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Abstract

The objective of this paper is to test the validity of the proposition known as long run neutrality of money (LRN) that changes in monetary aggregate, defined either as narrow or broad money, do not affect real output in the long run in Fiji. The empirical study, which is based on an autoregressive integrated moving average model, utilizes data on real GDP and nominal monetary aggregates, M1 and M2 over 1970-2011. The study results reveal that the proposition of LRN of money is rejected in both cases, when M1 or M2 is used as measures of nominal money supply, and that changes in monetary aggregate did have a positive impact on real output in Fiji.

Key words: money supply, neutrality of money, real output, Fiji

JEL codes: E51 E52 N17

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1. Introduction

The concept of long run neutrality of money has fascinated researchers for a long time. As an off-shoot of the quantity theory of money, the LRN concept is that any permanent change in money supply will not in the long run affect the real variables in the economy, such as real output, employment and real interest rate. In other words, changes in money supply would in the long run result only in changes in the nominal prices leaving real output unchanged (Mishkin 2012).

Having a prior knowledge of LRN is important for the monetary authority of a country since it helps to evaluate the effectiveness of monetary policy in the long-run. Amongst the 14 Pacific Island countries (PICs)[1], Fiji is one of the six[2] with independent currencies of their own, the other eight being dollarized ones[3] having adopted the currencies of metropolitan powers as legal tender.

The monetary authority of Fiji, the Reserve Bank of Fiji (RBF), which was established on July 1, 1973 completed 40 years of its existence in 2013. The RBF has accumulated over the period considerable experiences in formulating and implementing monetary policies for promoting the objectives of economic growth as well as price and exchange rate stability. Although there are a number of studies on monetary policy transmission mechanism in Fiji and other PICs (Yang *et al.* 2011, Jayaraman and Narayan 2011), there are no studies on LRN.

The objective of this paper, which is to test the validity of LRN in Fiji, is organized on the following lines. The second section briefly reviews the literature with reference to empirical studies conducted in developed and developing countries; the third section outlines the methodology employed for the study; the fourth section presents the results and the last section is a summary of the findings with policy recommendations.

2. A Brief Review of Theory and Empirical Evidence

The neutrality of money hypothesis has important implications from the points of view of formulation and implementation of monetary policy. In monetary-business-cycle (MBC) models, active and discretionary monetary policy plays a significant role towards stabilizing the economy (Friedman and Schwartz 1963). Referring to Gurley's (1961) parody of Friedman's monetary theory that "money is a veil, but when the veil flutters, real output sputters", Lucas (1972) noted that if information received by economic agents is inadequate, they are unable to distinguish real from monetary disturbances; and in that

[1] The 14 Pacific Island countries, which form the intergovernmental organization known as Pacific Islands Forum, are: Cook Islands, Fiji, Kiribati, Republic of Marshall Islands, Federated States of Micronesia, Nauru, Niue, Palau, Papua New Guinea (PNG), Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

[2] The six PICs with independent currencies of their own are: Fiji, Papua New Guinea, Samaoa, Solomon Islands, Tonga and Vanuatu.

[3] The eight dollarized PICs: Kiribati, Nauru, Tuvalu (using Australian dollar as legal tender), Cook Islands and Niue (using New Zealand dollar as legal tender) and Federated States of Micronesia, Republic of Marshall Islands and Palau using the United States dollar as legal tender).

setting monetary fluctuations lead to real output movements in the same direction.

On the other hand, according to real-business-cycle (RBC) theory, changes in monetary policy decisions which target the monetary aggregate do not work. As argued by RBC proponents, changes in aggregate output would arise only from real shocks such as tastes and technology and not from monetary shocks. The proponents of RBC theory hold that any correlation of output with money might reflect reverse causation; that is the business cycles drive money rather than the other way around (Mishkin 2012, King and Plosser 1984).

Furthermore, other developments over last two decades have increasingly questioned the practice of monetary targeting for influencing output. The reason behind this was the fast pace of liberalization process since the 1970s, which marked policy makers switching on to free market mechanism. There were notable shifts by state and monetary authorities, who dismantled controls by the state on savings and investment. Central banks removed ceilings on interest rates charged by commercial banks and discontinued restrictive limits ceilings on credit and the earmarking of credit for the so-called priority sectors. The emergence of interest bearing assets in the midst of rapid financial liberalization process increasingly rendered the relationship between money and output unstable. Consequently, monetary policy actions aiming at monetary aggregates as intermediate targets for achieving goals of economic growth were found to be ineffective (Habibullah *et al*. 2002).

