Empirical Evidence on the Long-Run Neutrality Hypothesis Using Divisia Money

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EMPIRICAL EVIDENCE ON THE LONG-RUN NEUTRALITY HYPOTHESIS USING DIVISIA MONEY

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ABSTRACT

By employing Fisher and Seater's (1993) long-run neutrality test, the researchers tested the monetary neutrality proposition in Singapore for the period of 1980-2009. Empirical findings show that monetary neutrality does not hold in Singapore when both the simple-sum money and Divisia money are employed. As both the simple-sum and Divisia monetary aggregates are non-neutral, monetary authorities may consider their use as a monetary policy tool affecting real economic activity.

Keywords: Monetary Neutrality, Divisia Money, ARIMA Model

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1. INTRODUCTION

The long-run neutrality (LRN) hypothesis is one of the most controversial topics among economists as it is closely related to monetary theory and policy making. The LRN hypothesis is a classic economics theory extracted from the quantity theory of money which indicates that changes in the money supply affect nominal variables but leave real variables unchanged as time elapses. The theory suggests that money injection by government does not have a real impact on the economy as the growth of real variables is determined by the production and technology levels available in the economy. Monetarists believe that economic performance can be influenced by changes in the money supply. However, if LRN holds, the effectiveness of monetary policies will be empirically denied.

For decades, voluminous studies have attempted to ascertain the precision of the monetary neutrality proposition in reality. However, the findings have been mixed and far from convincing, with some supporting the LRN proposition and others rejecting it (see for example, Bae et al., 2005; Bernake & Mihov, 1998; Habibullah et al., 2002; Puah et al., 2008a; Puah et al., 2008b; Puah et al., 2010; Serletis & Krause, 1996). Moreover, evidence has indicated that different measures of monetary aggregates used in analysis tend to provide different results on LRN tests (see Coe & Nason, 1999; Leong & McAleer, 2000; Olekalns, 1996; Puah et al., 2010). Thus, the existence of the LRN proposition is still being questioned. For that reason, this study was intended to investigate the impact of money on real output by testing the LRN of money with

different measurements of monetary aggregates for the case of a fast-growing economy - Singapore.

Singapore is a small but rich country among the Association of Southeast Asian Nations (ASEAN) countries. As an international financial center, Singapore adopted an exchange rate management policy in the 1980s with the aim of preventing capital inflow from affecting the money supply. In Singapore, most of the factor inputs were imported from other countries. Thus, Singapore had high potential for imported inflation. Controlling the exchange rate by maintaining reserves and capital inflows is the strategy usually used by the Monetary Authority of Singapore (MAS). Understanding the nexus between money and real output will provide better insight into the conduct of exchange rate policy because if money is non-neutral, an expansionary monetary policy may lead to higher inflation and hence affect exchange rate targeting.

2. RATIONALE OF DIVISIA MONETARY AGGREGATE

The conventional monetary aggregate, simple-sum money, is a monetary aggregation measurement that sums all the monetary component assets to create a total amount of money supply. Under the perfect substitution assumption of simple-sum money, all the monetary component assets have the same weight in simple-sum monetary aggregation. Simple-sum money has received great criticism since the financial liberalization of the 1980s. The reason is that the assumption of perfect substitution in simple-sum money means that simple-sum money cannot appropriately measure the monetary services

provided by different financial assets (Barnett, 1978; Drake & Mills, 2005; Thornton & Yue, 1992). Therefore, simple-sum money is said to have low accuracy in predicting economic conditions. Financial liberalization also distorted the measurement of simple-sum money as the relationship between simple-sum money and macroeconomic indicators became unstable when more interest-bearing assets were introduced to the market (see Belongia & Batten, 1992; Drake & Fleissig, 2004; Habibulah, 1999; Puah et al., 2008a).

As a result, Barnett (1980) introduced a weighted monetary aggregate as an alternative to simple-sum money. Each monetary component asset is weighted differently in the Divisia monetary aggregate according to its monetary services. The impact of financial liberalization can be handled well by the Divisia monetary aggregate. Habibullah (1998) stated that the Divisia monetary aggregate has a long-run relationship with income and that it can be considered one of the intermediate variables in formulating monetary policy. Similar studies conducted by Dahalan et al. (2005), Aksoy and Piskorski (2006), Puah et al. (2006), and Puah and Hiew (2010) also validated the usefulness of Divisia monetary aggregates in conducting monetary policy.

