On the Long-Run Monetary Neutrality: Evidence from the SEACEN Countries

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Abstract

This paper tests the long run neutrality (LRN) and long run superneutrality (LRSN) propositions using annual observation from 10 member countries of the South East Asian Central Banks (SEACEN) Research and Training Centre. The Fisher and Seater (1993) methodology is applied to do the task. Special attention has been given in identifying the number of unit root and cointegrating vector, as a meaningful LRN (LRSN) test is critically depends on such properties. Empirical results reveal that LRN can be deviated from the case of Asian developing economies. In particular, monetary expansion seems to have long run positive effect on real output in the economies of Indonesia, Taiwan and Thailand. However, LRSN is neither fail or not addressable in our study.

Keywords: Neutrality and superneutrality of money; sequential unit root test; SEACEN

JEL classification: C12; C32; E50; O53

1. Introduction

The classical theory of macroeconomics asserts that there exists a 'Classical Dichotomy' in which nominal variables has no effect on real economic activity in the long run. This line of research has attracted great academic interest for a long period. There are various econometric procedures in testing this classical quantity theoretic proposition. Nevertheless, the empirical tests of monetary neutrality are always difficult to interpret, as assumptions for the underlying economic structure are required to be made. Also, the neutrality tests results are sensitive to different restrictions imposed. Moreover, some pervious findings have cast doubt in the sense that they overlook the time series properties of the data used.

Recently, the empirical studies on the long-run neutrality (LRN) and long-run superneutrality (LRSN) of money have followed the nonstructural bivariate ARIMA framework developed by Fisher and Seater (1993, henceforth FS). The only assumption in FS model is that money supply must be exogenous in the long run. The structural free model is used because neither LRN nor LRSN refers to the short run effects of money shocks. Therefore, FS argue that structural details are not relevant to LRN and LRSN. FS also consider the nonstationarity property of the data in their reduced-form model to make inferences about the neutrality propositions. Their tests are critically depending on the order of integration of money and real variables.

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Specifically, for LRN (LRSN) to make sense, the order of monetary variables should be at least equal to one (two), or there will be no stochastic permanent changes in the level (growth) of money that can affect the real economic activity. In addition, the money supply and real variables should not be cointegrated, indicating there is no long run stable relationship between the series.

This study attempts to test empirically the propositions of LRN and LRSN of money with respect to real output in 10 member countries of the South East Asian Central Banks (SEACEN) Research and Training Centre. These countries include Indonesia, Malaysia, Myanmar, Nepal, the Philippines, Singapore, South Korea, Sri Lanka, Taiwan, and Thailand. The motivation of our study is that there are relatively few studies testing the LRN and LRSN in the context of Asian developing economies. To our best knowledge, an analysis of the classical neutrality propositions with FS methodology has not been carried out for the SEACEN member countries. We consider only long run phenomena of money. In the short run, monetary policy tends to be less effective due to the time lag associated with changes in the stock of money and in other macroeconomic variables, which are 'long and variable' and depend a great deal on the surrounding circumstances.

For all the series that satisfied the non-stationarity and cointegration properties, which are required by the FS test, we found that LRN is rejected in the data of Indonesia, Taiwan, and Thailand. On the other hand, LRSN is either fail or not addressable. The rest of this paper is organized as follows. In Section 2, we examine the integration and cointegration properties of the data. Section 3 provides a brief discussion of the econometric framework proposed by FS. Empirical results are reported at Section 4, and conclusion remarks are given in the last section.

2. Integration and Cointegration Properties of the Data

This study makes use of annual observation of narrowly defined money supply M1, and real output measured by real Gross Domestic Product (GDP) for 10 SEACEN member countries. The cross countries sample period are as follows: Indonesia (1965-2002), Malaysia (1950-2002), Myanmar (1950-2002), Nepal (1964-2002), the Philippines (1950-2002), Singapore (1963-2002), South Korea (1953-2002), Sri Lanka (1950-2002), Taiwan (1951-2002), and Thailand (1953-2002). Even though the countries under study are not identical in their economic performances, they do have many similarities but pursue quite different monetary polices. Therefore, according to Lucas (1980), they are suitable candidates for the multi-country testing. The data were collected from various issues of the *International Financial Statistics* published by International Monetary Fund. All variables were in the natural logarithm form.

