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Simple-sum Versus Divisia Monetary Aggregates for Malaysia: Cointegration, Error-Correction Model and Exogeneity

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ABSTRAK

Kajian ini cuba menentukan hubungan jangka panjang di antara wang dan pendapatan di Malaysia. Agregat kewangan Divisia dibentuk untuk Malaysia dan dibandingkan dengan agregat kewangan Campuran-mudah untuk tempoh masa 1980:1 hingga 1994:4. Hubungan jangka panjang di antara agregat-agregat kewangan dan pendapatan dinilai menggunakan kaedah dua peringkat Engle-Granger (menguji kointegrasi) dan rangka kerja pembetulan-ralat untuk menguji "weak exogeneity" dan "superexogeneity". Keputusan kajian menyarankan penggunaan agregat-agregat kewangan sebagai petunjuk-petunjuk dasar tidak tertakluk kepada "Lucas critique" dan juga agregat kewangan Divisia berpotensi digunakan untuk tujuan dasar kewangan di Malaysia.

ABSTRACT

In this study we attempt to investigate the long run relationship between money and income in Malaysia. We constructed Divisia monetary aggregates for Malaysia and compared its performance with the Simple-sum monetary aggregates for the period 1980:1 to 1994:4. The long run relationship between the monetary aggregates and income were evaluated using the Engle-Granger's two-step procedure (testing for cointegration) and the error-correction for weak exogeneity and superexogeneity. Our result suggest that the use of monetary aggregates as policy indicators are not subject to the Lucas critique and that there is potential role for Divisia monetary aggregates as a useful guide for monetary policy purpose in Malaysia.

INTRODUCTION

The financial system in Malaysia has undergone a radical structural transformation. In the 1960s, the financial system was characterised by financial markets dominated mainly by the Central Bank and commercial banks with demand deposits and currency as the main financial instruments and regulated low interest rates. However, in the 1990s, the scenario has turned into a more efficient and sophisticated financial system characterised, among other things, by the prevalence of various non-bank financial intermediaries, varieties of interest-bearing financial assets with varying maturity dates and a spectrum of interest rates offered, market-determined interest rates and well-developed money, commodity and capital markets.

The development within the financial system has important implications for the purpose of monetary policy. For the past forty years, the Malaysian monetary authority has focused on the narrow money supply M1, as an indicator or guide for monetary policy purposes. However, more recently, the Central Bank has been concerned with the behaviour and the stability of money supply M1 as a policy tool. The Central Bank realised that as a result of rapid growth and innovations in the financial sector, there has been a shift out of currency holdings and demand deposits into interest-bearing deposits of the commercial banks, finance companies, merchant banks and other non-bank financial intermediaries, thus showing substitution between non-interest-bearing and interest-bearing financial assets (Bank Negara Malaysia 1985). As a result more emphasis is now given to broader money supply M2 and M3 for monetary management.

The purpose of the present study is three-fold. First, the study investigates the long-run relationship between money and income in the error-correction framework for a developing country – Malaysia. Second, the study addresses the issue of whether the Lucas critique is relevant in the case of monetary aggregates used for policy variables in Malaysia. Third, is to provide alternatives to the monetary aggregates currently defined and published by Bank Negara Malaysia. The alternative monetary aggregate propose is the Divisia aggregate which according to Barnett (1980) (who pioneered this line of work), is an appropriate measurement for the monetary services of a nation.

METHODOLOGY

The Estimation Approaches

In recent years, discussion in econometric analysis has focused on the time series properties of economic variables. A key concept underlying much of econometric theory is the assumption of stationarity. This assumption has important consequences for the interpretation of economic models and data. This is so because the level of a stationary series, for example, will not vary greatly with the sampling period and has a tendency to return to its mean value (Granger 1986; Hendry 1987). On the other hand, the properties of non-stationary series, which are more interesting to study, are quite different from those of stationary ones because the former will be characterised by a time varying mean which have a tendency to drift away from its mean. Some possible sources of non-stationarity deal with polynomial time trends, unit roots and integrated series (Granger 1986; Engle and Granger 1987).

