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Testing Long-Run Neutrality of Money in Malaysia

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INTRODUCTION

Monetary aggregates movements and their influence on domestic economy are important and essential to policy makers and researchers. To the policy makers, the influence and the existence of special relationship between monetary aggregates and other macroeconomic variables are important in designing policies such as to curb inflation pressure, stimulating economic growth and reduce unemployment problem. On the other hand, the researchers may use these aggregates and their relations with macroeconomic variables to estimate a complex macro model of an economy.

In Malaysia, traditionally, monetary aggregate has been the major monetary policy strategy. Targeting M1, M2 and M3 has been the main policy targets until the mid- I 990s. However, by the mid-1990s, the Central Bank of Malaysia (BNM) has shifted their policy strategy from monetary targeting to interest rate targeting. As a matter of fact, the de-emphasizing of monetary aggregates as intermediate target begins with the de-emphasizing of MI in 1987. One of the major reasons for de-emphasizing monetary aggregates as policy variables is the availability of alternative interest-bearing financial assets in the markets as a result of active financial liberalization in recent years. As a result of the shifting of money into interest bearing financial assets, the relationship between money and income becomes unstable, consequently, monetary policy actions using monetary aggregates as targets become ineffective.

Our question is: Does the move made by BNM to de-emphasis monetary aggregates point to the fact that money does not affect output in Malaysia? In other words, one can ask: Does changes in money bring about in the changes on real economic variables? If none of the real economic variables would change in response to the change in money, we say that money is neutral. The neutrality of money has important implications for the role of monetary policy. In monetary-business-cycle (MBC) models,

active and discretionary monetary policy can stabilize the economy. But, according to real-business-cycle (RBC) models, stabilization policy does not work. As argued by RBC, for example, movement in aggregate output should arise from exogenous shocks to supply, reflecting changes in technology or production factors other than labor and capital.

The purpose of the present paper is to determine the long-run neutrality of money with respect to aggregate output and its disaggregate output; namely the output of agriculture, manufacturing and services sectors for the period 1973:1 to 1999:4. By long-run neutrality (LRN) of money, we mean that a permanent, exogenous changes in the level of money supply will leave the level of real economic variables unchanged.

The plan of the paper is as follows. In Section 2, we present some related literature on long-run neutrality of money and the econometric framework used to test LRN. Section 3 presents the empirical results. Section 4 concludes the study.

REVIEW OF RELATED LITERATURE

The neutrality of money has been studied extensively, both theoretically and empirically. Empirical studies have generally followed three testing methodologies.

The first methodology examines neutrality from a cross-country perspective. Using data averaged over long periods for a cross-section of countries, the LRN of money is tested in Lothian (1985) and Hsing (1990) for 20 OECD countries; in Dwyer and Hafer (1988) for 62 countries; in Duck (1988, 1993) for a total of 33 countries (16 industrialized and 17 developing countries); in Loef (1993) for 12 EC countries; in Weber (1994) for the G7 countries; and in Bhanumurthy (1999) for 9 developing economies. Except for Bhanumurthy (1999), the cross-country evidences from these studies are generally support the LRN of money.

The second approach is based on frequency-domain time series techniques. Lucas (1980) and Mills (1982) extract low-frequency signals data and analyse the comovements between these signals. Geweke (1982, 1986) uses a bivariate vector-autoregressive model to test the neutrality and superneutrality of money at both high and low frequencies. The results from the studies by Lucas (1980), Mills (1982), and Geweke (1982, 1986) are consistent with the LRN of money.

In a third class of studies, which is found in Stock and Watson (1988), King and Watson (1992) and Fisher and Seater (1993), inference about LRN propositions is based on explicit tests of coefficient restrictions in

bivariate vector-autoregressive models. LRN implies a zero restriction on the sum of coefficients of the contemporaneous and tagged monetary variables in a regression on real economic activity.[1] The evidences reported in these studies are largely in favor of the LRN of money.