FS tests critically depend on the order of integration of the variables, that is, the test for the presence of unit roots. In doing so, most of the empirical studies used augmented Dickey-Fuller (*ADF*) (Said and Dickey, 1984), *Z* (Phillips and Perron, 1988), and the stationarity *KPSS* (Kwiatkowski *et al*., 1992) tests. Both the *ADF* and *Z* tests are based on the assumption of at most one unit root, while the *KPSS* test has its null of stationary. However, Dickey and Pantula (1987, hereafter DP) suggest that it is appropriate to use a sequential test that testing the number of unit roots starting from an arbitrary upper value, that is, check for three unit roots, then two unit roots

and finally a single unit root. This procedure is particularly relevant for money series in many of the empirical literatures. Fisher and Seater (1993), Serletis and Koustas (1998), Bae and Ratti (2000), Shelly and Wallace (2003), Noriega (2004), are among others, have found that money series do contain more than one unit root.

Following DP, we utilized the sequential unit root tests to identify the order of integration of money and real output series. The asymptotically consistent procedure of DP comprises the following three steps:

Step I: H_{O3}: $y_t \sim I(3)$; H_{A3}: $y_t \sim I(2)$

Compute *t*-statistic of α_3 from the following auxiliary regression:

$$\Delta^3 y_t = \alpha_0 + \alpha_3 \Delta^2 y_{t-1} + \sum_{i=1}^{k} \Delta^3 y_{t-i} + \varepsilon_t \quad (1)$$

If H_{O3} is rejected (compare *t*-statistic associated with estimated α_3 against critical value from τ_μ Table of Fuller (1976)), go to step II.

Step II: H_{O2}: $y_t \sim I(2)$; H_{A2}: $y_t \sim I(1)$

Compute *t*-statistic for α_2 from the following equation:

$$\Delta^3 y_t = \alpha_0 + \alpha_2 \Delta y_{t-1} + \alpha_3 \Delta^2 y_{t-1} + \sum_{i=1}^{k} \Delta^3 y_{t-i} + \varepsilon_t \quad (2)$$

If H_{O2} is rejected, go to step III.

Step III: H_{O1}: $y_t \sim I(1)$; H_{A1}: $y_t \sim I(0)$

Compute *t*-statistic for α_1 from the equation:

$$\Delta^3 y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 \Delta y_{t-1} + \alpha_3 \Delta^2 y_{t-1} + \sum_{i=1}^{k} \Delta^3 y_{t-i} + \varepsilon_t \quad (3)$$

The presence of lagged dependent variables is to ensure the error terms are white noise. The results of the DP unit root tests on all real and monetary series for each country are presented in Table 1.

It is clearly shown in Table 1 that the null hypothesis of the presence of three unit roots in money and real output can be rejected in Step I for all the countries under study. In the second steps, the null of two unit roots in real GDP are rejected for all countries. However, for money series in Singapore and Sri Lanka, we fail to reject the existing of two unit roots. It implies that money supply in these two countries appear to be integrated of order two, that is *I*(2). In the last step of DP test, as all the *t*-statistics of α_1 for both M1 (expect for Singapore and Sri Lanka) and real GDP are less than the critical value at five percent level, we conclude that there are *I*(1) processes.