3. METHODOLOGY

In this study, an econometric methodology derived by Fisher and Seater (1993) (hereinafter FS) is used to test for the LRN proposition. The FS test is a bivariate autoregressive integrated moving average (ARIMA) model in reduced-form that is a

convenient setting for LRN analysis as the LRN proposition does not depend on short-run dynamics (FS, 1993). We follow the notation and description used by FS (1993) in the following explanation. The FS neutrality test is given by:

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

$$d(L)\Delta^{\langle y\rangle}y_t = c(L)\Delta^{\langle m\rangle}m_t + w_t \qquad (1)$$

where m is the natural logarithm of the monetary aggregate, y is the natural logarithm of real income, while $\langle m\rangle$ and $\langle y\rangle$ denote the order of integration of m and y. Δ represents first difference, L is the lag operator, and $a(L)$, $b(L)$, $c(L)$, and $d(L)$ are distributed lag polynomials. Note that $a_0 = d_0 = 1$, and for $b(L)$ and $c(L)$, b_0 and c_0 are not restricted. The vector of error terms (u_t, w_t) is assumed to be independently and identically distributed with mean zero and covariance $\sum$.

The stationarity of y is explained by the stationarity of m over time. Therefore, the LRN of money can be defined in terms of the long-run derivative (LRD), which is used to test the dynamics of the partial effects of m_t on y_t. If $z_t \equiv \Delta^j y_t$ and $x_t \equiv \Delta^i m_t$, where i and j equal 0 or 1, the LRD can be formed as follows:

$$LRD_{y,m} \equiv \lim_{k\to\infty} \frac{\delta z_{t+k}/\delta u_t}{\delta x_{t+k}/\delta u_t} \qquad (2)$$

where $\lim_{k\to\infty} \delta z_{t-k} / \delta \mu_t \neq 0$, or else there will be no permanent changes in the level of money and thus the LRN proposition cannot be tested. $LRD_{z,x}$ expresses the ultimate effect of an exogenous money disturbance on z relative to that disturbance's ultimate effect on x. As such, the specific value of the $LRD_{z,x}$ depends on $\langle x \rangle$ and $\langle z \rangle$. 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, $\langle m \rangle = \langle y \rangle$, the $LRD_{y,m}$ 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 (1). The special case occurs when $\langle m \rangle = \langle y \rangle = 1$; then, the $LRD_{y,m} = c(1)/d(1)$. The LRN requires that $LRD_{y,m} = 1$ if y is a nominal variable, and $LRD_{y,m} = 1$ if y is a real variable.

With the assumption that error terms u_t and w_t are uncorrected and the money supply is exogenous in the long-run, the coefficient $c(1)/d(1)$ equals the frequency-zero coefficient in a regression of $\Delta^{\langle y \rangle} y_t$ on $\Delta^{\langle m \rangle} m_t$. The estimator of $c(1)/d(1)$ is given by $\lim_{k\to\infty} \beta_k$, where β_k is the slope coefficient from the following equation:

$$\left[\sum_{j=0}^{k} \Delta^{\langle y \rangle} y_{t-j}\right] = \alpha_k + \beta_k \left[\sum_{j=0}^{k} \Delta^{\langle m \rangle} m_{t-j}\right] + \varepsilon_{kt} \qquad (3)$$

When $\langle m \rangle = \langle y \rangle = 1$, Equation (3) can be estimated in following reduced form:

$$(y_t - y_{t-k-1}) = \alpha_k + \beta_k (m_t - m_{t-k-1}) + \varepsilon_{kt} \qquad (4)$$

where β_k is the slope coefficient of the equation. The null hypothesis of the FS neutrality test is $\beta_k = 0$, which indicates that the change in money supply will not have an impact on real output. A significant value of β_k indicates rejection of the LRN proposition. To see the effect of the money supply on real output, both variables *y* and *m* must have permanent stochastic changes and be uncorrelated in the long-run. Thus, preliminary tests to examine the stationarity property and the absence of cointegration are needed to provide a testable condition for the LRN.