The study of LRN of money by using the third method has cast doubt on the empirical findings of other studies that overlook the time series properties of the underlying variables. King and Watson (1992) and Fisher and Seater (1993) assert that the coefficient restrictions can only be imposed if the order of integration of the monetary and real series is at least one and equal for both series.

Fisher and Seater (1993) have developed a relatively structure free LRN tests in a bivariate ARIMA model. The test is based on a simple, reduced-fonn specification that assumes money supply is exogenous in the long run. Their test has power when the data are integrated of a certain order (at least of order 1). The order of integration is important for two reasons. First, in order to make inferences regarding LRN in the absent of knowledge of the underlying structure, the data must contain permanent stochastic changes in the level of the money supply. Second, the parameter restrictions implied by LRN depend on the difference between the order of integration of the money supply and the other variable of interest.

Fisher and Seater (1993) applied their test on the Friedman and Schwartz (1982) U.S. annual data for prices, nominal and real income from 1869 to 1975. Their results support LRN with respect to prices and nominal income but reject it with respect to real income. While Fisher and Seater (1993) found evidence against LRN with respect to real output for the U.S. during the last century, Boschen and Otrok (1994) showed that the long-run derivatives that measure the effect of money on output are close to zero and are consistent with the hypothesis of LRN. In another study, Bullard (1994) adopts the Fisher and Seater approach using U.S. quarterly data from 1960 to 1992. He tests the proposition of LRN from a nonstructural and low-frequency point of view. He also found that the LRN hypotheses were generally supported.

Malliaropulos (1995) uses quarterly data for money supply, consumer prices, real and nominal GDP, and equity prices from 1965:1 to 1994:2 to present empirical evidence on the LRN of money in the U.K. based on the Fisher and Seater (1993) approach. The variables appear to be $I(1)$ in their logs, so LRN restriction is testable. Money is found to be long-run neutral with respect to real GDP and real equity prices. However, in the short to medium term, permanent positive shocks to money supply seem to be

positively correlated with real GDP and negatively correlated with real equity prices.

Serletis and Krause (1996) test the LRN proposition using the Fisher and Seater (1993) nonstructural methodology and the Backus and Kehoe (1992) long, low-frequency data set for 10 industrialized countries.[2] They found that money is $I(1)$ except in Germany and Japan where it is $I(0)$; therefore, the latter two countries are uninformative on LRN test. They also discovered that output is $I(0)$ for Australia, Canada, Denmark, Italy, U.K. and U.S. Thus, these countries provide direct evidence in favor of LRN with respect to output. Long-run signals from the time series have been extracted by using Lucas's (1980) two-sided exponential filter. They then examined the filtered data to see if they contain evidence consistent with the LRN of money. They found general support for LRN of money, even in the U.S. and Australia, where Fisher and Seater (1993) – for the U.S. – and Olekalns (1996) for Australia – had cast doubt.

Haug and Lucas (1997) apply the Fisher and Seater (1993) model to Canada to test the Boschen and Otrak (1994) conclusion that the inclusion of the Great Depression period explained the failure of Fisher and Sester to uncover evidence supporting LRN. They noted that there was no bank failures reported in Canada in the 1930-39 periods. Estimating the model for the 1914-1994 period yields results that support LRN although these results are strengthened when a dummy variable is included for the 1930-39 period. Because the inclusion of a time period dummy strengthens their results supportive of LRN, Haug and Lucas suggest that bank failures alone do not entirely explain the rejection of LRN when data from the 1930-39 periods are included in the sample.

Wallace (1999) employs the Fisher and Seater (1993) model to Mexico for the 1932-92 period. Mexico provides an interesting study because its recent monetary history can be termed tumultuous, at the very least. Empirical results support the proposition that exogenous changes in the quantity of money have no long-run effect on the level of real output. The conclusion is robust whether MI and M2 are used as the money measure. It is also robust for an alternative specification with a time period dummy for the 1982-90 periods during which domestic banks in Mexico were nationalized. This support for the LRN proposition is especially noteworthy in the context of Mexico's stormy banking and monetary history during the period under study.