It is generally argued that testing for the presence of unit roots in the autoregressive representation of a time series can be considered as testing for stationarity. This is because the test amounts whether certain coefficients of the representation are unity. Accordingly, the question of how many times we should difference the series or whether to detrend a series to achieve stationary may also be answered.[1]

Since our interest is to determine the long-run relationships between monetary aggregates and nominal income, the first step is to determine the order of integration of each of the series involved. The standard procedure for determining the order of integration of a time series is the application of augmented Dickey-Fuller test (Dickey and Fuller 1979) which requires regressing Δy_t on a constant, a time trend, y_{t-1} and several lags of the dependent variables to render the disturbance term white-noise. Then the t-statistic on the estimated coefficient of y_{t-1} is used to test the following null and alternative hypothesis:

$$H_0 : y_t \sim I(1) \quad \text{vs} \quad H_1 : y_t \sim I(0)$$

The null hypothesis is saying that variable y_t is stationary to the order one or it is integrated of order one compared to the alternative that y_t is integrated of order zero. If the null cannot be rejected, it is said that y_t probably need to be differenced once to achieve stationarity. If on the other hand, the null is rejected then y_t is stationary in its level form. The critical values are called the 'ADF statistics' and are available in Fuller (1976), Engle and Yoo (1987) and in MacKinnon (1991).

If the null hypothesis cannot be rejected then y_t is non-stationary and it may be I(1) or I(2), or have an even higher order of integration. To find out the order of integration, the test is repeated with Δy_t in place of y_t, thus regressing $\Delta^2 y_t$ on a constant, Δy_{t-1} and several lags of $\Delta^2 y_t$. The ADF statistic therefore tests the following:

$$H_0 : \Delta y_t \sim I(1) \quad \text{vs} \quad H_1 : \Delta y_t \sim I(0) \text{ i.e.}$$
$$H_0 : y_t \sim I(2) \quad \text{vs} \quad H_1 : y_t \sim I(1)$$

If the ADF statistic is not large and negative then we cannot reject H_0 and y_t cannot be I(1). In this case the test is repeated with $\Delta^3 y_t$ as the

1. For references and further discussion on unit roots, see Perman (1991) and Dolado *et al.* (1990).

dependent variable and so on, until the order of integration is determined. To supplement the ADF unit root test, we also estimate the Phillips and Perron (1988) (hereafter the PP test) unit root test. The PP unit root test is a non-parametric method of detecting whether a time series contains a unit root. This test is robust to a wide variety of serial correlation and time dependent heteroskedasticity.

After determining that the series are of the same order of integration, we test whether the linear combination of the series that are non-stationary in levels are cointegrated. To conduct the cointegration test, we follow the popular Engle and Granger (1987) two-step procedure for testing the null of no cointegration. The first step of the Engle and Granger's procedure is to determine α as the slope coefficient estimate from the OLS regression of y on a constant (c) and x. A test of cointegration is then that the residuals μ_t (i.e. y_t-c-αx_t) from the 'cointegrating regression' be stationary. So in the second step, the ADF unit root test is conducted on the residual μ_t so as to reject the null hypothesis of integration (of order 1) in favour of stationarity, using the critical values which are provided in Engle and Yoo (1987) and MacKinnon (1991). If the ADF statistics are not large and negative then it is likely that the series are not cointegrated. A less powerful test of cointegration is the 'cointegrating regression Durbin-Watson' (CRDW) statistic where cointegration is rejected if the Durbin-Watson statistic is too low. The critical values for CRDW are provided by Engle and Yoo (1987).

If it was shown that x and y are both I(1), but are cointegrated, then the two series will be generated by an error-correction model of the following form,

$$\Delta y_t = c_0 + \sum_{i=1}^{q} \phi_i \Delta y_{t-1} + \sum_{j=0}^{p} \lambda_j \Delta x_{t-j} + \theta \mu_{t-1} + \varepsilon_t \qquad (1.1)$$

where μ_{t-1} is the lagged residuals saved from running the static cointegrating regression with y on a constant and x. The error-correction mechanism (ECM) is usually referred to μ_{t-1}. Our point of interest is that $\theta<0$ and significant implies that x and y are cointegrated.

