The Demand for Money in an Open Economy: the Case of Malaysia

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ABSTRACT

The purpose of this paper is to estimate the demand for money in Malaysia over the 1980:1-1994:10 period using cointegration and error correction methodology. The analysis shows that money balance, income, exchange rate, price and interest rate are cointegrated. Thus, the long-run demand for money balances for M1 is specified and estimated by using Johansen and Juselius Maximum likelihood cointegration method. The calculated errors from the long run money demand for M1 are then used in the error correction model of M1 demand. Hendry and Ericsson's general to specific procedure is used to reach the final form of the short-run dynamic demand for money. The explanatory variables that influence the money demand (M1) in the short run are income, expected inflation rate, 6-months mode deposit rate, expected rate of change of exchange rate, seasonal dummies, and the error correction from the long-run demand for money. Chow test shows that the estimated demand function remains stable over the 1980:1-1994:10 period. The findings, also, indicate the presence of currency substitution in Malaysia.

1. INTRODUCTION

The link between the demand for money and the expected depreciation of the exchange rate has been documented by earlier studies (see for example, Mandell (1963), Arango and Nadiri (1981), Bahmani-Oskooee and Malixi (1991), and Marashdeh (1990, 1994 and 1995)). The currency substitution literature provides evidence of how the exchange rate influences the demand for money. Currency substitution postulates that when the exchange rate depreciates, foreigners reduce their holdings of domestic money balances and domestic residents increase their holdings of foreign money balances. This in turn leads to an increase in the monetary base in the home country and domestic interest rates to decrease resulting in higher demand for money.

The impact of real effective exchange rate on the demand for money in Malaysia is examined by Marashdeh (1995). Marashdeh (1995) specifies the demand for money as a function of real income, own rate of return, interest rate on alternative assets, real effective exchange rate, and lagged money balances. He reports that the demand for narrow money is influenced by income, 3-months t-bills, and lagged money balances; whereas M2 is influenced by real income, own rate of return (6-month mode deposit rate), 3-month t-bill rate and lagged money balances. He finds that real effective exchange rate has a negative impact in the short-run, whereas it has no impact in the long-run. However, his study does not check for the degree of cointegration among the variables, i.e., the presence of spurious correlation problem among the variables.

Earlier studies of the Malaysian money demand did not examine the impact of the exchange rate on the money demand (see for example, Semadram (1981), Habibullah and Ghaffar (1987), and Habibulah (1989)). Semadram (1981) concludes that the demand for money is influenced by real income and interest rate; whereas Hibibulah and Ghaffar (1989) conclude that money demand is determined by real income, interest rate and inflation rate. Hibibulah (1989) shows that the demand for M3 is influenced by real income, interest rate, inflation rate, rate of return on money and previous holdings of money. However, these studies also suffer from the spurious correlation problem. One way to deal with this problem is the error correction approach to dynamic modelling.

Cointegration and error correction mechanisms have been used by, among others, Arize (1994), Hendry and Ericsson (1991), and Mehra (1991 and 1993) to study the demand for money. Mehra (1991 and 1993) uses cointegration and error correction to examine the stability of the U.S. demand for M2. Arize (1994) uses cointegration and error correction to show the stability of the U.S demand for M2 over the 1953:1-1991:4 period. Hendry and Ericsson (1991) apply the general to specific error correction procedure to examine the U.K demand for money.

However, none of the earlier studies on the Malaysian Money demand examines for the stationarity of the data. As such, the purpose of this study is to use cointegration and error correction techniques to model the Malaysian demand for money over the 1980:1-1994:10 period and to examine the impact of the exchange rate on the Malaysian money demand.

The period under-study witnessed the economy going through the recessions years of 1985-1986 and the subsequent recovery of the Malaysian economy thereafter. For the boom years of 1987 to 1994 the economy achieved an average annual growth rate of around 8%. This period, also, witnessed the deregulation of interest rates on loans and deposits as well as the introduction of several measures to deregulate the financial market and make it more competitive.