Leong and McAleer (2000) analyse the LRN of money in Australia using different source of intra-vear data, which permits an examination of the effects of seasonality and the robustness of previous empirical study.

A reduced-form ARIMA model introduced by Fisher and Seater (1993) is used with both quarterly seasonally unadjusted and adjusted Australian real GDP and nominal money supply to test the neutrality hypothesis. Using two measures of money stock, namely M1 and M3, it is shown that the hypothesis is supported using M1 as the measure of money supply, while it is rejected using M3. These results for Australia indicate the sensitivity of the outcome to the type of money supply used. Recent demand-side disturbances and the easing of monetary policy, which affected the two monetary aggregates, are likely cause of the disparity. Their results support earlier findings by Olekalns (1996). Olekalns concludes that broad money M3 does matter in the long-run for the Australian economy, but not for the narrow money M1.

THE ESTIMATING MODEL

This study adopts Fisher and Seater (1993) methodology to test LRN of money on real output in Malaysia. Let m be log money supply and y the log of real GDP. The model is given as follow:

$$a(L)\,\Delta^{\langle m\rangle} m_t = b(L)\,\Delta^{\langle y\rangle} y_t + u_t$$

$$d(L)\,\Delta^{\langle y\rangle} y_t = c(L)\,\Delta^{\langle m\rangle} m_t + w_t \qquad (3)$$

where L is the lag operator, $a(L)$, $b(L)$, $c(L)$ and $d(L)$ are distributed lag polynomials, and $\langle m\rangle$ and $\langle y\rangle$ are the orders of integration of the money stock and real GDP. The vector (u_t, w_t) is assumed to be independently and identically distributed (i.i.d.), with mean zero and covariance Σ. Constants and trends are suppressed; if a variable is stationary around a deterministic trend, we treat it as $I(0)$. For the distributed lag $a(L)$ and $d(L)$, it is convenient to set the initial values $a_0 = d_0 = 1$, and b_0 and c_0 are not restricted.

The parameters of the second part of Equation (3) indicate that the stationary values of y over time are explained by stationary values of m over time. LRN can be defined using the long-run derivative (*LRD*) of $\Delta^{\langle y\rangle} y_t$ with respect to a permanent change in $\Delta^{\langle m\rangle} m_t$:

$$\mathrm{LRD}_{y,m} \equiv \lim_{k\to\infty} \frac{\partial(\Delta^{\langle y\rangle} y_{t+k})/\partial u_t}{\partial(\Delta^{\langle m\rangle} m_{t+k})/\partial u_t}$$

where $\lim_{k\to\infty} \partial(\Delta^{\langle m\rangle} m_{t+k})/\partial u_t \neq 0$. $LRD_{y,m}$ is defined as the long-run effect of a permanent change in m on y divided by the long-run effect of the same

permanent change on m itself. The specific value of the $LRD_{y,m}$ depends on $\langle m \rangle$ and $\langle y \rangle$. When $\langle m \rangle \geq 1$ and $\langle y \rangle \geq 1$, there are permanent changes in both m_t and y_t. If the variables have the same order of integration, $\langle m \rangle = \langle y \rangle$, $LRD_{y,m}$ can be treated as the long-run elasticity of y with respect to m and it can be evaluated using the impulse response representation of Equation (3). The special case occur when $\langle m \rangle = \langle y \rangle = 1$, $LRD_{y,m} = c(1)/d(1)$. Money is long-run neutral if $LRD_{y,m} = \lambda$ where $\lambda = 1$ if y is a nominal variable, and $\lambda = 0$ if y is a real variable.

