short-run asymmetries can only be drawn if cointegration exists among the variables.

Quarterly data ranging from 1991:Q1 to 2018:Q4 are used for estimation of the money demand function. The year 1991 also marked the year for the launch of the National Development Policy. Real money demand is measured by using the Divisia M2 monetary aggregate. The interest rate for Divisia money is proxied by the dual price, which is formulated as a chained superlative index identical to the Divisia monetary aggregate. The real gross domestic product (GDP) and nominal exchange rate are used as proxies for the real income and exchange rate. All data are transformed to natural logarithm, except for dual price. The variables used are summarised in Table 2.

Table 2

Summary of variables under investigation

Notation	Variable	Description
RDM2	Real Divisia money demand	Divisia M2 monetary aggregate
RGDP	Real income	Real gross domestic product (GDP)
DPM2	Nominal interest rate	Dual price
ER	Nominal exchange rate	Ringgit per United States (U.S.) dollar
ERPOS	Partial sums of positive exchange rate changes	Derived from nominal exchange rate using NARDL approach
ERNEG	Partial sums of negative exchange rate changes	Derived from nominal exchange rate using NARDL approach

Note: The natural logarithm term for RDM2, RGDP, ERPOS and ERNEG is denoted as LRDM2, LRGDP, LERPOS and LERNEG, respectively.

3. RESULTS AND DISCUSSION

Although the unit root test is not a compulsory test for the bounds testing approach, a unit root test is conducted to ensure that there is no I(2) variable. The results of the unit root test are tabulated in Table 3. By utilising the augmented Dickey-Fuller (ADF) unit root test, all variables are integrated on the order of one. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationary test is conducted to reconfirm the results of the ADF test. The results of the KPSS test are consistent with the ADF test results as all variables are stationary in first difference. As there is no I(2) variable, the bounds testing approach is valid for the estimation of long-run and short-run relationships among the variables.

Table 3

Unit root test results

Variable	ADF		KPSS	
	Level	First Difference	Level	First Difference
LRDM2	-1.6184(1)	-8.1998(0)***	0.1249(7)*	0.0963(7)
LRGDP	-1.4354(9)	-4.7107(8)***	0.1763(8)**	0.1513(8)
DPM2	-2.2733(0)	-9.2197(0)***	0.2045(8)**	0.0526(3)
LERPOS	-1.7050(1)	-7.6581(0)***	0.1268(9)*	0.0947(5)
LERNEG	-1.0209(0)	-9.7281(0)***	0.2097(8)**	0.1902(1)

Notes: The constant and trend terms are included in the estimation of ADF and KPSS tests. Schwarz information criterion is used for the lag selection in ADF test.

Table 4

Nonlinear ARDL estimation results

Panel A Estimated Model		
Independent Variable	**Coefficient**	**p-value**
Constant	-0.1352	0.1947
LRDM2(-1)	-0.1800	0.0001
LRGDP(-1)	0.2201	0.0000
DPM2(-1)	-0.0063	0.0783
LERPOS(-1)	-0.0729	0.0049
LERNEG(-1)	-0.0558	0.2026
ΔLRDM2(-1)	0.0998	0.2599
ΔLRDM2(-2)	0.3556	0.0007
ΔLRDM2(-3)	0.1366	0.1769
ΔLRGDP	-0.1834	0.0158
ΔLRGDP(-2)	-0.1136	0.0794
ΔLRGDP(-3)	-0.1648	0.0082
ΔLRGDP(-7)	-0.1222	0.0430
ΔDPM2(-1)	-0.0079	0.2040
ΔDPM2(-2)	0.0199	0.0025
ΔDPM2(-3)	0.0030	0.6081
ΔLERPOS(-2)	-0.4019	0.0000
ΔLERPOS(-4)	0.1837	0.0162
ΔLERPOS(-5)	0.1791	0.0112
ΔLERNEG	-0.1999	0.1042
ΔLERNEG(-2)	0.1965	0.0990
ΔLERNEG(-3)	0.1156	0.3315
ΔLERNEG(-5)	-0.3491	0.0039
Panel B Diagnostic Statistics		
R-squared	0.6288	
Serial Correlation	0.2961	0.7446
Functional Form	1.6534	0.1022
Normality	2.0864	0.3523
Heteroskedasticity	0.0959	0.7575
CUSUM	Stable	
CUSUM of Squares	Stable	

Notes: Serial correlation refers to the Lagrange multiplier (LM) test of residual serial correlation. Ramsey's RESET test employs the square of fitted values to check the functional form. The Jarque-Bera normality test is founded on the skewness and kurtosis of residuals tests. The heteroskesdascity (ARCH) test is used to regress squared residuals on squared fitted values. The stability test comprises cumulative sum of recursive residuals test (CUSUM) and cumulative sum of squares of recursive residual test (CUSUM of squares).