The deregulation of interest rates started in October 1978 by allowing banks to determine their deposit rates. This deregulation was suspended from October 1985 to January 1987 due to tight liquidity in the market and ensuing recession. During this period, commercial banks were asked to peg their deposit rates of up to one year maturity to the deposit rates of the two leading domestic banks. The deregulation was resumed in February 1987. The deregulation of the interest rates created more competitive environment in the banking industry.

The period under-study witnessed the introduction of several new financial products and technological changes. Automated Teller Machines (ATMs) were introduced in the mid 1980s. Electronic banking and telebanking were introduced in the early 1990s. Newly introduced financial products include deposit cum investment facility, cash management accounts (savings cum current account facility), multi-tiered accelerated interest rate savings deposits, Repurchase agreements (Repos), Negotiable Certificate of Deposits (NCDs), and Credit Cards. The introduction of new financial instruments and technological changes led to changes in the demand for money, away from currency and demand deposits towards quasi-money during this period.

2. **MODEL SPECIFICATIONS**

In general, a demand for money is assumed to depend on a scale variable, the rate of return on money, and the opportunity cost of holding money. To account for the openness of the economy, expected depreciation of the nominal effective exchange rate is usually added to the model. Since banks and financial institutions are not allowed to offer interest on current accounts, the appropriate rate of return on M1 is the expected inflation rate. Therefore, a long-run demand for money could be specified as follows:

$$LnM1_t = a_0 + a_1LnY_t + a_2LnP_t - a_3AR_t \pm a_4 LnE_t + e_t \qquad 1$$

where

M1 is desired money balances (defined as currency in circulation plus demand deposits).
Y is nominal income proxied by the Industrial production index (1988=100).
P is the consumer price index (1988=100) (the rate of return on money).
AR is opportunity cost of holding money (6-months mode average deposit rate (%)).
E is a trade weight nominal exchange rate (Malaysian ringgit per unit of foreign currency) for U.S.A., UK, Japan, and Singapore. The weight is taken from Marashdeh (1995).
e is an error term.

Equation 1 poses several technical problems: first, are the data stationary in their level form? Non-stationarity of data leads to biased t-statistics and invalidates the results of the regression. As such, testing for the stationarity of the data is a prerequisite for further analysis. This is done by applying Phillips-Perron unit root tests. Second, the above equation ignores the dynamic nature of money demand. Therefore, to account for the dynamics of the model, an error correction model could be specified in first difference as follows:

$$\Delta LnM_{t} = b0 + \sum_{i=0}^{n1} b_{1i}\Delta LnY_{t-i} + \sum_{i=0}^{n2} b_{2i}\Delta P_{t-i} + \sum_{i=0}^{n3} b_{3i}\Delta AR_{t-i} + \sum_{i=0}^{n4} b_{4i}\,\Delta LnE_{t-i} + + \sum_{i=1}^{n5} b_{5i}\lambda RES_{t-i} + e_{t} \qquad 2$$

Where RES_{t-i} is the lagged value of the long-run error term (equation 1) and λ is the error correction coefficient. e is an error term.

The time series properties of the data are tested for stationarity by Phillips-Perron (due to Phillips (1987), Perron (1988) and Phillips-Perron (1988)) tests for unit root. The tests are based on the following equation for the ith time series

$$\Delta X_{t} = B + (1 - A)X_{t-1} + \sum_{i=1}^{n} \theta_{i}\Delta X_{t-i} + u_{t} \qquad 3$$

Where X= LnM1, AR, LnY, LnP, LnE, and u is a residual.

A rejection of the unit root hypothesis, i.e., A=1, means that the time series is stationary, i.e., integrated of order zero, I(0). Sufficient number of lags are included based on the highest significant ACF and PACF to ensure that the residuals are not serially correlated. Equation 3 was, also, augmented with a time trend to allow for the possible presence of deterministic time trend. The equation was augmented with seasonal dummies to account for the seasonality of the data. The unit root test was, also, performed on the first difference of each time series to test for higher order unit roots. A rejection of the unit root hypothesis for the first difference means that the time series is integrated of order one, I(1), and the first difference is integrated of order zero, I(0). That is, differencing each series one time leads to stationarity.