When the error terms u_t and w_t in the ARIMA model are uncorrected, or when money is exogeneous, $c(1)/d(1)$ is the frequency-zero coefficient in a regression of $\Delta^{\langle y \rangle} y_t$ on $\Delta^{\langle m \rangle} m_t$. The term $c(1)/d(1)$ can be estimated using the Bartlett estimator of the frequency-zero regression coefficient. This estimator is given by $\lim_{k \to \infty} \beta_k$, where β_k is the slope coefficient in the following regression:

$$\left[\sum_{j=0}^{k} \Delta^{\langle y \rangle} y_{t-j} \right] = \alpha_k + \beta_k \left[\sum_{j=0}^{k} \Delta^{\langle m \rangle} m_{t-j} \right] + \varepsilon_{kt} \tag{4}$$

When $\langle m \rangle = \langle y \rangle = 1$, which is the case applicable for testing LRN, Equation (4) becomes:

$$(y_t - y_{t-k-1}) = \alpha_k + \beta_k (m_t - m_{t-k-1}) + \varepsilon_{kt} \tag{5}$$

SOURCES OF DATA

This study uses quarterly data for monev supply, M1, and real GDP. Real GDP are collected for the national output and by sectoral output, namely; agriculture, manufacturing and services output sectors. The quarterly data span from the period of 1973:1 to 1999:4. All data were collected from various issues of the Quarterly Bulletin published by Bank Negara Malaysia and National Accounts Statistics published by the Department of Statistics, Malaysia. All variables were transformed into natural logarithm form.

EMPIRICAL RESULTS

UNIT ROOT TEST RESULTS

Fisher and Seater (1993) and King and Watson (1992) have pointed out that meaningful LRN tests can only be conducted if both nominal and real

variables satisfy certain nonstationarity conditions. In particular, LRN tests require both nominal and real variables are at least integrated of order one and of the same order of integration. Hence, the first step in conducting LRN tests is to test for stochastic trends in the autoregressive representation of each individual time series. In doing so, we employ the most frequently used augmented Dickey-Fuller (ADF) (Said and Dickey, 1984) unit root test to test for the nonstationarity of the series on the levels and the first difference of their logarithms.

The unit root tests results are presented in Table 1. We report the results, which contain a constant and a linear time trend for the series in levels and constant without a linear time trend for the series in first difference. Then, we compare the results with the critical value provided by MacKinnon (1991). The chosen lag length is 4 which was based on Schwert's (1987) formula, $l_4 = \text{int}\{4(T/100)^{1/4}\}$. The ADF test statistics suggest that in all cases, we cannot reject the null hypothesis of unit roots in their level form which imply that the series are all not $I(0)$. In their first difference, the series are stationary. This implies that all the series are difference stationary process or $I(1)$.

TABLE 1. Unit root test results

Series	Augmented Dickey-Fuller (ADF):	
	Levels	First-difference
Money	–3.08	–3.75
National output	–3.15	–4.46
Agriculture output	–2.26	–5.76
Manufacturing output	–3.41	–4.69
Services output	–2.81	–2.92

Notes: Critical values at 5 percent level are: –3.45 for series in levels and –2.88 for series in first-difference.

THE LONG-RUN NEUTRALITY TEST RESULTS

Result from the PP unit root tests show that all the series appear to be integrated of order one, that is $I(1)$ in their logs, thus the LRN restriction $c(1)/d(1) = \lambda$ is testable. Equation (5) is estimated for each series with k equal 1-25. The lag length k is chosen using $n/3$, where n is the number of observations. The error term, ε_{kt}, from the regression for the various lags may be non-spherical, possibly leading to biased t-ratios and outcomes of

the LRN tests. Thus, following Fisher and Seater (1993), the standard error of β_k has been calculated using the Newey and West (1987) procedure to correct for autocoffelation.

Estimated results of Equation (5) are presented in both tabulate and graphical forms.[3] In the tabulate form, we present the values of estimated coefficients (β_k), Newey-West standard error (SE_k), *t*-statistic of null hypothesis (t_k) and the marginal significance level of null hypothesis (*p*-value). The null hypothesis is $\beta_k = 0$ for *y* is a real variable. Test outcome of the LRN was also examined by plotting the estimated coefficients, β_k, against the lag length *k*. The estimated coefficients are denoted by solid line and the confidence interval is denoted by dashed line. The *t*-distribution with *n/k* degrees of freedom is used to construct the confidence intervals. The 95 percent confidence intervals are obtained using standard errors that are adjusted by the Newey-West (1987) technique.