Quarterly data of simple-sum M1, Divisia M1, gross domestic product (GDP), and consumer price index (CPI) were used in this study. Real output was obtained by deflating GDP with CPI, and the Divisia M1 data was constructed by the authors following the method proposed by Barnett (1980). All the other data were obtained from the *International Financial Statistics* published by International Monetary Fund (IMF) and MAS. The data set covered the sample period of 1980:Q1 through 2009:Q4. All variables were transformed into natural logarithm form.

4. EMPIRICAL FINDINGS

In this study, we employed the augmented Dickey-Fuller (ADF) (Said & Dickey, 1984) and the stationarity Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski et al., 1992) tests to examine the stationary condition of real output and monetary variables. Both the test results indicated that monetary aggregates and real output are integrated with the order of one, *I*(1). In other words, the FS test can be constructed in a valid

context. To conserve space, the ADF and KPSS test results are not reported, but are available from the authors upon request.

Under the FS LRN test, money and real output should not have common stochastic trends. This argument was supported by Serletis and Koustas (1998), who stated that money and real output cannot be cointegrated as the existence of cointegration will cause inefficiency in the LRN test. The reason is that money must be exogenous in the sense that a permanent change to money has no effects on real output in the long-run. The Johansen and Juselius (1990) cointegration results in Table 1 show that there is no cointegration between real output and the simple-sum M1 or the Divisia M1. This further implies that the conditions necessary for a meaningful LRN test hold for the data under study.

Table 1: Johansen and Juselius Cointegration Tests Results

Series	λ-trace		λ-max	
	H_0: r=0	H_0: r≤1	H_0: r=0	H_0: r≤1
Simple-sum M1	5.279	0.167	5.111	0.167
Divisia M1	7.985	0.517	7.467	0.517

Notes: Critical values for Trace statistic r = 0 and r ≤ 1 are 20.04 and 6.65, while for Maximum Eigenvalue statistic r = 0 and r ≤ 1 are 18.63 and 6.65, respectively.

The FS neutrality results are then presented in both tabulated and graphical forms. Tables 2 and 3 clearly show that the null hypothesis of the LRN is rejected as the estimated coefficients of β_k are statistically significant at $k > 1$ for simple-sum M1 and $k > 0$ for Divisia M1. Figures 1 and 2 further re-confirm that the LRN hypothesis is rejected since the estimated β_k parameters lie far from zero and the zero line does not lie within the 95% confidence interval bands. This implies that monetary aggregates influenced the real output in Singapore.

Table 2: LRN Results of Simple-sum M1

k	β_k	SE_k	t_k	*p-value*
1	0.146	0.099	1.475	0.143
2	0.228	0.097	2.352	0.020
3	0.296	0.098	3.008	0.003
4	0.352	0.101	3.488	0.001
5	0.400	0.100	4.000	0.000
6	0.444	0.095	4.670	0.000
7	0.484	0.090	5.370	0.000
8	0.516	0.089	5.797	0.000
9	0.540	0.091	5.945	0.000
10	0.558	0.094	5.949	0.000
11	0.570	0.096	5.913	0.000
12	0.579	0.099	5.877	0.000
13	0.586	0.100	5.845	0.000
14	0.590	0.101	5.819	0.000
15	0.593	0.102	5.793	0.000
16	0.594	0.096	6.175	0.000
17	0.594	0.097	6.153	0.000
18	0.593	0.097	6.120	0.000
19	0.593	0.098	6.072	0.000
20	0.592	0.099	6.009	0.000
21	0.593	0.100	5.935	0.000
22	0.595	0.102	5.854	0.000
23	0.598	0.103	5.778	0.000
24	0.602	0.106	5.709	0.000
25	0.609	0.108	5.662	0.000
26	0.617	0.109	5.636	0.000