Table 1: Dickey-Pantula Integration Tests Results

Country & Series	Step 1 Test for three unit roots		Step 2 Test for two unit roots		Step 3 Test for one unit root	
	α_3	Lag	α_2	Lag	α_1	Lag
Indonesia						
Y	-6.24**	0	-4.98**	0	-2.37	0
M1	-4.55**	1	-4.43**	0	-1.52	0
Korea						
Y	-6.81**	3	-4.08**	0	-1.82	3
M1	-8.01**	1	-4.57**	0	-2.26	1
Malaysia						
Y	-6.26**	3	-3.60**	1	0.70	0
M1	-7.17**	1	-4.71**	0	0.99	0
Myanmar						
Y	-6.28**	2	-5.33**	0	-0.58	0
M1	-8.34**	1	-3.26*	0	2.53	0
Nepal						
Y	-11.79**	1	-7.96**	0	1.45	0
M1	-7.28**	2	-4.53**	0	0.82	0
Philippines						
Y	-6.52**	3	-5.96**	0	-2.58	0
M1	-7.57**	2	-3.11*	1	0.75	1
Singapore						
Y	-6.68**	1	-3.59**	0	-1.99	0
M1	-4.08**	4	-2.22	3	-	-
Sri Lanka						
Y	-7.32**	2	-4.35**	0	-0.70	0
M1	-6.99**	3	-1.47	3	-	-
Taiwan						
Y	-6.14**	3	-4.78**	0	-1.26	0
M1	-6.10**	3	-3.58**	0	-1.52	0
Thailand						
Y	-7.59**	1	-4.30**	0	-0.54	0
M1	-5.97**	3	-5.63**	0	1.09	0

Notes: Y and M1 denote real output and narrow money supply. Asterisks (*) and (**) denote statistically significant at the 5% and 1% levels, respectively. Critical values are taken from Fuller (1976); for T=50, τ_μ= -2.93 at 5% level, and –3.58 at 1% level.

As stated by FS, a meaningful LRN (LRSN) is testable in the absence of cointegration between money and output. The reason behind is that in order for money to be LRN (LRSN) with respect to real variable, it must exhibit instances of permanent change and that the respective stochastic trends driving monetary and real variables are uncorrelated in the long run. Therefore, the Johansen and Juselius (1990) maximum likelihood cointegration test was applied to reveal the long run relationship between money and real output. As reported in Table 2, we cannot reject the null hypothesis of no cointegration except for Sri Lanka. This further indicates that the conditions necessary for meaningful LRN and LRSN tests hold for all countries except Sri Lanka.

Table 2: Results of Cointegration Test

Country	Maximum Eigenvalue Statistics	
	r=0	r≤1
Indonesia	6.60	2.86
Korea	8.81	5.51
Malaysia	9.78	0.29
Myanmar	10.94	6.53
Nepal	10.59	0.05
Philippines	14.69	0.01
Singapore	7.19	4.52
Sri Lanka	28.64*	2.47
Taiwan	5.25	2.52
Thailand	10.37	0.30

Notes: Asterisks (*) indicate significant at the 5% level. Critical values are taken from Table 1, Osterwald-Lenum (1992). Lag selection is based on Schwert (1987) formula, where $k = [4(T/100)^{1/4}]$.

3. The Fisher and Seater Methodology

In this study, we adopt the stationary invertible bivariate ARIMA model derived by FS to present some international evidence on the monetary neutrality on a group of 10 Asian emerging economies. Let *m* be the log of nominal money supply and *y* is the log of real output:

$$a(L)\Delta^{\langle m\rangle} m_t = b(L)\Delta^{\langle y\rangle} y_t + u_t$$
$$d(L)\Delta^{\langle y\rangle} y_t = c(L)\Delta^{\langle m\rangle} m_t + w_t \qquad (4)$$

where $a(L)$, $b(L)$, $c(L)$ and $d(L)$ are distributed lag polynomials in the lag operator L, with $a_0 = d_0 = 1$, and b_0 and c_0 are not restricted. $\Delta = (1 - L)$, and $\langle m\rangle$ and $\langle y\rangle$ are the orders of integration of the money supply and real output[1]. The error vector $(u_t\ w_t)'$ is *iid* $(0, \Sigma)$, where $0 = (0,0)'$ and the elements of Σ are σ_{uu}, σ_{uw}, and σ_{ww}.