The estimated result of Equation (5) for the aggregate output is presented in Table 2. The data support the LRN hypothesis with respect to the aggregate output series examined. The *p*-value of the null clearly indicate, that the slope coefficient, β_k, equals zero at k=25 is 0.80 thus supporting that M1 money is neutral in the long-run in Malaysia. On the other hand, Figure 1 show the plots of the slope of the coefficients, β_k, with respect to the lag length for $k = 1,\ldots,25$ for the aggregate output series examined. As can be seen in the graph, the zero line is contained within the 95 percent confidence interval for values of $k = 1,\ldots,25$. This too indicates that money M1 is neutral in the long-run in Malaysia.

To determine whether the support for the LRN is sensitive to disaggregate data, the model is re-estimated using sectoral data such as data for the agriculture, manufacturing and services sectors. The LRN test results for the disaggregate output, the estimated result of Equation (5) for agriculture, manufacturing and services output are presented in Tables 3-5 respectively. Similar to the earlier findings for aggregate output, the disaggregate data support the LRN hypothesis in the agriculture, manufacturing and services sectors. The *p*-value of the null that the slope coefficient, β_{25}, equals zero is 0.98 for real agriculture output, 0.62 for real manufacturing output and 0.14 for real services output.

The plots of the slope of the coefficients, β_k, with respect to the lag length for $k = 1,\ldots,25$ for each agriculture, manufacturing and services output are presented in Figures 2-4 respectively. As can be seen in the graph, the zero line is contained within the 95 percent confidence interval for values of $k = 1,\ldots,25$ for all disaggregate output series examined. Thus, these results, clearly indicate that Malaysian data, both at the aggregate

TABLE 2. Long-run regressions of real output on money supply, M1

k	β_k	SE_k	t_k	p-value
1	0.113	0.108	1.046	0.298
2	0.069	0.110	0.626	0.533
3	0.040	0.115	0.346	0.730
4	0.021	0.122	0.171	0.865
5	0.012	0.130	0.095	0.924
6	0.011	0.138	0.078	0.938
7	0.012	0.145	0.082	0.935
8	0.017	0.142	0.121	0.904
9	0.023	0.145	0.156	0.877
10	0.027	0.148	0.183	0.855
11	0.029	0.149	0.194	0.847
12	0.028	0.149	0.186	0.853
13	0.022	0.148	0.146	0.884
14	0.011	0.146	0.075	0.940
15	–0.003	0.143	–0.020	0.984
16	–0.017	0.141	–0.122	0.904
17	–0.030	0.140	–0.217	0.829
18	–0.041	0.141	–0.293	0.770
19	–0.049	0.142	–0.343	0.732
20	–0.053	0.144	–0.365	0.716
21	–0.054	0.146	–0.366	0.715
22	–0.052	0.148	–0.351	0.726
23	–0.049	0.150	–0.325	0.746
24	–0.044	0.153	–0.290	0.772
25	–0.039	0.155	–0.253	0.801

