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Abstract

For successful monetary policy formulation and implementation, monetary authorities need to establish the existence of a stable relationship between reserve money and money supply so that changes in reserve money manipulated by policy changes can have desirable, intended effects on money stock. Thus, the basic requirement is that reserve money, also known as monetary base, is exogenous. In open economies under fixed exchange rate regimes, it is generally held that domestic monetary authorities cannot control money supply, since money has a causal predominance over reserve money. The objective of this paper is to examine whether any such generalization could be made in the case of Pacific island countries (PICs), which have independent currencies of their own. Among the six PICs, five of them, namely Fiji, Samoa, Solomon Islands, Tonga and Vanuatu have fixed exchange rate regimes, while Papua New Guinea has a flexible exchange regime. Our results show that there is bi-directional causality between monetary aggregates and reserve money for both Fiji and Vanuatu. On the other hand, there is unidirectional causality running from reserve money to monetary aggregates for Papua New Guinea, Samoa, Solomon Islands and Tonga. The findings have significant policy implications from the point of view of conducting monetary policy.

Keywords: Monetary aggregates, reserve money, money endogeneity, causality

I. Introduction

Successful conduct of monetary policy and its implementation depends on a stable relationship between money supply and monetary base. The assumption behind this relationship is that monetary base, also known as reserve money, changes in which are targeted by monetary policy changes, is exogenous. In other words, the causal relationship is assumed to run from monetary base to money. This assumption was investigated by Goodhart (1984, 1994) and Howells and Hussein (1998) in the advanced countries and by McLean (1981, 1985, 1997, 1998) and Greenidge, et al. (2001) in the developing countries including Caribbean island countries. The empirical studies on the G-7 countries (Howells and Hussein 1998), which have flexible exchange rate regimes, established that money was endogenous. On the other hand, the results obtained from studies in the Caribbean region were mixed (Greenidge, et al., 2001).

In open economies with fixed exchange rate regimes, the central bank ends up in times of balance of payments surplus by purchasing foreign exchange from exporters at the fixed exchange rate, which increases international reserves and also the monetary base by the same amount. When there is a deficit in the balance of payments, the central bank sells foreign exchange at a fixed exchange rate and in the process reduces its international reserves and monetary base by the same amount. Thus, monetary authorities have no discretion to change the monetary base at will, thus rendering it as an endogenous variable. The implication is that with fixed exchange rates, domestic monetary authorities cannot control their own money supplies (Pierce and Tysome 1985: 36).

McClean (1985, 1998) concluded that narrow money in Barbados had a causal predominance over reserve money and therefore, monetary base in an open economy could be endogenous. Greenidge, et al. (2001), however cautioned that such a conclusion could not be generalized for all the open island economies in the Caribbean region. Jayaraman and Ward (2004) in their study on Fiji, a Pacific Island country (PIC) with an open economy under a fixed exchange rate regime, observed that there was a two-way causal relationship between Fiji's monetary aggregate and monetary base.

The objective of this paper is to examine whether any generalization could be made in respect of all six Pacific island countries, which have their own independent currencies. The countries chosen are Fiji, Samoa, Solomon Islands, Tonga and Vanuatu, all of which have fixed exchange rate regimes; and Papua New Guinea, which has adopted a flexible exchange regime since 1994. There are no studies on Pacific islands on the lines of a regional study by Greenidge, et al. (2001). The only study available is on Fiji (Jayaraman and Ward 2004), which is related to an earlier period of 1980Q1-2001Q3. In the present study, a more recent period for all the relevant countries, including Fiji is covered. The remainder of the paper is organized as follows: the second section outlines the methodology adopted for the empirical analysis, the third section reports the results and the third and last section presents a summary and conclusions.

II. Data and Methodology

The variables for the econometric analysis include narrow money (M1) representing currency and checking deposits; broad money (M2) representing M1 plus savings and time deposits and reserve money (RM) consisting of currency held outside the banks and reserves kept by commercial banks with the monetary authority.

The period of analysis varies in respect of each country as dictated by availability of data, which are drawn from IMF (2008). For Fiji, PNG, Samoa and Solomon Islands the period covered is 1980Q1 to 2007Q4; for Tonga the period covered is 1983Q3 to 2007Q4 and for Vanuatu 1981Q3 to 2007Q4. The number of quarterly observations for the data series of Fiji, PNG, Samoa and Solomon Islands is 112; the number of quarterly observations for data series for Tonga is 74; and Vanuatu is 106. The variables were transformed into logs for the empirical analysis for checking unit roots and testing the presence of a long-term relationship or cointegration between the monetary aggregates and reserve money.