Empirical studies testing the concept of LRN date back to 1980s[4]. These include Dwyer and Hafer (1988) for 62 countries; Lothian (1985) and Hsing (1990) for OECD countries, Loef (1993) for 12 European Coimmunity countries; Weber (1994) for G7 countries; Duck (1988, 1993) for 33 countries; and Fisher and Seater (1993) for one country, namely USA; Bhanumurthy (1999) for 9 developing countries. Except for Bhanumurthy (1999), all the aforementioned studies confirmed the proposition of LRN of money in many countries.

Studies on countries of the South East Asian Central Banks Research and Training Centre (the SEACEN) which include Puah *et al.* (2008), concluded that three out of nine countries namely Indonesia, Taiwan and Thailand did not show any evidence of LRN proposition while the evidence in regard to six other SEACEN countries supported LRN hypothesis. Chen (2007) also noted mixed results in his study: there was evidence in supporting LRN of money in South Korea but not in Taiwan. The findings also varied depending upon the choice of monetary aggregates studied. The LRN hypothesis is sensitive to the choice of money supply data as different measures of monetary aggregates used in analysis tend to provide different conclusions on LRN proposition. The empirical study done by Olekalns (1996) in Australia found supporting evidence in favour of LRN on M1 but not on M3.

A similar result is obtained by Leong McAleer (2000), where broader definition of

[4] For an extensive summary of findings of various empirical studies, see Habibullah *et al*. (2002), Puah *et al*. (2010) and Tang (2013).

money M3 was found to be non-neutral toward real output and contrasted results occurred when narrow definition of money M1 was used to represent money supply. Coe and Nason (1999) also provided evidence to support the proposition of LRN when M1 is used. However when M1 is replaced by monetary base, evidence against the LRN hypothesis was confirmed by Coe and Nason (1999).

However, there are studies which showed that both narrow and broad money do not support LRN hypothesis. Tan and Baharumshah (1999) obtained empirical evidence that both narrow and broad monetary aggregates in Malaysia impacted the economic growth. Similar result was also obtained by Puah *et al.* (2006) where both narrow and broad Divisia monetary aggregates were found to be non-neutral in the context of Malaysia. A later study by Puah *et al.* (2010) also indicated that both M1 and M2 do have impact on Malaysian real output.

3. Modelling and Methodology

We adopt the methodology of Fisher and Seater (FS) (1993) for testing LRN proposition in Fiji. FS neutrality test is a bivariate ARIMA model in reduced-form which is a convenient setting for LRN analysis as the LRN does not depend on short-run dynamics. It can be derived as below:

$$\begin{aligned} a(L)\Delta^{<m>} m_t &= b(L)\Delta^{<y>} y_t + u_t \\ d(L)\Delta^{<y>} y_t &= c(L)\Delta^{<m>} m_t + w_t \end{aligned} \tag{1}$$

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 as 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. Noted 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) are assumed to be independently and identically distributed with mean zero and covariance matrix.

The stationarity of y is explained by the stationarity of m over time. Therefore, FS define the LRN in terms of the long-run derivative (LRD) of y with respect to a permanent change in m as follows:

$$LRD_{y,m} \equiv \lim_{k\to\infty} \frac{\partial y_{t+k} / \partial u_t}{\partial m_{t+k} / \partial u_t} \tag{2}$$

where $\lim_{k\to\infty} \partial m_{t+k} / \partial u_t \neq 0$, or else there will be no permanent changes in the level of money and thus the neutrality propositions cannot be tested. $LRD_{y,m}$ expresses the ultimate effect of an exogenous money disturbance on y relative to that disturbance's ultimate effect on m.

As such, the specific value of the $LRD_{y,m}$ depends on $\langle y \rangle$ and $\langle m \rangle$. 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 $LRD_{y,m} = c(1)/d(1)$. LRN requires that $LRD_{y,m} = 1$ if y is a nominal variable and $LRD_{y,m} = 0$ if y is a real variable. Long-run super-neutrality (LRSN) requires that $LRD_{y,\Delta m} = 1$ if y is a nominal variable and $LRD_{y,\Delta m} = 0$ if y is a real variable.