FS then defined the LRN in terms of the long-run derivative (*LRD*) of *y* with respect to a permanent change in *m* as follows:

$$LRD_{y,m} \equiv \lim_{k\to\infty} \frac{\partial y_{t+k} / \partial u_t}{\partial m_{t+k} / \partial u_t} \qquad (5)$$

where $\lim_{k\to\infty} \partial m_{t+k} / \partial u_t \neq 0$. If $\lim_{k\to\infty} \partial m_{t+k} / \partial u_t = 0$, there will be no permanent innovations in the level of money and thus the neutrality propositions cannot be tested. $LRD_{y,m}$ measures the ultimate effect of a stochastic monetary disturbance on *y* relative to that disturbance's ultimate effect on *m*. The definitions used by FS of LRN and LRSN are as follows[2]:

[1] In all discussions, we follow the FS notation.
[2] See the original article of FS, page 405-6.

LRN: 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.

LRSN: Money is long run superneutral if $LRD_{y,\Delta m} = \mu$, where $\mu = 1$ if y is a nominal variable, and $\mu = 0$ if y is a real variable.

For $\langle m \rangle \geq 1$, FS show that Equation (5) can be written as:

$$LRD_{y,m} \equiv \frac{(1-L)^{<m>-<y>}\gamma(L)\big|_{L=1}}{\alpha(L)} \tag{6}$$

where $\alpha(L)$ and $\gamma(L)$ are functions of the coefficients from the original reduced-form model in Equation (4)[3]. Clearly, the specific value of the $LRD_{y,m}$ is depends on $\langle y \rangle$ and $\langle m \rangle$. Equation (6) allows us to derive the relevant values of λ and μ under LRN and LRSN, as summarized in Table 3.

As discussed earlier, a meaningful condition of LRN test exists only when money is at least equal to one, otherwise, there will be no stochastic permanent changes in money that can affect real output. In the case where $\langle m \rangle \geq \langle y \rangle + 1 \geq 1$, the $LRD_{y,m} = 0$, providing direct evidence of LRN. For example, when $\langle m \rangle = 2$, $\langle y \rangle \leq 1$, and $\langle m \rangle = 1$, $\langle y \rangle = 0$, LRN is said to be held by construction. FS show that LRN is testable when both $\langle m \rangle$ and $\langle y \rangle$ are at least equal to or greater than one, in which the $LRD_{y,m} = \gamma(L)/\alpha(L) = c(1)/d(1)$. The special case occur when $\langle m \rangle = \langle y \rangle = 1$, where $LRD_{y,m}$ indicates whether permanent changes in money do have effect on permanent changes in real output.

Table 3: Long-run Neutrality and Superneutrality Restrictions

	$LRD_{y,m}$ LRN = $LRD_{y,m} = \lambda$			$LRD_{y,\Delta m}$ LRN = $LRD_{y,\Delta m} = \mu$		
<y>	<m> = 0	<m> = 1	<m> = 2	<m> = 0	<m> = 1	<m> = 2
0	Undefined	≡ 0	≡ 0	Undefined	Undefined	≡ 0
1	Undefined	c(1)/d(1)	≡ 0	Undefined	Undefined	c(1)/d(1)

Source: Adapted from Fisher and Seater (1993, see Table 2).

On the other hand, the test of LRSN required different values of integration in the money series. In particular, LRSN requires $\langle m \rangle \geq 2$, or it is not addressable since there are not permanent changes in the growth rate of money. When $\langle m \rangle = 2$, and $\langle y \rangle = 0$, both LRN and LRSN hold by construction. LRSN becomes testable if there are permanent stochastic innovations in the growth rate of money and permanent stochastic movements in the level of real output. It happens when $\langle m \rangle = 2$, and $\langle y \rangle = 1$; and the long-run derivative is given by $LRD_{y,\Delta m} = \gamma(L)/\alpha(L) = c(1)/d(1)$.

[3] See FS (page 404), in which $\alpha(L) = d(L)/[a(L)c(L)-b(L)c(L)]$ and $\gamma(L) = c(L)/[a(L)c(L)-b(L)c(L)]$.