Testing for Lucas Critique

The concept of exogeneity and its testable application has been introduced by Engle *et al.* (1983) and Engle and Hendry (1993). Engle *et al.* (1983) have proposed three types of exogeneity: weak exogeneity, strong exogeneity and superexogeneity. The test for exogeneity is important because in empirical applications, while only weak exogeneity is needed for estimation purposes and for testing, and strong exogeneity for forecasting, superexogeneity is required for policy analysis. According to Engle *et al.* (1983), the concept of superexogeneity is closely associated with the Lucas (1976) critique. Lucas (1976) argues that an econometric model is unstable and will perform poorly in different time period because the underlying structure changes as expectation-generating mechanism and/or policy regime changes over time. Therefore, a relevant economic series or an economic model needs to be invariant to these changes to be useful for policy analysis.

Favero and Hendry (1992) have shown that the concept of superexogeneity can be used to examine if a policy variable is subject to the Lucas (1976) critique. More recently, the relevance of Lucas critique on the performance of economic modelling has been subjected to rigorous empirical investigations and testings in the literature (Favero and Hendry 1992; Fischer 1989; Fischer and Peytrignet 1991; Caporale 1996; Kwan and Kwok 1995; Kwan *et al.* 1996). However, the majority of the studies conclude that the Lucas critique is not of empirical significance in accounting for the failures of the econometric models (see also Fischer 1988). Thus, in our case, if a monetary aggregate possesses the superexogeneity status, that is, the coefficient of money variable is invariant to policy changes, then policy evaluation using this approach is possible and thus useful to the monetary authority.

Lets consider the following simple regression model,

$$y_t = a + bx_t + \varepsilon_t \qquad (1.2)$$

where y_t and x_t have normal distribution with means $E(y_t) = \mu_y$, $E(x_t) = \mu_x$ and variances and covariances given by $var(y_t) = \sigma_y^2$, $var(x_t) = \sigma_x^2$, and $cov(y_t,x_t) = \sigma_{yx}$. The conditional distribution of y_t given x_t is,

$$y_t \mid x_t \sim IND(a + bx_t, \sigma^2) \qquad (1.3)$$

where 'IND' denotes independently and normally distributed, $b = (\sigma_{yx}/\sigma_x^2)$, and $\sigma^2 = [\sigma_y^2 - (\sigma_{yx}/\sigma_x^2)]$. The joint distribution of y_t and x_t can be written as,

$$f(y_t, x_t) = g(y_t|x_t)h(x_t) \quad (1.4)$$

where $g(y_t|x_t)$ involves the parameter Φ and $h(x_t)$ is the marginal distribution of x_t. Based on equation (1.1), a variable is said to be weakly exogenous for estimating a set of parameters Φ, if inference on Φ conditional on x_t involves no loss of information. Weak exogeneity represents a necessary condition for satisfactory single-equation regression model. Furthermore, in a dynamic context, weak exogeneity allows feedback from the endogenous to the exogenous variables and therefore, weak exogeneity may tell us nothing about the direction of causality of y_t to x_t or x_t to y_t. In other words, weak exogeneity implies that the marginal distribution $h(x_t)$ does not involve the parameter Φ. On the other hand, if x_t is weakly exogenous and is not Granger caused by any of the lagged values of y_t, it is said to be strongly exogenous. Thus, Granger non-causality (from y_t to x_t) is considered to be a necessary condition for strong exogeneity. As for superexogeneity, if x_t is weakly exogenous and the parameters in $g(y_t|x_t)$ remain structurally invariant to changes in the marginal distribution of x_t (i.e. to changes in regime or policy interventions), then x_t is said to be superexogenous (Engle *et al.* 1983).