The equation reflecting the long-term relationship to be estimated is:

$$LM_t = \beta_0 + \beta_1 LRM_t + e_t \qquad (1)$$

where

LM = log of *M1* or log *M2*, as the case may be;
LRM = log of reserve money;
e is the Gaussian error term; and
t = time period

In order to examine the endogeneity of money in six PICs, the study uses a few econometric techniques, namely ADF and Ng-Perron unit root test, Johansen and Juselius (JJ) cointegration procedure, and Granger causality test within vector error correction model (VECM). ADF and Ng-Perron tests are used to examine the order of integration of each time series. Cointegration test is applied to examine the long-run relationships between monetary aggregates and reserve money while Granger causality test is aimed to investigate the short-run dynamic causal relationship between them.

Cointegration test

When monetary aggregates and reserve money become stationary after first differencing (that is, integrated of order one), they may have linear combinations and cointegrated in the long-run (Engle and Granger, 1987). The next step is to apply cointegration techniques to examine whether there appears a long-run stable relationship between monetary aggregates and reserve money. In this analysis, we use the JJ (Johansen and Juselius 1990) framework of testing for the existence of cointegrating vector. The JJ cointegration procedure applies a system approach to cointegration that enables determination of up to *r* linearly independent cointegrating vectors (r≤m-1), where m is the set of variables used for cointegration. The cointegration equation is constructed as follows:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + BX_t + \varepsilon_t \qquad (2)$$

where $\Pi = \sum_{i=1}^{p} A_i - I$, $\Gamma_i = \sum_{j=i+1}^{p} A_j$, Z_t is a k-vector of I(1) variables, X_t is a d-vector of deterministic variables, and ε_t is vector of white noises with zero mean and finite variance. The cointegrating equations are reflected by the rank of the coefficient matrix Π. This cointegration technique is to estimate the Π matrix in an unrestricted model, then test the restrictions implied by the reduced rank of Π.

In order to examine the number of cointegrating vectors, the JJ cointegration technique provides two types of likelihood ratio tests. The first test is based on the trace test and the second test is based on the maximum eigenvalue test. We use both test statistics to examine the long-run relationship between monetary aggregates and reserve money. .

Granger Causality test

Engle and Granger (1987) demonstrate that once variables are found to be cointegrated, there should be a corresponding error-correction representation in which the short-run dynamics of the variables in the system are influenced by deviations from equilibrium. Accordingly, it is implied that changes in the dependent variables are a function of the level of disequilibrium in the cointegrated relationship (captured by the error-correction term), as well as, changes in other explanatory variable(s).

Given that M1 and RM are cointegrated, the Granger representation theorem suggests that the dynamic relation between these variables should be examined within the framework of vector error correction model (VECM), and the system of the short-run dynamic of M and RM is:

$$\Delta LM_t = \gamma_1 ECT_{t-1} + \sum_{t=1}^{k} \theta_{1k} \Delta LM_{t-k} + \sum_{t=1}^{k} \theta_{2k} \Delta LRM_{t-k} + \mu_{1t} \quad (3)$$

$$\Delta LRM_t = \gamma_2 ECT_{t-1} + \sum_{t=1}^{k} \pi_{1k} \Delta LM_{t-k} + \sum_{t=1}^{k} \pi_{2k} \Delta LRM_{t-k} + \mu_{2t} \quad (4)$$

where ECT_{t-1} is the error correction term obtained from the cointegration equation, γ, θ and π are estimated parameters, and μ is stationary random processes with zero mean and constant variance. Granger (1988) notes that ECM provides two channels through which Granger causality can be detected. In the cointegrated system above [Equation (3)], *LRM* does not Granger cause *LM* if all the θ' s are jointly insignificant or γ_1 is statistically insignificant. Specifically, this hypothesis of no causality from *LRM* to *LM* can be formulated as $H_0 : \theta_{1i} = 0$ and $\sigma_1 = 0$. Conversely, the hypothesis of no causality from *LM* to *LRM* can be expressed as $H_0 : \pi_{1i} = 0$ and $\sigma_2 = 0$, for all *i*.

