The Stability of Demand for Money in Malaysia: A Cointegration And CUSUM Approach

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Abstract: The study investigates the stability of demand for money in Malaysia by using a cointegration and CUSUM approach. Monthly time series data (1996-2014) encompassing monetary aggregates M1, M2, interest rate and a scale variable represented by the Industrial Production Index (IPI) are used in the regression. The results show a long-run cointegrating relationship between the real money demand for money (both monetary aggregates), real output and interest rate. The money demand functions as revealed by CUSUM and CUSUMSQ statistical tests are relatively stable for the period studied. Empirical evidence would suggest that monetary policy decisions are effective in the broad economic objectives of Malaysia.

Key words: M1 and M2 monetary aggregates, cointegration, real output and interest rate, CUSUM and CUSUMSQ, money

INTRODUCTION

The money demand function has been studied extensively by economists and policy makers but the central issue has been on the subject of its stability in monetary theory. The long run stability of money demand has been a major macroeconomic concern for many developing countries including Malaysia and thus, warrants an empirical study.

Monetarist models as postulated by Friedman and Schwartz argue that the characteristics of real money demand in the long-run remain relatively stable namely, the parameters of money demand do not change over time. Under the quantity theory of money, the two key assumptions have been that the velocity of money (V) and aggregate output (Y) are assumed constant. Thus, changes in money quantity of demand largely depend on fluctuations of price level (P) and not interest rate (R).

On the other hand, the liquidity preference theory postulates three motives to holding money; namely transactions motive, precautionary motive and speculative motive. So under the speculative motive, money demand depends negatively on interest rate. In comparison, the liquidity preference theory assumes that velocity of money is not constant as it fluctuates directly with the interest rate. So, the demand for money depends on real income, interest rate and in an open economy, on exchange rate.

It has been argued optimistically that the effectiveness of monetary policy to move the macro economy into its desired level would be more effective if the demand for money is relatively stable in the long-run period. On the other hand, if the money demand is unstable, then monetary policy may not be effective in moving systematically the economy to its proper course in the events of fluctuating income and prices.

Hence, forth the stability of money demand function warrants further attention and investigation. A serious misspecification of the money demand function would erode the effectiveness of money as a policy instrument. It could also misguide the relationships between money demand and income, prices and other macro economic variables of the economy. The issues of model specification and its empirical evidence for money demand stability are pertinent in monetary economics. It also serves as a basis for formulating effective monetary policy to stabilize the financial sector. The study provides further empirical evidence on the stability of M1 and M2 monetary aggregates and their determinants, real output and interest rate for the Malaysian monetary sector.

Objectives of study: This study, purports to investigate the stability of money demand functions for Malaysia covering the analytical duration period of 1996:01 till 2010:12 by using monetary aggregates, M1 and M2.

Literature review: Early studies of money demand such as Chow (1966) specifies the Koyck transformation approach with the partial-adjustment or stock-adjustment process to capture the dynamics of money demand both in the short run and long run periods. However, money and other macroeconomic variables may be cointegrated,

implying that these variables have a long term relationship or equilibrium. There may be short run disequilibrium. As such, the 'error term' from the short run disequilibrium is then applied to the Error Correction Model (ECM) to estimate the long run relationships of these variables. These models assume a linear relationship with symmetric response. However, money demand function may not follow a linear relationship or assume a symmetric response.

In their study, Haug and Tam (2007) utilize monetary aggregates M0, M1 and M2 with real GNP as the scale variable as well as short or long run interest rate as a measure of opportunity costs for estimating the linear and nonlinear money demand function for the United States economy. They find that a linear error-correction model with the Monetary base (M0) performs better a model with M1 monetary aggregate. A specification with M2 monetary aggregate is not supported.

Singh and Kumar (2010) investigate the narrow money demand functions for the Pacific Island countries for the periods: 1974-2004 and 1980-2004. The study suggests that real income, nominal interest rate and real narrow money are cointegrated; while the CUSUM and CUSUMSQ stability tests indicate that the demand functions are stable.

A study by Tang (2009) on the long run M2 money demand function and its stability conducted for the period from 1971-2007 for Malaysia by using Johansen-Julius cointegration test suggests that M2 Money demand function is cointegrated with its determinants such as real income, inflation rate and exchange rate. Using the rolling regression procedure, the study concludes that M2 Money demand function is not stable over the analysis period due to a series of shocks in the monetary environment.