Equation 1 was estimated by Johansen and Juselius (1990) Maximum Likelihood procedures. The procedure is based on the interim multiplier form of the vector autoregressive (VAR) representation of the system (equation (4)).

$$\Delta X(t) = \sum_{i=1}^{q-i} \Pi_i \Delta X(t-i) + \Pi_q X(t-q) + \mu + V(t) \qquad 4$$

where X(t) is nx1 vector of variables, Π_q is a square nxn matrix of ranks r ≤ n, μ is nx1 vector of constants and V(t) is nx1 vector of residuals.

The testing procedure involves the null hypothesis H_0: Π q=αβ, i.e., there are at most r cointegrated vectors β_1, β_2,.., β_r which provide r stationary linear combinations β'X(t-q). The test proceeds by regressing the n-element vectors ΔX(t) and X(t-q) on ΔX(t-i), i=1,2,...,q-1, monthly dummies and a constant, and obtaining the associated n-element residual vectors R_0(t) and R_q(t). The test for the number of cointegrating vectors is obtained by solving the eigenvalue problem

$$\left| \lambda S_{qq} - S_{q0} S_{00}^{-1} S_{0q} \right| = 0 \qquad 5$$

by the Choleski decomposition of S_{qq}. Where $S_{jj} = T^{-1} \sum_{t=1}^{T} R_{it}^{'} R_{jt}$,

i,j=0,q and T denotes the number of observations.

The likelihood ratio test (trace), for the number of cointegrating vectors is less than or equal to r, H_0: Π q=αβ , is

$$-2LnQ_r = -T \sum_{i=r+1}^{g} Ln(1-\lambda_i) \qquad 6$$

where λ_i corresponds to the n-r smallest eigenvalues of $S_{qo} S_{oo}^{-1} S_{0q}$ with respect to S_{qq}. The maximal eigenvalue statistic for testing the null hypothesis that the number of cointegrating vectors is r against the alternative r+1 is given by:

$$-2Ln(Q) = -TLn(1-\lambda_{r+1}) \qquad 7$$

3. EMPIRICAL RESULTS

The first difference of LnP and LnE were obtained as follows: a constant, and current and two lags of nominal money balances, 3-months t-bill rate, 6-months mode deposit rate, nominal income, and nominal exchange rate are used as instruments for expected inflation rate and expected depreciation of the exchange rate. The new variables were tested for unit roots and used in the subsequent analysis.

Table 1 shows the Phillips-Perron tests for unit roots for the level and first difference for log narrow money demand (lnM1), log income (LnY), 6-month mode fixed deposit rate (AR), log price (lnP), and nominal effective exchange rate (LnE). The table shows that, for the level of the variables, lnM1, LnY, AR, lnP, and LnE are cointegrated of order one, i.e, I(1), For the first difference, money demand, nominal income, expected inflation rate, expected change in the exchange rate, and 6-months mode deposit rate are stationary. Therefore, LnM1, LnY, LnP, LnE, and AR in their level form are not stationary but in their first difference are stationary. Thus, cointegration between money demand, income, exchange rate, price, and interest rate on 6-month mode deposit rate is tested. Therefore, the final form of the error-correction model to be estimated is:

$$\Delta LnM_{it} = b_0 + \sum_{i=0}^{n1} b_{1i}\Delta LnY_{t-i} + \sum_{i=0}^{n2} b_{2i}\Delta P_{T-I} + \sum_{i=0}^{n3} b_{3i}\Delta AR_{t-i} + \sum_{i=0}^{n4} b_{4i}\ \Delta LnE_{t-i} + + \sum_{i=1}^{n5} b_{5i}\lambda RES_{t-i} + e_t \qquad 8$$