III. Results and Interpretations

The first step is to examine the order of integration of each series. It is important to check the stationarity properties of each variable as both the cointegration and Granger causality tests require all series must be I(1). The results of the augmented Dickey-Fuller (ADF) and Ng-Perron tests are shown in Table 1. Both unit root tests give similar results. The null hypothesis of non-stationary cannot be rejected in levels at the 5% significance level. The null hypothesis, however, can be rejected for all variables in first difference at the 5% significance level. Moreover, the tests suggest a possible deterministic trend for all series. This indicates that monetary measures (M1 and M2) and reserve money (RM) are I(1).

These findings testify that the cointegration test is a good starting point for examining the existence of long-run relationship between these series. The results of cointegration test between narrow money (broad money) and reserve money are reported in Table 2. The test shows that there is a single cointegrating vector for each one of six PICs, at 10% significance level or better.

The sign of reserve money (RM) on monetary aggregates is shown in Table 3. For narrow money (M1), the sign is positive and statistically significant for all PICs, which would suggest that a rise in the reserve money would lead to higher narrow money in the long-run. The long-run estimated coefficients of reserve money on M1 show that an increase in reserve money by 1%, other thing being constant, leads to an increase in M1 ranging from 0.7089% (Vanuatu) to 2.8267% (Samoa). Similarly, we find that there exists a strong positive relationship between broad money (M2) and reserve money for all PICs, and the estimated coefficients are ranged from 0.6178% (Vanuatu) to 3.9541% (Samoa). These findings are consistent with *a priori* expectations, which suggest that reserve money has a significant and positive effect on monetary aggregates in the long run.

The existence of a long run equilibrium relationship between monetary measures (M1 and M2) and reserve money indicates that causality relationship must appear in at least one direction (Engle and Granger, 1987). Hence, we proceed to estimate a Granger causality test in examining the dynamic linkages of the variables in the short-run. Granger causality test within VECM model is estimated for those countries with a long run equilibrium relationship. The results of VECM estimation are shown in Table 4.

Granger causality tests show that there exists a bi-directional causality between monetary aggregates and reserve money for Fiji and Vanuatu (Table 4). The coefficients of error correction terms (ECTs) for these two countries are significant at the 10% level or better, and have a negative sign. This suggests that in Fiji and Vanuatu, money supply, (narrow and broad money) is endogenous. For these reasons, money multiplier in Fiji and Vanuatu would not be relevant, as was argued by Jayaraman and Ward (2003).

Table 1: The results of unit root tests

Variable / Country	ADF test				Ng-Perron test			
	Level		First Difference		Level		First Difference	
	Constant, without trend	Constant, with trend	Constant, without trend	Constant, with trend	Constant, without trend	Constant, with trend	Constant, without trend	Constant, with trend
Fiji								
M1	0.36 (0)	-3.06 (2)	-12.22** (0)	-12.26** (0)	2.16 (0)	-14.61 (0)	-54.01** (0)	-53.49** (0)
M2	-0.36 (0)	-1.10 (0)	-11.38** (0)	-11.34** (0)	1.67 (3)	-2.10 (0)	-43.58** (0)	-53.70** (0)
RM	0.57 (3)	-2.84 (6)	-9.51** (2)	-9.54** (2)	2.43 (2)	-15.59 (2)	-59.07** (1)	-51.78** (0)
Papua New Guinea								
M1	1.92 (0)	-2.51 (0)	-11.99** (0)	-12.62** (0)	2.71 (0)	-1.97 (0)	-21.37** (1)	-54.80** (0)
M2	2.92 (0)	-0.67 (0)	-8.62** (0)	-9.14** (0)	2.82 (1)	0.06 (0)	-27.38** (0)	-45.88** (0)
RM	1.00 (3)	-2.87 (3)	-8.64** (1)	-8.96** (1)	0.63 (0)	-4.53 (0)	-22.49** (0)	-22.48** (1)
Samoa								
M1	-1.46 (3)	-2.98 (7)	-10.92** (2)	-10.96** (2)	0.61 (0)	-1.62 (0)	-9.90** (0)	-18.44** (0)
M2	-2.33 (0)	-3.37 (6)	-9.81** (0)	-9.95** (0)	-2.33 (0)	-3.39 (2)	-9.81** (0)	-9.95** (0)
RM	-2.34 (2)	-2.05 (2)	-4.96** (3)	-4.94** (3)	1.57 (0)	-2.65 (0)	-16.20** (1)	-52.84** (0)
Solomon Islands								
M1	-0.18 (1)	-2.06 (0)	-13.85** (0)	-13.78** (0)	1.92 (0)	-8.55 (0)	-9.40** (1)	-21.08** (1)
M2	0.45 (0)	-1.21 (0)	-9.38** (0)	-9.38** (0)	1.80 (2)	-3.07 (0)	-34.09** (1)	-34.29** (1)
RM	0.37 (0)	-3.14 (4)	-10.38** (0)	-10.48** (0)	1.54 (0)	-5.66 (0)	-54.97** (0)	-55.00** (0)
Tonga								
M1	1.02 (7)	-1.26 (7)	-3.28** (6)	-3.64** (6)	2.33 (7)	-3.07 (7)	-11.40** (2)	-48.25** (2)
M2	1.38 (3)	-1.28 (4)	-4.58** (3)	-10.49** (2)	1.97 (4)	-4.89 (4)	-30.71** (1)	-48.57** (1)
RM	-1.54 (0)	-2.18 (0)	-10.50** (0)	-10.51** (0)	-5.57 (0)	-8.52 (0)	-34.21** (0)	-34.12** (0)
Vanuatu								
M1	-0.60 (1)	-3.41 (0)	-13.06** (0)	-13.00** (0)	1.97 (1)	-11.17 (0)	-51.22** (0)	-49.58** (0)
M2	-2.57 (2)	-3.16 (2)	-10.65** (0)	-11.05** (0)	1.19 (0)	-1.76 (0)	-10.75** (2)	-51.75** (0)
RM	-0.81 (3)	-3.02 (4)	-8.89** (2)	-8.85** (2)	1.05 (0)	-11.97 (4)	-64.03** (6)	-36.97** (5)