Table 3: LRN Results of Divisia M1

k	β_k	SE_k	t_k	*p-value*
1	0.234	0.107	2.191	0.031
2	0.352	0.100	3.521	0.001
3	0.456	0.098	4.665	0.000
4	0.541	0.098	5.509	0.000
5	0.606	0.102	5.925	0.000
6	0.653	0.108	6.052	0.000
7	0.685	0.113	6.061	0.000
8	0.709	0.118	6.030	0.000
9	0.728	0.121	5.992	0.000
10	0.743	0.125	5.956	0.000
11	0.755	0.127	5.932	0.000
12	0.764	0.129	5.924	0.000
13	0.772	0.130	5.927	0.000
14	0.778	0.131	5.936	0.000
15	0.782	0.132	5.944	0.000
16	0.784	0.123	6.381	0.000
17	0.785	0.123	6.390	0.000
18	0.785	0.123	6.389	0.000
19	0.785	0.123	6.374	0.000
20	0.785	0.124	6.343	0.000
21	0.785	0.125	6.299	0.000
22	0.787	0.126	6.245	0.000
23	0.790	0.128	6.191	0.000
24	0.795	0.129	6.139	0.000
25	0.802	0.131	6.107	0.000
26	0.810	0.133	6.093	0.000

Figure 1: Real GDP on Simple-sum M1, 1981:1 - 2009:4

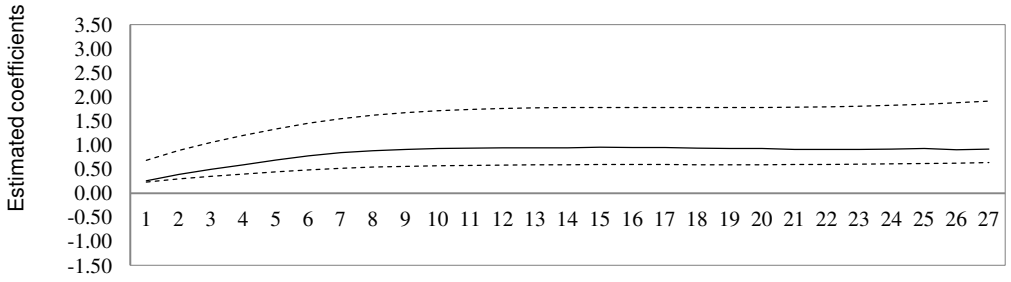
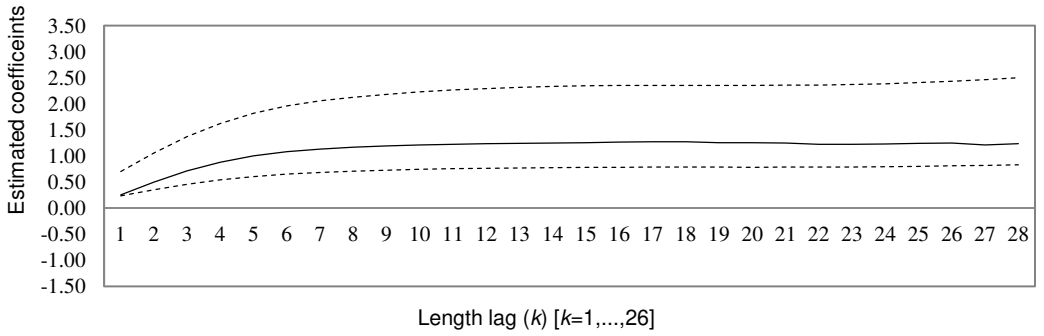


Figure 2: Real GDP on Divisia M1, 1981:1 - 2009:4



5. CONCLUSION

This research empirically examined the impact of long-run monetary shock on real output in Singapore by investigating the existence of the LRN proposition using the FS neutrality test. The findings indicated that monetary aggregates in Singapore have long-run impacts on real output. These findings are consistent with Chen (2007), Wallace and Shelley (2007), Atesoglu and Emerson (2009), and Puah et al. (2010), who reported that money is non-neutral in the long-run. The non-neutrality of money means that money can be used to influence economic growth in the long-term because money has a close

relationship with real economy activity (Habibullah, 1998; Tan & Baharumshah 1999; Darrat et al., 2005; Puah et al., 2008a; Puah et al., 2008b). The monetary authority in Singapore may consider the use of Divisia money together with traditional simple-sum money in the conduct of monetary policy as both variables can affect real output.

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