In our case, to construct a test for the null hypothesis that money, x_t is weakly exogenous, we first estimate an instrumental variable estimates of x_t, and then test for the presence of the predicted values of x_t in the dynamic error-correction model. The significance of the residuals or the fitted estimates from the instrumental variables regression may be tested with a *t*- or *F*-tests. In this study, the following general autoregressive model for money supply (the instrumental variable equation) is estimated,

$$\Delta_4 x_t = \alpha_0 + \sum_{i=1}^{L} \beta_i \Delta_4 x_{t-i} + DUM + \omega_t \quad (1.5)$$

where dummy variables, DUM act as proxies for possible structural breaks. The estimated ϖ_t is then substituted in the conditional model specified by equation (1.1) as follows,

$$\Delta y_t = c_0 + \sum_{i=1}^{q} \phi_i \Delta y_{t-1} + \sum_{j=0}^{p} \lambda_j \Delta x_{t-j} + \theta \mu_{t-1} + \delta_1 \varpi_t + \varepsilon_t \quad (1.6)$$

If ϖ_t is significant in terms of the t-statistic in the dynamic error-correction model, then the null hypothesis that money is weakly exogenous is rejected. On the other hand, to test for superexogeneity, the estimated ϖ_t and the square estimated ϖ_t^2 are included in equation (1.1) and test for their joint significance as follows,

$$\Delta yt = c_0 + \sum_{i=1}^{q} \phi_i \Delta y_{t-1} + \sum_{j=0}^{p} \lambda_j \Delta x_{t-j} + \theta \mu_{t-1} + \delta_1 \varpi_t + \delta_2 \varpi_t^2 + \varepsilon_t \quad (1.7)$$

A significant *F*-test indicates a rejection of superexogeneity.

Sources of Data and the Construction of Divisia Aggregates

Data on money supply M1 and M2, monetary components, bank reserves, rates of return on financial assets, bank lending rate used in the computation of the Divisia monetary aggregates were collected from various issues of Quarterly Economic Bulletin published by Bank Negara Malaysia.

Despite the ability of money supply M1, M2 and M3 to predict nominal income in Malaysia, the practice of Bank Negara Malaysia in computing the national money supply aggregates is flawed. Barnett (1980) has emphasized that the conventional "Simple-sum" monetary aggregate which was calculated on the assumption that their components receive equal weights of one, is an incorrect measurement of the flow of monetary services. Following Barnett (1980), a Divisia monetary aggregate is constructed in the following manner: Let q_{it} and p_{it} represent the quantities and user costs of each asset to be included in the aggregate at time t. The expenditure share on the services of monetary asset i in period t is:

$$s_{it} = p_{it}q_{it}/\Sigma_j p_{jt}q_{jt}. \quad (1.8)$$

The user cost (Barnett 1978) of each asset is measured as:

$$p_{it} = (R_t - r_{i,j})/(1 + R_t) \quad (1.9)$$

where R_t is the benchmark rate, the maximum $[r_j, r_i; i=1,2,...,n). j=1,2,..k. i \neq j]$. The growth rate of a Divisia aggregate then can be written as

$$G(Q_t) = \sum_{i=1}^{n} s_{it}^* G(q_{it}) \qquad (1.10)$$

where $s_{it}^* = 0.5(s_{it}+s_{it-1})$ and n is the number of assets in the aggregate. Single period changes, beginning with a base period can be cumulated to determine the level of the Divisia aggregate in each succeeding period.

Details of the monetary components and their respective user costs in constructing the Divisia monetary aggregates are presented in Table 1.[2] From Table 1, we can observe that the rate of return on currency is assumed to be zero since it is a perfectly liquid asset. On the other hand, although the explicit rate of return on demand deposits is also zero, Offenbacher (1980) and Barnett *et al.* (1981) strongly argue that an implicit rate of return must be imputed to demand deposits, if the substitutability between currency and demand deposits is to be estimable. Barnett (1982: p. 699) proposes that, 'In some cases implicit rates of return must be used in computing the interest rates in the formula p_i, especially when the own rate of return on an asset is subject to governmental rate regulation. An implicit imputation is also used in the measurement of R. The Divisia quantity index has been found to be robust to those imputations within the plausible ranges of error in the imputation'.