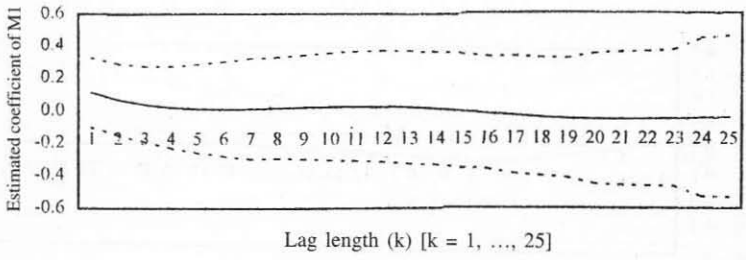

FIGURE 1. Real output on money, M1: 1973:1-1999:4

TABLE 3. Long-run regressions of real agriculture output on money supply, M1

k	β_k	SE_k	t_k	p-value
1	0.175	0.341	0.514	0.608
2	0.092	0.384	0.239	0.812
3	0.012	0.402	0.029	0.977
4	–0.062	0.404	–0.154	0.878
5	–0.132	0.391	–0.338	0.736
6	–0.191	0.377	–0.506	0.614
7	–0.228	0.373	–0.610	0.543
8	–0.226	0.361	–0.626	0.533
9	–0.203	0.363	–0.559	0.578
10	–0.169	0.367	–0.460	0.647
11	–0.132	0.372	–0.354	0.724
12	–0.092	0.381	–0.240	0.811
13	–0.059	0.393	–0.149	0.882
14	–0.037	0.407	–0.090	0.929
15	–0.026	0.420	–0.063	0.950
16	–0.022	0.432	–0.050	0.960
17	–0.025	0.441	–0.056	0.956
18	–0.032	0.448	–0.072	0.943
19	–0.041	0.452	–0.091	0.928
20	–0.046	0.456	–0.101	0.920
21	–0.048	0.458	–0.104	0.017
22	–0.045	0.459	–0.098	0.922
23	–0.038	0.460	–0.083	0.934
24	–0.026	0.461	–0.057	0.955
25	–0.011	0.461	–0.023	0.981

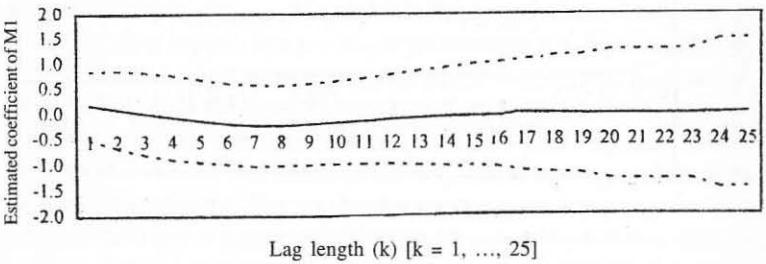

FIGURE 2. Real agriculture output on money, M1: 1973:1-1999:4

TABLE 4. Long-run regressions of real manufacturing output on money supply, M1

k	β_k	SE_k	t_k	p-value
1	0.053	0.164	0.324	0.747
2	0.004	0.190	0.021	0.983
3	–0.023	0.214	–0.106	0.916
4	–0.046	0.239	–0.193	0.847
5	–0.063	0.266	–0.236	0.814
6	–0.073	0.292	–0.250	0.803
7	–0.080	0.315	–0.255	0.799
8	–0.088	0.312	–0.282	0.778
9	–0.097	0.324	–0.300	0.765
10	–0.109	0.335	–0.325	0.746
11	–0.124	0.345	–0.359	0.721
12	–0.143	0.354	–0.405	0.686
13	–0.167	0.363	–0.459	0.648
14	–0.191	0.373	–0.513	0.609
15	–0.215	0.383	–0.561	0.576
16	–0.237	0.394	–0.603	0.548
17	–0.254	0.404	–0.629	0.531
18	–0.264	0.413	–0.639	0.524
19	–0.269	0.422	–0.637	0.526
20	–0.269	0.430	–0.627	0.532
21	–0.267	0.437	–0.610	0.544
22	–0.262	0.445	–0.588	0.558
23	–0.255	0.452	–0.563	0.575
24	–0.246	0.461	–0.533	0.596
25	–0.236	0.470	–0.501	0.618