Sriram (2002) employs the dynamic Error-Correction Models (ECMs) to test the stability of M2 money demand function for Malaysia. Based on the weak-exogeneity test results, short run dynamic Error-Correction Models (ECMs) are also specified and estimated. The results indicate that the long-run income elasticity is close to one and the opportunity cost variables (own-rate and alternative return on money, including expected inflation rate) exhibit correct signs and acceptable magnitudes. Both the long- and short-run models are well-specified with the external events exerting a certain degree of influence on the stability.

Yol (2007) estimates the effect of foreign financial variables on money demand in Malaysia for the period 1991-2005. The test finds a single cointegration relation among the variables. The results of FMOLS Model indicate that the coefficients of real income, real exchange rate and foreign interest rate are important economic variables. Additionally, the significance of error-correction term which measures the speed of

adjustment would suggest that approximately 26% of total disequilibrium in real money demand was being corrected in each quarter in Malaysia.

Martinez and Soledad empirically investigate the monetary impact of banking crises in Chile, Colombia, Denmark, Japan, Kenya, Malaysia and Uruguay during 1975-98. Cointegration analysis and error correction modeling are used for their study. The results suggest no systematic evidence that banking crises cause money demand instability. However, the empirical results on price stability for these countries are mixed; for three out of the seven countries, there appears to be evidence of instability. Henceforth, the money demand stability results appear mix for these countries studied.

Bahmani-Oskooee and Rehman (2005) estimate the money demand function in Asian developing countries. The cointegration results show sign of stability of estimated parameters. After incorporating the CUSUM and CUSUMSQ tests into cointegration analysis, they conclude that in some Asian countries, even though real M1 or M2 monetary aggregates are cointegrated with their determinants, the estimated parameters are unstable.

Jiranyakul and Opiela (2014) investigate the shor -run and long run stability properties of money demand in Thailand by using the monetary aggregates M1, M2 and M3, for the period from 1993Q1-2012Q4. The study, uses the dynamic OLS specification and the estimation technique of the Johansen cointegration test to determine the stability of money demand. The results from the Johansen cointegration test reveal that there is only a long-run relationship between M1 money demand and real GDP (a proxy for real income) and interest rate. In the short run, only a change in real GDP affects M1 money holdings. In the long-run both real GDP and interest rate determine money demand. The study concludes that short-run instability of M1 money demand would be ineffective for the monetary authorities to control both short-run and long-run inflation.

MATERIALS AND METHODS

The econometric model: The conventional demand for money function can be expressed by a log linear relationship given as follows:

$$m_t = a + by_t + cR_t + \in_t \qquad (1)$$

Where:
m_t = Log of real money demand
y_t = Log of real income
R_t = Interest rate
$\in_t$ = Stationary error term

Based on the money demand theory, the elasticity coefficient, b for y is expected to be positive; while the elasticity coefficient, c for R is expected to be negative.

The money demand model uses the money aggregates of M1 (narrow money) and M2 (broad money), deflated by the price level as depicted in Eq. 1 is now re-written in log-linear forms and postulated below: Real narrow money (m1) demand function is given by:

$$m_t = a_1 + b_1 y_t + c_1 R_t + \in_t \qquad (2)$$

Real broad money (m2) demand function is given by:

$$m2_t = a_2 + b_2 y_t + c_2 R_t + \in_t \qquad (3)$$

The estimated model is then subjected to several statistical tests such as covariance stationary as most macroeconomic series are non-stationary in characteristic. The long-term relationships of these macroeconomic variables are estimated by using the Johansen (1988)'s test for cointegration. So, if these variables are cointegrated, then there exists a long-run equilibrium among these economic variables.

Stability tests are provided by the statistical results from the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) tests. This technique is appropriate for time series as the structural change is usually unknown. Unlike Chow test, the CUSUM and CUSUMSQ tests do not require a prior specification of structural change. The tests simply state that the null hypothesis of coefficient vector, say β is the same in every period while the alternate states that the disturbance variance is not.