According to FS (1993), when $\langle m \rangle \geq 1$, Equation (2) can be expressed as below:

$$LRD_{y,m} \equiv \frac{(1-L)^{<m>-<y>}\gamma(L)|_{L=1}}{\alpha(L)} \tag{3}$$

where $\alpha(L) = d(L)/[a(L)c(L) - b(L)c(L)]$ and $\gamma(L) = c(L)/[a(L)c(L) - b(L)c(L)]$. The value of $LRD_{y,m}$ in Equation (3) depends on the orders of integration of the monetary and real variables, $\langle m \rangle$ and $\langle y \rangle$. When $\langle m \rangle = \langle y \rangle = 1$, then the long-run derivative of y with respect to m becomes $LRD_{y,m} = \gamma(L)/\alpha(L) = c(1)/d(1)$. Test of LRN is possible in this case, because there are permanent changes in both m and y. If there are permanent shocks to the growth rate of money, Δm_t, so that now $\langle m \rangle = 2$ while $\langle y \rangle = 1$, then the long-run derivative of y with respect to Δm becomes $LRD_{y,\Delta m} = \gamma(L)/\alpha(L) = c(1)/d(1)$.

With the assumption of exogeneity of money supply and error terms u_t and w_t are uncorrected in the ARIMA model for the LRN, or the coefficient $c(1)/d(1)$ equals the frequency-zero coefficient in a regression of $\Delta^{\langle y \rangle} y$ on $\Delta^{\langle m \rangle} m$. The 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:

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

When $\langle m \rangle = \langle y \rangle = 1$, LRN is testable and a reduced-form of Equation (4) can be estimated as below:

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

where β_k is the slope coefficient of the equation. The null hypothesis of FS neutrality test is $\beta_k = 0$, which indicates that the change of money supply will not have impact on real output. A significant value of β_k indicates the rejection of LRN proposition[5].

4. Data and Empirical Result

The data series for the empirical study for testing LRN of money in Fiji were sourced

[5] When $\langle m \rangle = 2$ and $\langle y \rangle = 1$, long run super neutrality (LRSN) of money is testable and a reduced-form of Equation (4) can be estimated as below:

$$(y_t - y_{t-k-1}) = \alpha_k + \beta_k (\Delta m_t - \Delta m_{t-k-1}) + \varepsilon_{kt} \tag{6}$$

The null hypothesis of FS super neutrality test is $\beta_k = 0$, which indicates that the change of money supply growth will not have impact on real output. A significant value of β_k indicates the rejection of LRSN proposition

from *International Financial Statistics* published by International Monetary Fund (2012). The time series on real GDP at 2000 prices, M1 and M2 cover a 42-year period (1970-2011).[6] Data are summarized in Table 1.

Table 1: Summary Statistics (Unit: Million Fijian Dollars)

Year	Real GDP	Nominal M1	Nominal M2
Average 1970-1979	2514.41	71.33	164.97
Average 1980-1989	3187.2	159.14	511.76
Average 1990-1999	3976.48	392.25	1330.81
Average 2000-2004	4740.3	747.92	2026.18
2005	5084.4	1205.1	2968.8
2006	5178.6	1149.9	3629.9
2007	5134.5	1621.4	3930.8
2008	5187.5	1357.3	3676.6
2009	5121.5	1262.1	3937
2010	5112.2	1411	4075
2011	5215.5	2000.1	4542

Since the empirical testing procedure is critically dependent on the order of integration of both monetary aggregates and real output, we resort to unit root tests for investigating properties of stationarity. Due to existence of heteroskedasticity pattern in the line graph of $\Delta\ln(M1)$ and $\Delta\ln(M2)$, Phillips-Perron unit root test, which is robust with respect to unspecified autocorrelation and heteroskedasticity in the disturbance process of the test equation, was preferred and therefore adopted.

Unit root tests are applied to level, first difference and difference of growth of each series. Tests results are reported in Table 2. In unit root tests for level of each series, since *z*-statistics are respectively greater than the negative critical values at the 5% level, the null hypothesis of non-stationarity is not rejected. In unit root tests for first difference of each series, since z-statistics are respectively less than the negative critical values at the 5% level, the non-stationarity hypothesis is rejected. We therefore conclude that real output and monetary aggregates under study are integrated of order one, that is in $I(1)$ processes. This makes testing for difference of growth meaningless, since the second unit root is surely rejected for each series, as shown in the last panel of Table 2.