Table 2 shows the residual misspecification test for the VAR model for money demand, income, expected change in the exchange rate, inflation rate, and interest rate. The lag length in the multivariate cointegrating system is determined by minimization of Akiake Information Criteria (log AIC), Schwarz Criteria (Log SC) and removal of serial correlations from the residuals. The optimal lag length to remove serial correlations is achieved at 6 lags. At lower lags the system suffers from serial correlation. Therefore, the results reported in this paper are those for the model with 6 lags. The residual misspecification tests for the residuals for the VAR model show that the M1 equation does not suffer from skewness and excess kurtosis, whereas the other equations suffer from excess kurtosis and lack of normality. The deviation from normality for the LnY, inflation, AR, and expected change in the exchange rate equations might be due to the exclusion of variables which determine income, inflation, expected change in the exchange rate, and interest rate equations other than those included in the system.

The Johansen-Juselius (1990) maximum likelihood test for the cointegration of M1, LnY, LnE, LnP and AR (table 3) indicates that there is, at most, one unique cointegrating vector. Normalizing on this vector for M1 yields:

LnM1 = 0.909LnY + 0.029R - 6.182LnE - 2.465LnP

The long-run relationship between income and money demand is positive as expected. The long-run relationship between the expected change in the exchange rate is negative, indicating the presence of currency substitution in Malaysia. The long-run relationship between money balances and inflation is negative, whereas the long-run relationship between money demand and interest rate is positive. This positive relationship could be explained by the presence of current cum interest bearing account facilities. These facilities offer the convenience of a current account with all the advantages of interest bearing account. As such, depositors might consider the rate of interest on interest bearing accounts as a rate of return on money.

The dynamic model for money demand is estimated by Hendry and Ericsson's (1991) general to specific procedure. The model uses lagged residual from the Johansen-Juselius cointegrating vector (tables 3). First, current and six lags of each explanatory variable, and the error correction term obtained from the Johansen and Juselius procedure are included. Second, insignificant variables are gradually eliminated. The validity of the restrictions is tested by using Schwarz Criterion; for reasons of space, the unrestricted form of the equation is not reported. Several diagnostic tests have been performed including Jarque-Bera test for normality, Box-Pierce-Ljung statistic for autocorrelation, the ARCH test for heteroskedasticity, the RESET test for functional misspecification, and the Chow test for structural stability.

The final form of the estimated dynamic model and the results of the diagnostic tests are presented in table 4. The model was augmented with a dummy variable to measure the impact of the deregulation suspension in October, 1985 to January, 1987. The dummy variable takes the value of one for October, 19985 to January 1987, and zero otherwise. The empirical findings presented in table 4 show that the overall fit of the estimated model is good as indicated by adjusted R-squared, SEE, the RESET test for functional misspecification, the ARCH test for conditional heteroskedasticity, the Box-Pierce-Ljung test for autocorrelation, and the Chow test for stability of the regressions after the deregulation of base lending rates in February 2, 1991. The hypotheses that the residual is not serially correlated cannot be rejected, and there is no significant autoregressive conditional heteroskedasticity or parameter instability. However, the normality assumption is rejected.

The results presented at table 4 show that income (current, and lags 1 to 6), 6-months mode deposit rate (lags 1,3, 4 and 6), expected inflation rate (current, and lags 1 and 3), expected change in the exchange rate (lags 1, 2, 4, and 6), the first lag of the error correction term and seasonal dummies are important factors in determining narrow money demand. That is, in the short-run, money demand depends on a weighted moving average of past and present income, opportunity cost of holdings money, expected inflation rate, and expected depreciation rate. The error correction from the Johansen-Juselius vector enters negatively at lag 1 with an overall impact of 0.3% adjustment every month, or 3.6% a year.

The short-run impact of income on the demand for money is alternating between positive and negative. The coefficient of Y_t is positive which implies that as income increases suddenly, money demand will not decrease rapidly as in the case of a steady rise in income. The new financial instruments which allow placement of money in interest bearing accounts, and, at the same time, allow the use of current account facilities explains the oscillating sign for income. The oscillating signs in the short-run may represent this effect: as income increases and bills are needed to be paid, a transfer from savings deposit to current accounts and currency is initiated, i.e., creating the positive relationship. However, when no bills are needed to be paid, money are then transferred back to savings accounts, i.e., creating the negative relationship. The overall impact of a rise in income is to increase money demand marginally by 0.1%.