Assuming the money supply is exogenous[4], and the error terms u_t and w_t are serial uncorrected in the ARIMA model, the term $c(1)/d(1)$ is the Bartlett estimator of frequency-zero coefficient in a regression of $\Delta^{\langle y \rangle} y_t$ on $\Delta^{\langle m \rangle} m_t$. An estimate of c(1)/$d$(1) is given by $\lim_{k \to \infty} \beta_k$, where β_k is the slope coefficient from the following OLS regression:

$$\left[\sum_{j=0}^{k} \Delta^{\langle y \rangle} y_{t-j} \right] = \alpha_k + \beta_k \left[\sum_{j=0}^{k} \Delta^{\langle m \rangle} m_{t-j} \right] + \varepsilon_{kt} \tag{7}$$

When $\langle m \rangle = \langle y \rangle = 1$, LRN is testable, and Equation (7) becomes:

$$(y_t - y_{t-k-1}) = \alpha_k + \beta_k (m_t - m_{t-k-1}) + \varepsilon_{kt} \tag{8}$$

The null hypothesis of LRN is $\beta_k = 0$. Significant values of β_k indicate an absence of LRN.

When $\langle m \rangle = 2$ and $\langle y \rangle = 1$, LRSN is testable, and Equation (7) becomes:

$$(y_t - y_{t-k-1}) = \alpha_k + \beta'_k (\Delta m_t - \Delta m_{t-k-1}) + \nu_{kt} \tag{9}$$

Similarly, the null hypothesis of LSRN is $\beta'_k = 0$. The non-rejection of the null hypothesis indicates the data supports the LRSN proposition.

4. The LRN and LRSN Tests Results

The results of DP sequential unit root tests suggest that real output contains a unit root for all countries, and the money series is integrated of order one except for Singapore and Sri Lanka, in which they are $I(2)$ processes. In the notion of FS framework, these order of integration imply that the LRN restriction $c(1)/d(1)$ is testable for Indonesia, Malaysia, Myanmar, Nepal, the Philippines, South Korea, Taiwan, and Thailand. At the same time, LRSN is the appropriate hypothesis to be tested for the economies of Singapore and Sri Lanka. However, not all of the countries are informative to the LRN (LRSN) tests. The λ-max statistics in Johansen and Juselius (1990) tests show that while most of the countries do not have long run cointegrating vector with money, the null of no cointegration is strongly rejected in the case of Sri Lanka. This result implies that money is not exogenous and it has the ability to affect real economic activity in Sri Lanka. In other words, money is non-neutral in Sri Lanka.

For the next step, we proceed to apply FS methodology by excluding Sri Lanka in our analysis. For those countries with one unit root for their money series (Indonesia, Malaysia, Myanmar, Nepal, the Philippines, South Korea, Taiwan, and Thailand), Equation (8) is used to test for LRN. For Singapore, where money is $I(2)$, Equation (9) is utilized to test for LRSN. The estimated results are then presented in Tables 4 to

[4] The assumption of exogenous money can be addressed using cointegration tests. Failure to reject the null of no cointegrated vector is not a sufficient condition for exogeneity; however, rejection of the null provides direct evidence against the exogeneity assumption.

12. We report the values of the estimated coefficients, Newey-West (1987) covariance matrix estimator, *t*-statistics of null hypothesis and the associated marginal significance level. A summary of the integration and LRN (LRSN) tests result is presented in Table 13.

LRN of M1 with Respect to Real GDP

We notice that there is a mixture of empirical results in the test of LRN. We fails to reject LRN proposition in Malaysia[5], Myanmar, Nepal, the Philippines, and South Korea, as the slope coefficient of β_k are insignificant at five percent level for all k values in these countries. Nevertheless, LRN does not hold in the other three economies of Indonesia, Taiwan, and Thailand. The null hypothesis of slope coefficient $\beta_k = 0$ is rejected at $k > 5$ for Indonesia, at $k > 7$ for Taiwan, and at $k > 1$ for Thailand. As such, money is said to be long-run neutral with respect to real output in Malaysia, Myanmar, Nepal, the Philippines, and South Korea. For Indonesia, Taiwan, and Thailand, we found that monetary stimulus do have positive impact on real output. In the case of Singapore, the LRN holds by construction as the money series is in $I(2)$ process.