However, the proper implicit rate imputation for demand deposits remains an open issue. Following Offenbacher (1980), the approach taken in this study is to compute an implicit rate using Klein's (1974) methodology. The formula used for constructing the implicit rate on demand deposits (DDr) is given as follows

$$DDr = r_L\ [1 - (BR/DD)] \qquad (1.11)$$

where r_L is the rate of return on bank's earning assets and BR is bank reserves on demand deposits. As for the benchmark asset, as shown in Table 1, we follow the envelope approach, that is, a series of benchmark rate is formed by selecting the benchmark rate which is higher than the rate of return of each monetary asset components. This will ensure that $p_i \geq 0$ (Mullineux 1996). Furthermore, Binner (1990) proposes adding 0.10 points to the benchmark

TABLE 1
Information used to construct divisia aggregates

Money	Asset Components	Rate of Return
M1	Currency in circulation	Zero
	Demand deposits	Implicit rate of return. Using Klein's (1974) method. The basic formula for computing Demand deposit rate of return (DDr) is as follows; DDr = rL*(1-RRDD), where rL is commercial bank's base lending rate (percent p.a.), and RRDD is reserve requirement on demand deposits.
M2	Saving deposits	Savings deposit rate (SDr) in percent p.a.
	Fixed deposits	Fixed deposit rate (FDr). FDr= max $[(r_i)]$, where i=1, 3, 6, 9 & 12 months maturity (percent p.a.).
	Negotiable Certificate of Deposits	Rate on NCDs (NCDr). Proxied with the Interbank rates, r. NCDr= max $[(r_i)]$, where i=overnight, 7-days, 1 month & 3-months call money (percent p.a.).
	Repurchase agreement (Repos)	Repo rate (REPOr). Proxied with the call money rate at discount houses, r. REPOr= max $[(r_i)]$, where i=3, 6 & 12-months maturity (percent p.a.).
	Benchmark asset	*Maximum available rate. Max = {[Ddr, SDr_i, FDr_i, NCDr, REPOr, r_j] + 0.1}, where i=rates at commercial banks and Finance companies; j= Treasury bill rates (3, 6 & 12-months) and yield on Goverment securities (5 & 20 years).*

Source: Author's calculation.

2. Divisia M3 is excluded from the analysis because data on savings and fixed deposits at discount houses and Bank Islam, interest rates on deposits at merchant banks, discount houses and Bank Islam are not available.

rate to ensure that this rate will be non-zero.

As for income variable, since GNP is only available annually, we follow Gandolfo's (1981) technique to interpolating quarterly data from annual observations.

THE EMPIRICAL RESULTS

Results of Integration Tests

Table 2 presents the results of the unit root tests on the levels and first-differences of the series. In order to choose the appropriate lag length, we follow the procedure suggested by Campbell and Perron (1991). According to this approach, we start with some upper bound on k, say k_{max}, chosen a priori. Estimate an autoregression of order k_{max}. If the last included lag is significant (using the standard normal asymptotic distribution), select $k=k_{max}$. If not, reduce the order of the estimated autoregression by one until the coefficient on the last included lag is significant. If none is significant, select k=0. Results in Table 2 clearly indicate that income and all four monetary aggregates are stationary after they have been first-differenced. In Table 3, we present the results of the cointegration test between the monetary aggregates and income. The results of the unit root test on the residuals of the cointegrating regressions for all monetary aggregates suggest that the null hypothesis of non-cointegration can be rejected at five percent significance level. But, on the contrary, the CRDW statistics indicate that there is no long-run relationship between income and both the

TABLE 2
Results of integration tests

Series	Series in levels		Series in first-differences	
	ADF	PP	ADF	PP
Simple-sum M1	-1.04 (6)	-0.28 (3)	-3.34* (5)	-7.89** (3)
Simple-sum M2	-0.50 (1)	-0.32 (3)	-5.58** (1)	-6.84** (3)
Divisia M1	-1.28 (4)	-0.28 (3)	-7.80** (1)	-7.99** (3)
Divisia M2	-1.44 (4)	-1.28 (3)	-6.19** (1)	-8.39** (3)
Income	-0.09 (8)	-1.28 (3)	-4.45** (3)	-5.59** (3)

Notes: Asterisks (*), (**) denote statistically significant at 10 and 5 percent level respectively. The critical values are –3.49 (1%) and –3.18 (10%) (see MacKinnon, 1991).