The short-run impact of the expected inflation rate is mixed and ranges from negative to positive. Short-run coefficients on expected inflation might be explained as follows: when expected inflation increases, the immediate reaction would be to decrease the holding of money . However, if the increase in inflation persists, agents would start to increase their holdings of money balances to meet the rise in prices. In the short-run, the overall impact of a rise in inflation rate is to increase the holdings of money balances by 10.8%.

Some of the short-run effects of the interest rate have the opposite sign to the long-run effect. The immediate impact of a rise in interest rates is to reduce the holdings of money balances. The intermediate effect is mixed and alternates between negative and positive, i.e., a decrease in the holdings of money balances in the third month, an increase in the fourth month, and so on. In the short-run, the overall impact of a rise in interest rate is to increase the holdings of money balances by 0.93% every six months compared to 2.9% in the long-run.

The long-run relationship between money demand and the expected depreciation of the exchange rate is negative. As the currency depreciates rapidly, the demand for money declines. This suggests the presence of currency substitution in Malaysia. The initial effect of a rise in the expected depreciation rate is to decrease the holdings of money balances. However, the intermediate effect is to increase the demand for money balances. In this case, the impact effect has a lower coefficient than both the intermediate effect and the long-run effect. For the short-run, the impact of a rise in expected depreciation rate of the exchange rate is to increase money balances by 1.44% compared to a reduction of 62% in the long-run. The long-run coefficient on expected depreciation is larger than the long-run coefficient of the interest rate on 6-month deposit rate. This suggests that foreign currency is a closer substitute for domestic money.

4. CONCLUSION

This study uses cointegration and error correction to estimate the Malaysian money demand (M1) over the 1980:1-1994:10 period. The study utilizes Johansen and Juselius maximum likelihood cointegration procedure to estimate the long-run money demand. The error correction from the long-run money demand is then used in a dynamic model to estimate the short-run money demand. The overall explanatory power of the model is good.

In general, the findings of this study indicate that the error correction mechanism is a good representation of money demand in Malaysia over the 1980:1-1994:10 period. The speed of adjustment or error correction under the Johansen and Juselius error correction mechanism is a round 0.3% a month. Chow test for structural stability of the estimated money demand indicates stability of the money demand over the period of the study. The factors that determine the Malaysian demand for money in the short-run are income, expected inflation rate, the rate of return on 6-months mode deposit rate, expected depreciation of the exchange rate, seasonal dummies, and the error correction from the long-run demand for money..

The study finds evidence to support the presence of currency substitution in Malaysia. The presence of currency substitution has several policy implications: the monetary authority should take into account the impact of the exchange rate on the Malaysian economy in its formulation of domestic monetary policy; the presence of foreign currency accounts in Malaysia may give the Central Bank more control over the conduct of domestic policy as the Central Bank will be able to monitor the conversion of domestic money into foreign money; and to have better control over these balances, the Central Bank may need to impose required reserves.

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Table 1

Phillips-Perron Tests for Stationarity of the variables (1980:1-1994:10)

Variable	$Z(t\alpha)$	$Z(t\alpha_*)$	Lag
Level Form			
LnM1		-2.53	13
AR	-3.23		4
LnY	-1.68		13
LnE	0.78		1
LnP		-2.11	13
First Difference			
LnM1	-161.1*		12
AR	-166.2*		1
LnY	**-182.9***		**12**
LnE	-178.8*		1
LnP	-148.5 *		12

* Significant at the 1% level.

The order of lags is set as the highest significant lag order from either the ACF or PACF of the first difference series and minimization of the Akaike Information Criterion.

$Z(t\alpha)$ and $Z(t\alpha_*)$ the Phillips-Perron tests for α=1 in the no trend and trend cases, respectively.