Table 4: Indonesia
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	0.043	0.054	0.798	0.431
2	-0.038	0.137	-0.277	0.784
3	-0.016	0.202	-0.080	0.937
4	0.067	0.222	0.303	0.764
5	0.165	0.178	0.925	0.362
6	0.241	0.115	2.089	0.046
7	0.284	0.090	3.137	0.004
8	0.304	0.092	3.291	0.003
9	0.312	0.097	3.203	0.004
10	0.312	0.093	3.355	0.003
11	0.304	0.092	3.310	0.003
12	0.293	0.087	3.351	0.003
13	0.276	0.078	3.549	0.002

Table 5: Nepal
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	-0.258	0.286	-0.902	0.373
2	-0.241	0.281	-0.857	0.397
3	-0.198	0.241	-0.820	0.418
4	-0.165	0.199	-0.831	0.412
5	-0.151	0.169	-0.896	0.377
6	-0.143	0.149	-0.960	0.345
7	-0.135	0.141	-0.963	0.344
8	-0.136	0.141	-0.963	0.344
9	-0.155	0.141	-1.102	0.280
10	-0.194	0.141	-1.371	0.182
11	-0.252	0.161	-1.568	0.130
12	-0.317	0.176	-1.801	0.084
13	-0.383	0.212	-1.804	0.084

Table 6: Malaysia
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	0.237	0.081	2.902	0.006
2	0.163	0.061	2.667	0.010
3	0.108	0.055	1.964	0.056
4	0.081	0.054	1.487	0.144
5	0.075	0.050	1.494	0.142
6	0.080	0.046	1.743	0.088
7	0.088	0.049	1.806	0.078
8	0.092	0.058	1.577	0.122
9	0.092	0.073	1.254	0.217
10	0.086	0.091	0.939	0.353
11	0.077	0.110	0.694	0.492
12	0.066	0.127	0.516	0.609
13	0.057	0.142	0.401	0.690
14	0.050	0.154	0.325	0.747
15	0.044	0.165	0.264	0.793
16	0.033	0.174	0.190	0.850
17	0.016	0.176	0.088	0.930
18	-0.011	0.172	-0.064	0.949

Table 7: Myanmar
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	0.001	0.034	0.038	0.970
2	-0.028	0.042	-0.677	0.502
3	-0.048	0.045	-1.054	0.298
4	-0.056	0.048	-1.167	0.249
5	-0.059	0.049	-1.190	0.240
6	-0.059	0.050	-1.169	0.249
7	-0.058	0.051	-1.137	0.262
8	-0.056	0.051	-1.103	0.276
9	-0.055	0.051	-1.081	0.286
10	-0.054	0.051	-1.064	0.294
11	-0.052	0.050	-1.042	0.304
12	-0.051	0.050	-1.010	0.319
13	-0.048	0.050	-0.963	0.342
14	-0.046	0.051	-0.908	0.370
15	-0.043	0.051	-0.849	0.402
16	-0.041	0.051	-0.795	0.432
17	-0.039	0.051	-0.753	0.457
18	-0.037	0.051	-0.728	0.472

[5] For Malaysia, LRN is rejected at $k < 3$, indicating money have a very short run effect on real output.

Table 8: Philippines
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	0.101	0.076	1.342	0.186
2	0.067	0.067	0.993	0.326
3	0.042	0.062	0.675	0.503
4	0.028	0.059	0.468	0.642
5	0.020	0.058	0.352	0.726
6	0.015	0.060	0.255	0.800
7	0.008	0.063	0.134	0.894
8	0.000	0.065	0.003	0.998
9	-0.008	0.066	-0.118	0.907
10	-0.013	0.067	-0.197	0.845
11	-0.016	0.067	-0.237	0.814
12	-0.016	0.067	-0.239	0.813
13	-0.015	0.067	-0.220	0.827
14	-0.012	0.067	-0.185	0.855
15	-0.010	0.068	-0.150	0.882
16	-0.007	0.068	-0.110	0.913
17	-0.005	0.068	-0.077	0.939
18	-0.002	0.069	-0.036	0.972