Data and variables: All monthly data covering the studied period 1996 till 2010 are compiled from Malaysia. The main variables consist of monetary aggregates of m1 (narrow money) and m2 (broad money), interest rate and industrial production index (IPI with base year = 2005). M1 and M2 are used as an alternative measure for the money demand. The interest rate is used as a measure for the opportunity cost of holding money. The 3 month Treasury bill of Bank Negara Malaysia is used as a measure for interest rate. Given that there is no monthly data on GDP and the difficulty of sourcing permanent income data, the study uses the Industrial Production Index (IPI) as a proxy for a scale variable to measure national income. Except for interest rate (R_t), time series data compiled for M1 and M2 are deflated by the price level (CPI with base year = 2005) and transformed in natural logarithm (m_t). Similarly, the scale variable for IPI is also transformed to natural logarithm (y_t) These monthly time series data are collected from the various issues (1990-2010) of Monthly Statistical Bulletins published by Bank Negara Malaysia.

RESULTS AND DISCUSSION

The Johansen's cointegration test requires that the time series data for the economic variables used in the study should be integrated of order one that is I(1). This implies that the economic series should be stationary in the first-difference but stationary in the levels. Thus, the Augmented Dickey-Fuller (ADF) method is used to test the order of integration for these economic variables. Subsequently, the stability of the long-run relationships between these macro-economic variables are tested by applying the Cumulative Sum of Recursive Residuals (CUSUM) and cumulative sum of recursive squared residuals (CUSUMSQ) as based on Brown *et al.* (1975) to the residuals of Eq. 2 and 3 for the respective narrow and broad money demand functions.

Unit root test results: The initial step is to test the variables for stationarity by using the Augmented Dickey-Fuller (ADF) Method. The preliminary statistical results of ADF unit-root tests for these macroeconomic indicators are summarized in Table 1.

These ADF results (with constant) indicate that the null hypothesis of non-stationarity for real narrow money ($m1_t$) and broad money ($m2_t$) as well as the real output (y_t) and interest rate (R_t) cannot be rejected at the level. However, the non-stationarity hypothesis is rejected at the first-difference time series for all these variables.

The ADF results (with constant and linear trend) indicate that the null hypothesis for narrow money ($m1_t$) can be rejected at the 1% level. For broad money ($m2_t$), the null hypothesis of non-stationary is rejected at the second-difference. For the scale variable (y_t) and interest rate (R_t), the null hypothesis of non-stationarity for the series is rejected at the first-difference.

Cointegration test results: The cointegration test results for real narrow money (m1) and broad money (m2) demand functions are summarized in Tables 2 and 3, respectively. Both demand equations as evidenced by the trace and eigenvalues reject the null hypothesis of no cointegration at the 95% level.

From Table 2, the trace statistic and the maximum eigenvalue tests indicate at least 1 cointegrating equation at the 5% level of significance. The findings that these series are cointegrated indicate that there exists at least one linear combination of these three economic variables in the long-run equilibrium. The cointegration is normalized on the economic variable m1. The estimated coefficients of the normalized equation and their respective standard errors are also reported at the lower row of Table 2. The estimated normalized cointegrating

Table 1: Summary of ADF unit root test results

Level	With constant		With constant and linear trend	
	First-difference	First-difference	Second-difference	Second-difference
$m1_t$	0.203 (14)	-3.601*** (14)	-5.522*** (13)	-2.785 (11)
$m2_t$	-0.246 (12)	-2.794* (11)	-2.425 (12)	-10.262*** (10)
y_t	-1.405 (12)	-3.59388*** (11)	-2.235 (12)	-3.611** (11)
R_t	-2.710 (10)	-3.958*** (9)	-2.909 (9)	-4.077*** (9)

Figure in parenthesis ( ) denotes lags; optimal lag is determined by Akaike Information Criteria (AIC); ***denotes significance at the 1% level; **denotes significance at the 5% level; *denotes significance at the 10% level

Table 2: Summary of Johansen cointegration test results for narrow money (m1) demand

Hypothesized No. of CE (s)	Eigen-value	Trace statistic	5% critical Prob.[1/]
None**	0.0831 (29.9982)	29.7971	0.0474
At most 1	0.0495 (11.1680)	15.4947	0.2014
At most 2	0.0007 (0.1641)	3.8415	0.6854
None	18.8302	21.1316	0.1019
At most 1	11.0039	14.2646	0.1540
At most 2	0.1641	3.8415	0.6854