TABLE 3
Results of cointegration tests

Series	Cointegrating regressions				ADF auxiliary regressions	
	Coefficient on regressors					
	Constant	α	R^2	CRDW	ADF	Lags
Simple-sum M1	1.70	0.84	0.98	0.48	-3.87**	4
Simple-sum M2	1.39	0.77	0.96	0.22	-3.68**	3
Divisia M1	0.05	1.02	0.98	0.54	-4.27**	4
Divisia M2	0.90	0.83	0.96	0.21	-3.38*	12

Notes: At 5 percent significance level, the critical values for CRDW is 0.78 (see Engle and Yoo, 1987), and cointegration test is -3.45 (see MacKinnon, 1991). Asterisks (*), (**) denote statistically significant at 10 and 5 percent level respectively.

3. Engle and Yoo (1987: p. 157) note that, "We have examined the behavior of the Durbin-Watson statistic from the co-integrating regression. Unfortunately, the discrepancy between the critical values for different systems remains significant even for the sample size two hundred. This is not surprising since the statistic is not asymptotically similar as are the preceeding tests. Hence this statistic does not appear to be useful for testing co-integration".

TABLE 4
Results of error-correction models

Variables	Simple-sum M1	Simple-sum M2	Divisia M1	Divisia M2
Constant	0.0147 (9.9107)*	0.0080 (2.7156)*	0.0122 (4.9017)*	-0.0015 (0.6821)
ECM_{t-1}	-0.1282 (6.9545)*	-0.1134 (3.0237)*	-0.2638 (7.0821)*	-0.0411 (2.9624)*
Δy_{t-1}	0.5441 (11.647)*	0.7221 (10.253)*	0.2169 (4.0415)*	1.0098 (22.474)*
Δy_{t-3}			0.1858 (3.3911)*	
Δy_{t-4}		-0.3944 (7.4493)*		-0.3633 (9.6407)*
Δy_{t-5}	0.1523 (3.7358)*	0.5254 (7.6567)*		0.3558 (9.5287)*
Δy_{t-8}	-0.2487 (5.7118)*	-0.3788 (6.4828)*		-0.3504 (10.931)*
Δy_{t-9}		0.2583 (6.2560)*		0.3566 (11.022)*
Δy_{t-10}		-0.0558 (2.6248)*		
Δy_{t-13}		0.0844 (2.6111)*		
Δy_{t-15}	-0.0697 (3.4623)*			
Δm_{t}	0.0533 (2.2491)*	0.0659 (2.0333)*	0.1343 (2.2128)*	0.0508 (1.5161)
Δm_{t-4}	-0.1801 (6.2235)*			
Δm_{t-6}		-0.0764 (1.8758)		
Δm_{t-7}	-0.1031 (3.0923)*			
Δm_{t-8}	0.1936 (5.3586)*	-0.1003 (2.6688)*		
Δm_{t-9}	0.0575 (2.1047)*	0.0717 (2.2513)*		
Δm_{t-11}	0.1938 (5.9527)*			
Δm_{t-12}			0.0145 (0.2122)	
Δm_{t-16}	-0.0893 (2.9004)*	-0.0866 (2.2492)*		
Δm_{t-19}		0.0801 (2.2190)*		
Δm_{t-20}	0.1129 (3.6200)*	0.0945 (2.6790)*		
D84:1				0.1078 (17.598)*
D84:2				-0.1106 (12.586)*
D86:1			-0.0599 (6.0728)*	
R-squared	0.92	0.95	0.82	0.97
SER	0.003	0.003	0.009	0.005
DW	2.68	2.53	1.49	2.36
Weak exogeneity test:				
t-statistic on θ_1	0.3373	0.1843	-0.8184	0.4329
Superexogeneity test:				
t-statistic on θ_1	0.3386	0.2249	-0.4960	0.4993
t-statistic on θ_2	1.2406	-0.2998	-1.5263	-0.6900
F-statistic, $\theta_1 \cap \theta_2 = 0$	0.827 [0.452]	0.061 [0.941]	1.513 [0.235]	0.330 [0.721]