Table 2

Residuals Misspecification tests for the VAR model

Equation	ΔLnM1	ΔLnY	ΔAR	ΔLnE	Inflation
Sigma	0.0329	0.1674	0.387	0.014	0.054
Log AIC	-436.7	-396.8	392.64	-773.8	-977.96
Log SC	-292.98	-253.1	536.34	-630.1	-834.3
Skewness	0.3199	-0.1524	0.3342	0.1256	0.2324
Kurtosis	0.7018	2.215	3.774	6.7011	1.9183
JB(2)	4.58	25.41*	74.66*	228.55*	19.8*
Chi Square(36)	25.6	38.5	30.5	16.4	39.5

* significant at the 1% level.

JB is Jarque-Bera test for normality of residuals

Chi-square (36) is autocorrelation test for the first 36 autocorrelations equal to zero.

Table 3
Johansen and Juselius Cointegration Test for the 4 VAR Model

r	Trace	Maximal Eigenvalue	Eigenvalue
4	4.24	4.24	0.1882
3	10.77	6.53	0.1435
2	23.91	13.14	0.0748
1	50.08	26.18	0.0379
0	85.31*	35.23*	0.0248

* significant at the 5% level.
r denotes the number of eigenvectors.

Table 4
The dynamic demand for narrow money (LnM1) (1980:12-1994:10)

Variable	lag	Coefficient	T-stat	Variable	Coefficient	T-stat
income	0	0.5303	9.8	February	-0.0432	-4.65
	1	-0.3642	-6.4	March	-0.0545	-5.88
	2	0.1413	2.4	April	-0.0303	-3.15
	3	-0.1961	-3.99	May	-0.0459	-4.94
	4	0.0533	3.9	June	-0.0262	-2.87
	5	-0.1281	-3.02	July	-0.0430	-4.83
	6	0.0402	3.3	August	-0.0402	-4.77
interest rate	1	-0.0099	-1.67	September	-0.0278	-3.47
	3	-0.0097	-1.97	October	-0.0399	-4.82
	4	0.0230	3.3	November	-0.0232	-3.1
	5	-0.0102	-2.26	December	-0.0134	--1.51
	6	0.0161	2.48	Constant	0.0088	0.79
inflation	0	-2.9654	-9.39	Dummy	-0.0066	-1.66
	1	2.3622	6.81			
	2	-1.2047	-3.28			
	3	1.1712	3.87			
	5	0.7443	3.14			
Exchange rate	1	-0.5647	-2.7			
	2	0.8914	5.76			
	4	0.7347	3.2			
	6	0.3744	2.13			
RES		-0.0032	-3.1			
Rho		-0.3939	-4.9			

Summary Statistics
R-Square = 0.78 R-Square Adjusted = 0.72
SEE-SIGMA = 0.0177 SSR= 0.0409
Model Selection Tests
Akaike (1973) Information Criterion- Log AIC = -463.97
Schwarz(1978) Criterion-log SC = -354.84
Skewness= 0.399 Excess Kurtosis=1.12 Jarque-Bera Normality Test: $\chi^2(2)$= 10.38
Heteroskedasticity Test: ARCH Test: $\chi^2(12)$= 16.2
Ramsey RESET Specification Tests:
RESET(1,131)= 1.226 RESET(2,130)= 0.641 RESET(3,129)=0.558
Autocorrelation Tests:
Box-Pierce-Ljung $\chi^2(36)$= 26.72 Durbin-watson= 1.95
joint significance of variables
seasonal dummies: F(11,131) = 6.4 income: F(7,131) = 16.7
interest rate: F(5,131) = 3.1 inflation: F(5,131) = 19.3
exchange rate: F4,131)= 11.9 regression: F(35131)= 17.6
Chow Test: F(34,100)= 15.3 Z(6) = -156.36

Z(n) is Phillips-Perron unit root test with and n lags.
RES is the error correction term from the Johansen and Juselius cointegration procedure.
Rho is the first order correlation coefficient.