To carry out NARDL, a maximum of eight lags is levied on the estimated model (Bahmani-Oskooee and Baek 2017; Bahmani-Oskooee and Nayeri 2017). The model estimation results are presented in Table 4. The model is checked by performing a set of diagnostic tests. The Lagrange multiplier test is used to identify serial correlation while Ramsey's RESET test is used to detect model misspecification. Both statistics are insignificant, indicating that the model is well specified and free from residual autocorrelation. A normality test is performed to scrutinise the skewness and kurtosis of residuals and the insignificant statistic verifies that the residuals are normally distributed. CUSUM and CUSUM of squares tests also offer evidence of the stability of the model tested. The results indicate that a stable money demand model can be derived by using the Divisia monetary aggregate as well as by including exchange rate changes as determinants of money demand. From Table 4, the short-run analysis indicates that LRDM2, LRGDP, DPM2, LERPOS and LERNEG transmit at least one significant lagged estimate and thus imply that all variables have short-run effects on money demand. To check whether the short-run asymmetric effects are translated to the long run, a bounds test for nonlinear cointegration is performed (see Table 5).

Table 5

Bounds test for nonlinear cointegration

Money Demand Specification	F-Statistics	95% Lower Bound	95% Upper Bound	Conclusion
RDM2 Model	5.0220	2.86	4.01	Cointegration

Based on Table 5, the estimated F-statistic is 5.0220, which is greater than the critical upper bound value and thus supports the presence of cointegration. The finding enables the exploration of the long-run relations among real GDP, dual price, the nominal exchange rate and real money demand as well as changes in the nominal exchange rate on real money demand.

The results for the long-run relation are presented in Table 6. The long-run coefficient for real GDP is positive and significant at the 1% significance level. The value of income elasticity is greater than one, which indicates certain economies of scale (Bahmani-Oskooee and Baek, 2017). For dual price, the coefficient value is negative and significant at the 10% level of significance. The finding is in line with a priori theory of money demand. The results in Table 6 also show that the long-run effect of the exchange rate is asymmetric.

Table 6

Long-run relation

Variables	Coefficient	p-value
Constant	-0.7511	0.6131
LRGDP	1.2227	0.0000
DPM2	-0.0348	0.0874
LERPOS	-0.4049	0.0001
LERNEG	-0.3100	0.1306

A significant negative coefficient value is found for LNERPOS, while an insignificant coefficient value is found for LNERNEG. The partial adjustment for the presence of asymmetric effects is supported by Bahmani-Oskooee and Baek (2016) as well as Bahmani-Oskooee and Baek (2017). The significant negative coefficient of LNERPOS indicates that when the U.S. dollar appreciates, Malaysia holds less in ringgits.

Thus, a significant long-run effect exists for U.S. dollar appreciation on the demand for money in Malaysia, supporting the substitution effect. When the U.S. dollar appreciates, Malaysia will expect the U.S. dollar to further appreciate and thus buy and hold less in ringgits. The result is consistent with Marashdeh (1998) and Azali *et al.* (2000). The substitution effect is stronger in Malaysia as the central bank can manage the floating exchange rate to reduce the pressure on the ringgit and, therefore, change the public expectation. In addition, due to the financial liberalisation, the convertibility of the exchange rate can be enhanced and more buying and selling of currencies can be boosted through exchange rate derivatives. Therefore, by separating appreciation from depreciation, appreciation has long-run effects on the money demand.

4. CONCLUSION

The performance of conventional monetary aggregates in Malaysia has been affected by financial liberalisation. To consider this impact of financial liberalisation, the Divisia monetary aggregate is utilised to estimate the money demand function. The results of this study specify that a stable money demand function can be derived by using the Divisia monetary aggregate, which means that financial liberalisation has an impact on the monetary aggregate used for estimating the money demand function. This also provides an alternative for policymakers for a more stable money demand function for interest rate determination under interest targeting. Furthermore, the effectiveness of monetary policy also depends on the stability of the velocity of money, which is facilitated by a stable money demand (Bahmani-Oskooee & Baek, 2016). Hence, identifying the missing variable to define the demand for money is critical. In this study, the exchange rate is included as one of the determinants of money demand. When currency depreciation is separated from currency appreciation, the findings indicate that the exchange rate has asymmetric effects on money demand via foreign currency appreciation. Positive partial sum of exchange rate is found significant with negative coefficient. When foreign currency appreciates, Malaysians expect further appreciation of foreign currecncy. Consequently, Malaysians hold more dollars while hold less local currency. This implies the presence of substitution effect, in which Malaysians will buy or sell dollars for speculation purpose. The other determinant, income, is also highly significant and possesses expected positive coefficient value. Finally, the dual price, which shows expected negative sign of coefficient is also significant in explaining the money demand. In short, the impact of exchange rate appreciation in addition to income and interest rate should be considered in the money demand determination for policy formulation purposes.

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