Table 9: South Korea
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	0.023	0.063	0.372	0.712
2	-0.036	0.072	-0.498	0.621
3	-0.078	0.086	-0.909	0.368
4	-0.100	0.098	-1.014	0.316
5	-0.114	0.109	-1.052	0.299
6	-0.136	0.114	-1.197	0.238
7	-0.169	0.115	-1.475	0.148
8	-0.201	0.117	-1.715	0.094
9	-0.226	0.122	-1.852	0.072
10	-0.240	0.128	-1.877	0.068
11	-0.246	0.132	-1.862	0.071
12	-0.248	0.135	-1.834	0.075
13	-0.250	0.138	-1.816	0.078
14	-0.255	0.140	-1.818	0.078
15	-0.262	0.143	-1.831	0.077
16	-0.272	0.146	-1.860	0.072
17	-0.284	0.150	-1.898	0.067

Table 10: Taiwan
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	0.054	0.099	0.540	0.592
2	0.044	0.107	0.411	0.683
3	0.055	0.114	0.485	0.630
4	0.077	0.123	0.622	0.537
5	0.111	0.132	0.839	0.406
6	0.159	0.136	1.170	0.248
7	0.221	0.129	1.712	0.094
8	0.279	0.116	2.417	0.020
9	0.322	0.105	3.055	0.004
10	0.343	0.100	3.415	0.002
11	0.351	0.097	3.636	0.001
12	0.356	0.093	3.812	0.001
13	0.360	0.090	3.986	0.000
14	0.363	0.087	4.158	0.000
15	0.366	0.085	4.315	0.000
16	0.367	0.082	4.458	0.000
17	0.367	0.080	4.591	0.000

Table 11: Thailand
Long-run regressions of real output on M1

k	β_k	SE_k	t_k	p-value
1	0.102	0.064	1.601	0.116
2	0.099	0.049	2.007	0.051
3	0.095	0.046	2.051	0.046
4	0.097	0.042	2.291	0.027
5	0.111	0.039	2.814	0.007
6	0.132	0.040	3.287	0.002
7	0.153	0.046	3.320	0.002
8	0.168	0.058	2.923	0.006
9	0.180	0.072	2.504	0.017
10	0.186	0.085	2.205	0.034
11	0.191	0.092	2.072	0.046
12	0.194	0.096	2.029	0.050
13	0.195	0.096	2.024	0.051
14	0.194	0.095	2.033	0.050
15	0.191	0.094	2.040	0.050
16	0.188	0.092	2.046	0.049
17	0.185	0.090	2.048	0.049

LRSN of M1 with Respect to Real GDP

Except for Singapore, the LRSN test is not addressable because there is no permanent innovation in the growth rate of money. The regression result of Equation (9) is tabulated in Table 12. The *t*-statistic of null hypothesis that $\beta_k^{'} = 0$ are positive and statistically significant at the conventional level at $k > 5$. This result means that LRSN does not hold for Singapore in the FS expression. To summarize, as shown in Table 13, LRSN is either not addressable or fail in the data of 10 Asian developing countries under study.

Table 12: Singapore
Long-run regressions of real output on ΔM1

k	β_k	SE_k	t_k	p-value
1	0.017	0.059	0.291	0.773
2	0.021	0.054	0.399	0.692
3	0.028	0.049	0.575	0.569
4	0.039	0.041	0.961	0.344
5	0.053	0.032	1.640	0.111
6	0.069	0.025	2.757	0.010
7	0.082	0.024	3.438	0.002
8	0.093	0.024	3.811	0.001
9	0.100	0.025	4.045	0.000
10	0.105	0.025	4.219	0.000
11	0.109	0.024	4.522	0.000
12	0.112	0.025	4.465	0.000
13	0.115	0.027	4.252	0.000

5. Conclusion

In this paper, the classical theoretic propositions of LRN and LRSN have been tested using the dynamic simultaneous equation model developed by FS. We apply the FS model to 10 SEACEN member countries, as there are relatively few empirical works in examining LRN and LRSN in the context of Asian developing economies. Special attention has been given to the non-stationarity and cointegration properties of the data, since meaningful FS tests critically depend on such properties. We discover that most of the money series are $I(1)$, except for Singapore and Sri Lanka, in which they have two unit roots. However, Sri Lanka has been excluded in the test of LRSN because its money series exists a common trend between real output.