Notes: ECM denotes error-correction term, i.e. the residuals from running the static cointegrating regression. SER denotes standard error of regression. DW denotes Durbin-Watson statistic. D denotes dummry variable. Numbers in parentheses (.) are *t*-statistics and numbers in the square brackets [.] are *p*-values. Asterisk (*) denotes statistically significant at the 5% level.

Simple-sum and Divisia monetary aggregates (M1 and M2). Nevertheless, since CRDW statistic has low power compared to the Engle-Granger's two-step approach,[3] we conclude that there is long-run relationship between monetary aggregates and income in Malaysia.

Results of the error-correction models estimated for each of the monetary aggregates are presented in Table 4. For all error-correction models estimated, the final models were derived according to the Hendry's 'general-to-specific' specification search and the congruency of the models with the data generating process (Hendry 1987) are observed from a battery of diagnostic tests which include the test for serial correlation, heteroskedasticity, normality of the residuals and incorrect functional form (not reported here in order to conserve space, but is available from the author upon request). Generally, the diagnostic tests indicate well-fitting error-correction models for each monetary aggregates that fulfills the condition of serial non-correlation, homoskedasticity, normality of residuals and no specification errors.

A very important observation is made from Table 4. The results for both Simple-sum and Divisia money (M1 and M2) suggest that money and income is cointegrated. In all four estimated equations, the coefficient of the error-correction terms are significantly different from zero at the five percent level. The t-statistics of the ECM terms are large and negative, and therefore support the notion that monetary aggregates and income in Malaysia exhibit long-run relationships over the period under study. This result suggests that both Simple-sum and Divisia money (both M1 and M2) are good intermediate indicators for monetary policy purpose.

The results of weak exogeneity tests as shown by the significance of the t-statistics of ϖ_t in the conditional models are presented in the lower section of Table 4. The results clearly indicate that for all four monetary aggregates, when the residuals ϖ_t from the money supply equation is added to the conditional model, the coefficient of ϖ_t is insignificantly different from zero at the five percent level. This indicates that Malaysia's monetary aggregates are weakly exogenous in the income equation. As a consequence, the use of a single-equation regression in estimating the impact of monetary aggregates on income is justified. And when both ϖ_t and ϖ_t^2 were included in the income equation, the results of the *F*-test indicate that their coefficients are statistically insignificant at the five percent level, joint hypothesis of superexogeneity cannot be rejected. This finding suggests that the monetary aggregates are not subject to the Lucas critique.

CONCLUSION

The question of the appropriate empirical definition of money is one of the most debatable and unsettled issues in economics. A survey by Kumah (1989) indicates that in general, the measurement of money supply used by the monetary authorities for over 150 countries is limited to M1, M2 and M3, depending on the level of development or monetisation of the financial system. As the financial sector develops, new financial intermediaries emerge, offering varieties of interest-bearing financial assets with various maturity dates, and these financial assets will be added as components of money giving a broader concept of monetary aggregates. However, the practice of adding the components of financial assets together without appropriately taking into consideration the weight of each assets components was criticised by Barnett (1980). They argued that in monetary aggregation, it is not which assets are to be included in the measure of money supply which is important, but rather how much of each monetary asset is to be included. This points to the conclusion that each component should be given a different weight when adding the various components of financial assets to arrive at the official monetary aggregates.