Trace statistic and maximum eigenvalue test indicate 1 cointegrating equation at the 5% level of significance; series-m1, y, R; **denotes rejection of the hypothesis at 5% level of significance; assumption-Intercept and no deterministic trend in cointegrating equation and no intercept in VAR lags based on AIC [1/]MacKinnon-Haug-Michellis (1999) p-values; Normalized cointegrating coefficients (standard errors in parentheses); m1 = 1.00; y = -4.9582; (2.3996); R = 0.7045; (0.3684); Log Likelihood; 898.1546

Table 3: Summary of Johansen cointegration test results for broad Money (M2) demand

Hypothesized No. of CE (s)	Eigen-value	Trace statistic	5% critical Prob.[1/]
None**	0.1076 (31.8346)	24.2760	0.0046
At most 1	0.0270 (7.1257)	12.3209	0.3127
At most 2	0.0054 (1.1890)	4.1299	0.3213
None**	24.7089	17.7973	0.0039
At most 1	5.9367	11.2248	0.3570
At most 2	1.1890	4.1299	0.3213

Trace statistic and maximum eigenvalue test indicate 1 cointegrating equation at the 5% level of significance; Series-m2, y, R; **denotes rejection of hypothesis at the 5% level; Assumption - no deterministic trend in cointegrating equation and no intercept in VAR lags based on AIC; 1/ MacKinnon-Haug-Michellis (1999) p-values; Normalized cointegrating coefficients (standard errors in parentheses); M2: 1.00; y: -2.0486; (0.3594) R: 0.0183; (0.0505); Log Likelihood: 1048.395

equation depicts correct signs for the macro-economic variables. Note that the results from the normalized equation shows that adjustment in the long-run period is much larger between m1 and R while smaller for m1 and y in relative terms. The statistical results show that the magnitude of income elasticity is greater than unity while the interest elasticity is <1. Both estimated coefficients have the expected correct signs and statistically significant at the 5% level.

In Table 3, the trace statistic and the maximum eigenvalue tests indicate at least 1 cointegrating equation at the 5% level of significance. The findings that these series are cointegrated substantiating that there exists at least one linear combination of these three economic variables in the long-run equilibrium. The cointegration is normalized on the economic variable m2 broad money in real term. The estimated coefficients of the normalized equation and their respective standard errors are also reported at the lower row of Table 3. The estimated
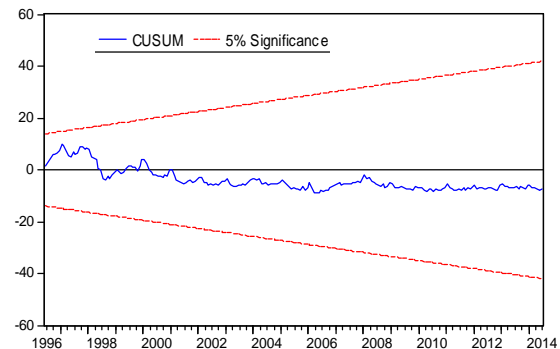

Fig. 1: Plot of CUSUM for narrow money (m1) demand function
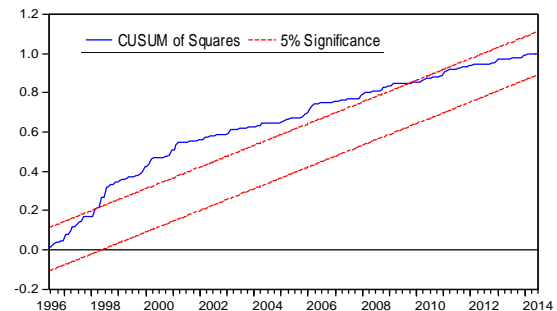

Fig. 2: Plot of CUSUMSQ for narrow money (m1) demand function

normalized cointegrating equation depicts correct signs for the macro-economic variables. Note that the results from the normalized equation shows that adjustment in the long-run period is much larger between m2 and y, while estimated coefficient R is not significant statistically at the 5% level. The statistical results show an estimated positive income elasticity of greater than unity.