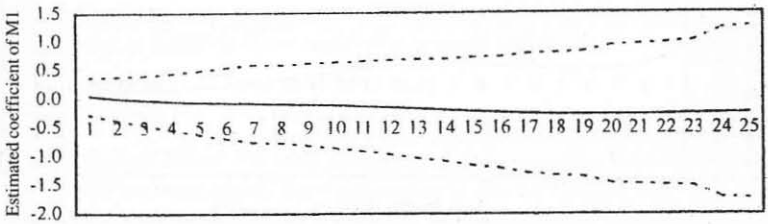

FIGURE 3. Real manuacturing output on money, M1: 1973:1-1999:4

TABLE 5. Long-run regressions of real services outpqt on money supply, M1

k	β_k	SE_k	t_k	p-value
1	0.011	0.064	0.168	0.867
2	–0.010	0.063	–0.162	0.871
3	–0.020	0.061	–0.335	0.738
4	–0.026	0.060	–0.428	0.670
5	0.027	0.061	–0.448	0.655
6	0.025	0.062	–0.404	0.687
7	–0.021	0.063	–0.329	0.743
8	–0.018	0.064	–0.272	0.786
9	–0.017	0.065	–0.254	0.800
10	–0.018	0.066	–0.274	0.785
11	–0.022	0.066	–0.330	0.742
12	–0.028	0.065	–0.431	0.668
13	–0.036	0.063	–0.576	0.566
14	–0.046	0.061	–0.763	0.447
15	–0.057	0.058	–0.981	0.329
16	–0.068	0.056	–1.211	0.229
17	–0.077	0.055	–1.408	0.163
18	–0.085	0.055	–1.546	0.126
19	–0.090	0.056	–1.622	0.109
20	–0.093	0.056	–1.648	0.103
21	–0.094	0.057	–1.645	0.104
22	–0.093	0.057	–1.623	0.109
23	–0.091	0.057	–1.590	0.116
24	–0.087	0.056	–1.545	0.126
25	–0.083	0.056	–1.491	0.140

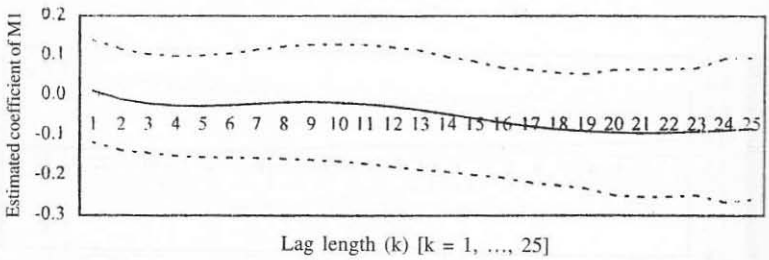

FIGURE 4. Real services output on money, M1: 1973:1-1999:4

and disaggregate output measures, the long-run neutrality of narrow money M1 cannot be rejected.

CONCLUSION

Generally, we found that narrow money M1 does not matter in Malaysia during the sample period. The output data at both aggregate and disaggregate sector support the long-run neutrality of money in Malaysia. This implies that permanent changes in narrow money does not lead to changes in real output. This would suggest that the growth of money supply M1 is not the prime mover for the Malaysia's economic growth during the period under study. Hence, the results show that de-emphasizing narrow money, M1, as intermediate target variable by mid-1980s was the right move by the Central Bank of Malaysia.

However, other questions would arise as to, what are the contributing factors for the rapid economic growth in Malaysia during the boom period of 1980s and 1990s? Does broad money M2 and/or M3 the prime mover for the rapid economic growth in Malaysia during those boom periods? This is an empirical question and the issue can be addressed in future research agenda.

NOTES

1. Short-run neutrality in this framework implies zero reactions on the individual coefficients of contemporary and lagged monetary variables (e.g. Sims 1972).
2. These countries are Australia, Canada, Denmark, Germany, Italy, Japan, Norway, Sweden, the United Kingdom, and the United States. Some data are missing, notably 1914-24 and 1939-49 for Germany and 1941-51 for Japan. Also, missing are 1915-20 for Denmark, and 1940-45 for Norway.
3. In the final estimating equation, three seasonal dummy variables were included in Equation (5) to capture the seasonal variations.

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