Note: The ADF critical value at 5% level is –2.9640 and –3.5629 for constant without trend and constant with trend regressions, respectively. These critical values are based on Mckinnon. The optimal lag is selected on the basis of Akaike Information Criterion (AIC). The Ng and Perron critical value is based on Ng and Perron (2001) critical value and the optimal lag is selected based on Spectral GLS-detrended AR based on SIC. The null hypothesis of the test is: a series has a unit root. The figures in brackets denote number of lags. The asterisk ** denotes the rejection of the null hypothesis at the 5% level of significance.

Table 2: Johansen cointegration test

	Null Hypothesis	Narrow Money (M1)		Broad Money (M2)	
		Trace Statistic	Maximum Eigenvalue Statistic	Trace Statistic	Maximum Eigenvalue Statistic
Fiji	r=0	26.5542***	26.2222***	13.5559*	12.9435*
	r≤1	0.3319	0.3319	0.6123	0.6123
Papua New Guinea	r=0	17.1633**	16.1190**	15.2034*	13.7595*
	r≤1	1.0443	1.0443	1.4438	1.4438
Samoa	r=0	15.4577*	14.9957**	13.4351*	13.4233*
	r≤1	0.4620	0.4620	0.0117	0.0117
Solomon Islands	r=0	14.6579*	14.5621**	16.3996**	13.6889*
	r≤1	0.0957	0.0957	2.7107	2.7107
Tonga	r=0	20.0533***	19.8109***	30.7949***	28.1522***
	r≤1	0.2423	0.2423	2.6426	2.6426
Vanuatu	r=0	19.3858***	18.6184**	14.7637*	14.3190**
	r≤1	0.7674	0.7674	0.4447	0.4447

Notes: *r* is the number of cointegrating vectors.
*, ** and *** denote rejection of the null hypothesis at the 0.10, 0.05 and 0.01 significance levels, respectively.

Table 3: Normalised coefficient between monetary aggregates and reserve money

Country	**M1**	**RM**	**M2**	**RM**
Fiji	-1.0000	1.1291*** [47.4913]	-1.0000	0.8951*** [15.7519]
Papua New Guinea	-1.0000	1.0578*** [20.2283]	-1.0000	0.8521*** [14.7299]
Samoa	-1.0000	2.8267*** [4.17947]	-1.0000	3.9541*** [3.82573]
Solomon Islands	-1.0000	1.0473*** [13.0516]	-1.0000	0.9337*** [8.59100]
Tonga	-1.0000	1.1544*** [6.25521]	-1.0000	0.8242*** [4.37768]
Vanuatu	-1.0000	0.7089*** [22.6164]	-1.0000	0.6178*** [8.75974]

Notes: The vectors are normalized for monetary aggregates (M1 and M2).
*, ** and *** indicate significance at 10%, 5% and 1% levels, respectively.
Figures in square parentheses [ ] refer to *t*-test statistics.