Empirical results show that long run deviations from LRN and LRSN exist in our data. While money does not matter for the economies of Malaysia, Myanmar, Nepal, the Philippines, and South Korea, it is long run non-neutral with respect to real output in Indonesia, Taiwan, and Thailand. Meanwhile, we found evidence against LRSN in Singapore data, indicating the permanent shock to the rate of monetary growth do have important effect on real economic performance.

The important implication from this study is that monetary authorities should not simply manipulate monetary policy to stabilize the fluctuations in business cycle without prior knowledge about the link between money and real output. For those countries in which LRN does not hold, monetary injection might help to raise output, eliminate recession and create more job opportunity. However, the monetary expansion in countries that LRN is holds will eventually create nothing but inflation.

Table 13: Summary of Results

Country	Series	Order of Integration	LRN	LRSN
Indonesia	Y	*I*(1)		
	M1	*I*(1)	Fails	Not addressable
Korea	Y	*I*(1)		
	M1	*I*(1)	Holds	Not addressable
Malaysia	Y	*I*(1)		
	M1	*I*(1)	Holds	Not addressable
Myanmar	Y	*I*(1)		
	M1	*I*(1)	Holds	Not addressable
Nepal	Y	*I*(1)		
	M1	*I*(1)	Holds	Not addressable
Philippines	Y	*I*(1)		
	M1	*I*(1)	Holds	Not addressable
Singapore	Y	*I*(1)		
	M1	*I*(2)	Holds by construction	Fails
Sri Lanka	Y	*I*(1)		
	M1	*I*(2)	Not informative	Not informative
Taiwan	Y	*I*(1)		
	M1	*I*(1)	Fails	Not addressable
Thailand	Y	*I*(1)		
	M1	*I*(1)	Fails	Not addressable

Note: Summaries for Tables 4 to 12.

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References

Bae, S.K., & Ratti, R.A. (2000). Long-run neutrality, high inflation, and bank insolvencies in Argentina and Brazil. *Journal of Monetary Economics*, 46, 581-604.

Dickey, D.A., & Pantula, S.G. (1987). Determining the order of differencing in autoregressive processes. *Journal of Business and Economic Statistics*, 5(4), 455-461.

Fisher, M.E., & Seater, J.J. (1993). Long-run neutrality and superneutrality in an ARIMA framework. *American Economic Review*, 83, 402-415.

Fuller, W.A. (1976). *Introduction to Statistical Time Series*. New York: John Wiley & Sons.

International Monetary Fund, *International Financial Statistics*, various issues. Washington, D.C.: IMF.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimated and inference on cointegration with application to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, 54, 59-78.

Lucas, R.E. (1980). Two illustrations of the quantity theory of money. *American Economic Review*, 70, 1005-1014.

Newey, W.K., & West, K.D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55, 703-708.

Noriega, A.E. (2004). Long-run monetary neutrality and the unit-root hypothesis: Further international evidence. *North American Journal of Economics and Finance*, 15(2), 179-197.

Osterwald-Lenum, M. (1992). A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics. *Oxford Bulletin of Economics and Statistics*, 54, 461-472.

Phillips, P.C.B., & Perron, P. (1988). Testing for a unit root in time series regression, *Biometrika*, 75(2), 335-346.

Said, S.E., & Dickey, D.A. (1984). Testing for unit root in autoregressive-moving average of unknown order. *Biometrika*, 71, 599-607.

Schwert, G.W. (1987). Effects of model specification tests for unit root in macroeconomic data. *Journal of Monetary Economics*, 20, 73-103.

Serletis, A., & Koustas, Z. (1998). International evidence on the neutrality of money. *Journal of Money, Credit and Banking*, 30, 1-25.

Shelley, G.L., & Wallace, F.W. (2003). *Testing for Long Run Neutrality of Money in Mexico*. Unpublished manuscript.