Johansen and Juselius (1990) cointegration test is employed to ensure the existence of a meaningful LRN test condition. From the cointegration results in Table 3, Trace statistics for the null hypothesis of no cointegration ($r = 0$) for two models (ln(RGDP) and ln(M1), ln(RGDP) and ln(M2)) are seen respectively to be higher than the 5% level critical

[6] Note that M3 was announced in 2012. Values of the M3 series, as published in the International Financial Statistics (2012), are the same as those of M2 until 2000. Due to the inconsistency of measuring M3, M3 is not covered in the current study.

values, leading to rejection of the no cointegration hypothesis. It also rejects the necessity of continuing the test for next higher rank. Trace statistics for the null hypothesis of up to one cointegration ($r \leq 1$) are respectively less than the 5% level critical values, leading to non-rejection of the null hypothesis. This suggests that both monetary variables are correlated with real output. Together with the integration tests' results, this indicates that LRN test can be conducted while LRSN is not testable due to lack of different integration orders of variables.

Table 2: Phillips-Perron Unit Root Tests Results

Series	Trend	Newey-West lags	*z* (*rho*)	5% critical value
ln(RGDP)	Trend	3	-2.095	-13.012
ln(M1)	Trend	3	-0.126	-13.012
ln(M2)	Trend	3	-1.278	-13.012
Δln(RGDP)	Constant	3	-49.607	-12.980
Δln(M1)	Constant	3	-46.246	-12.980
Δln(M2)	Constant	3	-31.158	-12.980
Δ^2ln(RGDP)	None	3	-58.242	-12.948
Δ^2ln(M1)	None	3	-53.995	-12.948
Δ^2ln(M2)	None	3	-50.823	-12.948

Note: The number of lags is chosen using the formula $\text{int}\left\{4(T/100)^{2/9}\right\}$.

Table 3: Johansen and Juselius Cointegration Test Results

	Trend	Lags	Eigenvalue Statistic		Trace Statistic		5% critical Value	
			r = 0	r ≤ 1	r = 0	r ≤ 1	r = 0	r ≤ 1
Model 1 : ln(RGDP), ln(M1)	Constant	2	-	0.49	39.14	12.14*	29.68	15.41
Model 2 : ln(RGDP), ln(M2)	Constant	2	-	0.50	39.34	11.54*	29.68	15.41

Notes: * indicates statistically significant at the 5% level.

After obtaining the non-stationarity properties and ensuring the presence of one cointegration relationship, we resort to LRN test along the lines indicated in Equation (5) for each data series. With the *t*-distribution with $n - k$ degree of freedom, β_k for $k = 1$ to 20 are estimated in the study. Dummy variables are included to capture structural breaks caused by military coups, Asian financial crisis and global financial crisis, with a view to correcting biases due to omission of variables and heteroskedasticity inefficiency. To correct for potential endogeneity bias, instrument variables estimators such as two-stage least squares estimator (2SLS) and general method of moments estimator (GMM) are employed, apart from the ordinary least squares estimator (OLS) and Prais-Winsten estimator, whereas appropriate,[7] to address serial correlation in the error term. These mentioned estimators provide similar conclusion on the property of long-run neutrality of

[7] The OLS and Prais-Winsten estimates are summarized in Table A1 in Appendix.

money in the country under study.

Furthermore, since the instrumental variables estimators are always consistent in a large sample even when an endogeneity problem does not exist, as long as valid instruments are employed, the GMM estimation results are reported in Tables 4a and 4b. The null hypothesis of LRN is $\beta_k = 0$.

The values of estimated coefficients (β_k), heteroskedasticity consistent standard error for LRN of M1 and M2 tests (SE_k), *z*-statistic of null hypothesis (z_k) and the marginal significance level of null hypothesis (*p*-value) are listed out. Regressions for each money supply measure end with k=20 which is long enough to be considered as a long term, meanwhile each regression has sufficient degrees of freedom to obtain stable estimates. These β_k, respectively for M1 and M2, are presented in Figure A1 in Appendix.