In this study we have constructed and computed Divisia monetary aggregates for Malaysia. The purpose of this paper is to investigate the long-run relationships between the alternative monetary aggregates and national income during the era of financial innovation and deregulation in Malaysia. Alternative monetary aggregates included in the analysis are Simple-sum (both M1 and M2) and Divisia (both M1 and M2) monetary aggregates. The Divisia aggregates are constructed using the method proposed by Barnett (1980). The long-run relationships between the monetary aggregates and national income were evaluated using the Engle-Granger's two-step procedure (testing for cointegration) and the error-correction framework.

The major results of this paper may be summarised as follows: First, the empirical tests indicate that income and all four monetary aggregates employed in this study are integrated of order one. Second, the cointegration test between the monetary aggregates and nominal income using the Engle-Granger's two-step procedure suggests that the two series are cointegrated. Third, our error-correction models further support the long-run relationships between money and income in Malaysia. Fourth, our weak exogeneity test suggests that the estimated single-equation error-correction model for income is well specified. Fifth, the superexogeneity test indicates that the use of monetary aggregates as policy indicators are not subject to the Lucas critique and therefore suggests that using monetary aggregates for making policy evaluation is possible. Finally, we conclude that there is potential role for Divisia monetary aggregate as a useful guide for monetary policy purpose in Malaysia.

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APPENDIX

The estimated instrumental variable regressions (i.e. money supply reaction function) used in the exogeneity tests are recorded below;

$$\Delta sm1_t = \underset{(5.2783)}{0.0307} + \underset{(2.0997)}{0.2167}\Delta sm1_{t-1} - \underset{(2.1507)}{0.2614}\Delta sm1_{t-6}$$

$$+ \underset{(3.2847)}{0.3537}\Delta sm1_{t-12} - \underset{2.3287)}{0.2841}\Delta sm1_{t-17} - \underset{(2.6871)}{0.0569}D86{:}1$$

$$- \underset{(2.6380)}{0.0505}D92{:}2 + \underset{(5.8554)}{0.1164}D93{:}4 \qquad (A1)$$

R2 = 0.766 D.W. = 1.90

$$\Delta sm2_t = \underset{(8.2860)}{0.0625} - \underset{(2.0667)}{0.2901}\Delta sm2_{t-13} - \underset{(3.5736)}{0.4685}\Delta sm2_{t-18}$$

$$- \underset{(2.5135)}{0.3852}\Delta sm2_{t-19} - \underset{(2.4951)}{0.0379}D88{:}1 - \underset{(2.3929)}{0.0369}D90{:}2$$

$$- \underset{(2.0875)}{0.03131}D91{:}2 + \underset{(3.0422)}{0.0453}D93{:}4 + \underset{(4.5874)}{0.0694}D94{:}1 \qquad (A2)$$

R^2 = 0.735 D.W. = 2.19

$$\Delta dm1_t = \underset{(3.8479)}{0.0165} + \underset{(5.4929)}{0.5141}\Delta dm1_{t-4} - \underset{(2.3337)}{0.2238}\Delta dm1_{t-10}$$

$$+ \underset{(2.5189)}{0.2545}\Delta dm1_{t-12} - \underset{(4.4220)}{0.0680}D84{:}3 - \underset{(2.1834)}{0.0344}D84{:}4$$

$$- \underset{(3.5096)}{0.0548}D85{:}2 - \underset{(2.1439)}{0.0339}D90{:}4 \qquad (A3)$$

R2 = 0.773 D.W. = 2.00

$$\Delta dm2_t = \underset{(3.8097)}{0.0240} + \underset{(2.7508)}{0.3702}\Delta dm2_{t-4} - \underset{(2.1909)}{0.3202}\Delta dm2_{t-6} + \underset{(2.9371)}{0.0662}D87{:}2$$

$$+ \underset{(3.2184)}{0.0678}D94{:}1 \qquad (A4)$$

R^2 = 0.373 D.W. = 2.18

The data are quarterly and cover the period 1981:1-1994:4. sm_j and dm_j denote Simple-sum and Divisia money respectively and j = 1,2 (1=M1, 2=M2). The inclusion of dummies, D proxy for regime shifts is also necessary to produce homoscedastic residuals. And Δ is the difference operator.