Stability test results: The Stability test results by applying the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squared Recursive Residuals (CUSUMSQ) for both real narrow money (m1) and real broad money (m2) demand functions are summarized as in Fig. 1-4, respectively.

Figure 1 shows the CUSUM test results for the stability of real narrow money (m1) demand function. The
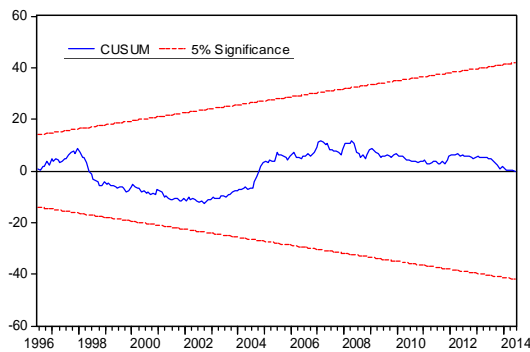
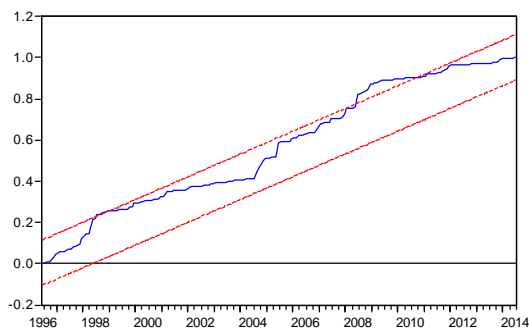Fig. 3: Plot of CUSUM for broad money (m2) demand ofunction

Fig. 4: Plot of CUSUMSQ for broad money (m2) demand function

CUSUM statistical results are used to check the stability of the economic parameters in the long-run period within the 5% critical values. The null hypothesis of parameter constancy cannot be rejected at the 5% level of significance. The CUSUM plot for m1 shows stability of the demand for money function.

Figure 2 shows the CUSUMSQ test results for the stability of real narrow money (m1) demand function. The null hypothesis of parameter constancy cannot be rejected as long as the CUSUMSQ statistics fall within the 5% significance bounds. But the movements for the period of 1998:05 till 2009:11 as depicted by CUSUMSQ statistics show them outside the 5% critical lines a period of parameter instability. This underscores the case that in a long-run equilibrium relationship, it does not always satisfy a stable parameter condition. This period of instability of the money demand function corresponds to the Asian financial crisis (1997/8) as experienced by the Malaysian financial sector.

Figure 3 plots the CUSUM test results for the stability of real broad money (m2) demand function. The CUSUM statistics are used to check the stability of the economic

parameters in the long-run period within the 5% critical values. The null hypothesis of parameter constancy cannot be rejected at the 5% level of significance. With this CUSUM plot for m2, it shows the stability of the money demand coefficients.

Figure 4 plots the CUSUMSQ test results for the stability of real broad money (m2) demand function. As observed, the null hypothesis of parameter constancy cannot be rejected as long as the CUSUMSQ statistics fall within the 5% significance bounds. The movements for the period of 2008:05 till 2010:11 as depicted by CUSUMSQ statistics in Fig. 4 show them outside the 5% critical lines a period of parameter instability. The instability of the money demand function for broad money corresponds to the period where the exchange rate for Malaysian ringgit was floated and capital controls lifted in 2008.

CONCLUSION

The empirical results of the study show that real M1 and M2 monetary aggregates are cointegrated with its determinants, namely real output and interest rate for Malaysia. It underscores the fact that there exists a linear long-run relationship between these economic variables, namely real money demand, real output and interest rate. Thus the existence of a long-run relationship further warrants the empirical investigation for their stability. In the cointegrated equations, the income elasticity of money demand is estimated to be greater than unity; while the interest elasticity of money demand is less than one. The estimated coefficients of these determinants have the expected signs.

For stability tests, the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squared Recursive Residuals (CUSUMSQ) statistical results provide the empirical evidence of a rather relatively stable long-run relationship for real M1 and M2 monetary demand balances for the studied period in Malaysia. Thus, monetary policy can rely on the monetary aggregates for broad economic objectives of Malaysia including targeting money supply and controlling inflation.

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