Table 4(a): LRN Results of M1 in Fiji (GMM estimates)

k	β_k	SE_k	z_k	*p-value*	*Hansen J statistic P-value*
1	.205	.115	1.78	0.076	0.6249
2	.181	.064	2.82	0.005	0.6968
3	.156	.068	2.30	0.022	0.5596
4	.217	.094	2.30	0.022	0.6651
5	.237	.115	2.04	0.041	0.9204
6	.278	.110	2.51	0.012	0.8170
7	.252	.117	2.15	0.031	0.9775
8	.165	.098	1.69	0.091	0.7460
9	.262	.107	2.43	0.015	0.8042
10	.183	.075	2.43	0.015	0.1571
11	.247	.064	3.85	0.000	0.3392
12	.253	.110	2.30	0.021	0.7317
13	.432	.122	3.52	0.000	0.1003
14	.124	.034	3.58	0.000	0.5128
15	.364	.088	4.11	0.000	0.2670
16	.294	.109	2.69	0.007	0.1528
17	.295	.090	3.25	0.001	0.3529
18	.352	.104	3.36	0.001	0.6362
19	.262	.056	4.61	0.000	0.6154
20	.209	.069	3.00	0.003	0.3415

Table 4(b): LRN Results of M2 in Fiji (GMM estimates)

k	β_k	SE_k	z_k	*p-value*	*Hansen J statistic P-value*
1	.094	.058	1.62	0.105	0.6257
2	.078	.043	1.81	0.071	0.3676
3	.097	.036	2.67	0.008	0.7160
4	.163	.056	2.92	0.003	0.1855

5	.097	.052	1.84	0.065	0.6449
6	.120	.064	1.87	0.061	0.6973
7	.199	.082	2.42	0.015	0.6458
8	.235	.123	1.90	0.057	0.5854
9	.207	.112	1.85	0.065	0.1561
10	.219	.059	3.68	0.000	0.2404
11	.184	.089	2.05	0.040	0.5686
12	.075	.040	1.88	0.061	0.7115
13	.110	.066	1.66	0.097	0.3290
14	.110	.028	3.83	0.000	0.8576
15	.199	.043	4.58	0.000	0.9555
16	.187	.033	5.66	0.000	0.7281
17	.151	.043	3.50	0.000	0.3286
18	.137	.040	3.38	0.001	0.7360
19	.112	.035	3.16	0.002	0.7778
20	.102	.030	3.38	0.001	0.4445

Tables 4(a) to 4(b) illustrate the estimated results from Equation (5). The empirical results show β_k at $k \geq 1$ are statistically significant at least 10% level, which implies that the proposition of LRN of money is rejected in both cases when M1 and M2 are used as measures of nominal money supply. Consistently positive signs of β_k suggest that monetary aggregates did have a positive impact on real GDP in Fiji during 1970-2011.

6. Conclusion

The topic of long run neutrality (LRN) of money is critically important from the point of view of monetary policy formulation. There has been so far no study conducted in the case of six PICs, including Fiji, which have independent currencies and have been using monetary policies for promoting growth. The focus of this paper is on Fiji. The study employed data on output and monetary aggregates covering a 42-year period (1970-2011).

The study results based on FS methodology show that LRN of money does not hold in regard to Fiji. The policy implications are clear. Fiji's central bank can continue to formulate policies targeting monetary aggregates for promoting and stabilizing growth.

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Appendix

In the LRN tests of M2 on real GDP, the error terms, ε_{kt}, are autocorrelated in most regressions. In order to address the autocorrelation problem, the standard errors of β_k in Equation (5) were calculated using Newey-West (1987) technique.

Table A1: The LRN Test Results from the OLS or Prais-Winsten Estimators

Table A1(a): LRN Results of M1 in Fiji

k	β_k	SE_k	t_k	*p-valu*
1	.10	.05	2.09	0.044
2	.16	.06	2.64	0.012
3	.18	.07	2.35	0.024
4	.19	.07	2.56	0.015
5	.18	.10	1.86	0.073
6	.17	.09	1.80	0.082
7	.17	.09	1.79	0.084
8	.17	.09	1.78	0.086
9	.19	.08	2.16	0.039

Table A1(b): LRN Results of M2 in Fiji

k	β_k	SE_k	t_k	*p-valu*
1	.11	.056	2.0	0.049
2	.12	.058	2.1	0.039
3	.12	.044	2.9	0.006
4	.15	.062	2.3	0.023
5	.15	.071	2.1	0.038
6	.14	.078	1.8	0.071
7	.12	.056	2.1	0.041
8	.14	.076	1.8	0.073
9	.15	.084	1.8	0.080