As regards four other PICs, namely PNG, Samoa, Solomon Islands and Tonga, the test results confirm the existence of causality linkage running from reserve money to monetary aggregates (both M1 and M2). In all the four PICs, the ECTs in the equations with monetary aggregates as dependent variables have not only the theoretically expected negative signs but they are also statistically significant. However, the coefficients of ECTs in the equations with reserve money as dependent variable, are found statistically not significant, ruling out any causality linkage running from monetary aggregate to reserve money. The results confirm that money supply is exogenous in PNG, Samoa, Solomon Islands and Tonga and the causality linkage runs only from reserve money to monetary aggregates.

IV. Conclusions with Policy Implications

The paper undertook an empirical investigation whether there was any long-run, stable relationship between monetary aggregates (narrow and broad money) and reserve money in six PICs, namely Fiji, PNG, Samoa, Solomon Islands, Tonga and Vanuatu, which have independent currencies of their own. The paper specifically focused on the direction of relationship between reserve money and monetary aggregate, both in the short-and long-runs.

The empirical findings are summarised as follows: (i) there is a long run, cointegrating relationship between monetary aggregates and reserve money in all PICs; and (ii) the long-run coefficient of reserve money in the equation with monetary aggregate, narrow money or broad money, has a positive sign which is also statistically significant

Resorting to Granger causality tests, we note that there is bi-directional causality between monetary aggregates and reserve money for Fiji and Vanuatu and hence the conclusion is money supply is endogenous in Fiji and Vanuatu.

On the contrary, the empirical results for PNG, Samoa, Solomon Islands and Tonga show that the linkage runs from reserve money to monetary aggregates and there is no bi-directional causality relationship. Thus, money supply is exogenous in these four PICs, confirming reserve money has great predictive power over monetary aggregates. Therefore, the four PICs can successfully aim at changes in reserves to influence changes in money supply.

On the other hand, Fiji and Vanuatu cannot exclusively rely on manipulating reserve money. They have to consider direct changes in monetary aggregates. Thus, indirect instruments in these two countries aiming at changes in central bank balance sheets for effecting changes in money supply will not be as effective as direct instruments. The latter will work better, as they alter commercial bank balance sheets, such as credit ceilings and other restrictions and they will have the desired one- to- one correspondence between instrument and target.

Table 4: Granger causality results based on vector error correction model for Selected PICs

Country	RM-led M1	ECT	M1-led RM	ECT	RM-led M2	ECT	M2-led RM	ECT
Fiji	42.5956***	-0.3231***	2.6333**	-0.2869*	17.9031***	-0.0655***	5.10***	-0.0645***
PNG	9.5825***	-0.0631*	1.5218	-0.0083	12.2327***	-0.0450**	0.9730	-0.0015
Samoa	2.6398**	-0.0153*	0.9308	-0.0056	3.5145***	-0.0031*	1.5374	-0.1410
Solomon Islands	6.8638***	-0.0522***	1.3578	-0.0143	4.0107***	-0.0563**	0.4532	-0.0212
Tonga	5.8885***	-0.3125***	1.1076	-0.0913	7.8667***	-0.0828*	0.7479	-0.9000
Vanuatu	4.5342***	-0.2107***	1.9991**	-0.4195*	3.0229***	-0.1199***	5.0029***	-0.2539*

Note: The Wald statistic which tests the joint significance of the lagged values of the independent variables is reported. This statistic is to be compared with F-statistics.

*, ** and *** denote rejection of the null hypothesis at the 0.10, 0.05 and 0.01 significance levels, respectively.

It is worth noting that from early 2007, following the December 2006 coup, Fiji's central bank suspended its regular open market operations in its Reserve Bank of Fiji (RBF) Notes, which were primarily intended at influencing short-term interest rates. Instead, RBF switched on to direct measures for discouraging credit growth. This was in keeping with study findings on G7 countries by Howells and Hussein (1998) that, if endogeneity existed, policy instruments should be aimed directly at the credit counterparts of the money stock.

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