10	.18	.08	2.24	0.033	10	.19	.104	1.9	0.067
11	.16	.07	2.28	0.031	11	.17	.078	2.2	0.035
12	.16	.09	1.75	0.093	12	.15	.089	1.7	0.094
13	.18	.09	1.95	0.063	13	.17	.071	2.4	0.024
14	.22	.10	2.12	0.044	14	.15	.091	1.7	0.093
15	.18	.07	2.55	0.018	15	.18	.028	6.3	0.000
16	.16	.05	2.91	0.008	16	.18	.041	4.5	0.000
17	.22	.07	3.18	0.005	17	.16	.045	3.5	0.002
18	.24	.06	3.78	0.001	18	.21	.052	4.0	0.001
19	.20	.05	3.40	0.003	19	.09	.036	2.6	0.018
20	.16	.07	2.11	0.050	20	.12	.028	4.5	0.000

Figure A1 (a). Money neutrality of M1 and M2

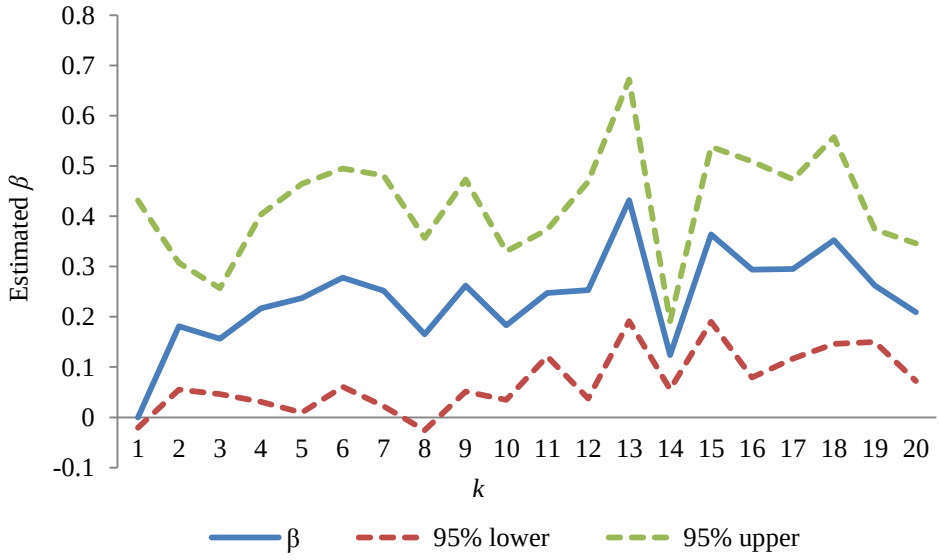
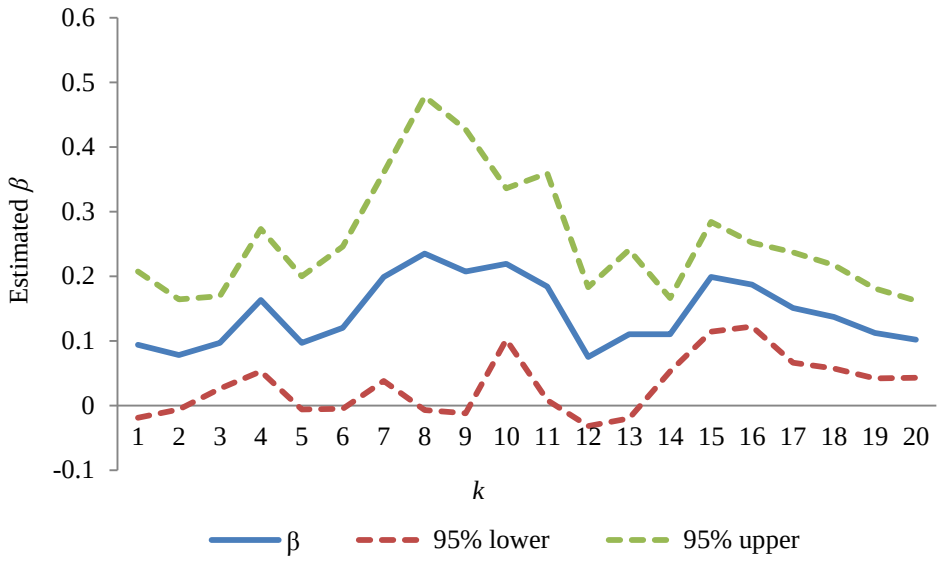


Figure A1 (b). Money neutrality of M1 and M2


0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
Estimated β
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
k
β
95% lower
95% upper