Testing the Stability of Demand for Money in Tonga

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Abstract

The aim of this study is to investigate if there is a stable demand for money for Tonga. Our empirical results based on the alternative time series approaches of LSE-Hendry's General to Specific (GETS) and Johansen's Maximum Likelihood (JML) show that there is a unique cointegrated and stable long run relationship between real narrow money, real income and nominal rate of interest. We found that the demand for money function for Tonga is stable and therefore targeting money supply by National Reserve Bank of Tonga is appropriate. We obtained consistent results with both methods and they indicate that income elasticity is unity and the interest rate elasticity is well- determined and significant.

Keywords: Demand for Money, Stability of Money Demand Function, General to Specific Approach and Johansen Maximum Likelihood Method.

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1. INTRODUCTION

In this paper, we estimate the demand for narrow money for Tonga from 1978 to 2004 using General to Specific (GETS) and Johansen Maximum Likelihood (JML) time series methods. The aim of this study is to examine whether the money demand function is stable in Tonga. It is important to investigate the stability of money demand function because it has monetary policy implications. According to Poole (1970), rate of interest to be targeted if the LM curve is unstable and money supply if the IS curve is unstable. Since the instability in the demand for money is a major factor for instability in the LM, it is vital to test the stability of the money demand function. In other words, money supply is to be targeted if demand for money is stable. In both developed and developing countries, a stable money demand function is one of the important issue that provides a reliable and predictable link between changes in monetary aggregates and changes in variables included in the demand for money function, Deadman and Ghatak (1981).

Though this is a widely used research topic in both developed and developing countries, there are only a handful of empirical studies on Pacific Island countries[4]. There is no empirical work on demand for money for Tonga. Therefore, this paper analyzes money demand function for Tonga and evaluates its stability. Our results indicate that income elasticity is around unity and the interest rate elasticity is negative, well- determined and significant. It is also found that growth in expected inflation seem to have temporarily affected their money demand function. Nevertheless, we found that the money demand function is temporally stable in Tonga. An important implication of this finding is that targeting money supply, instead of interest rate, is an appropriate conduct of monetary policy for Tonga.

[4] Some of the empirical studies on demand for money for Pacific Island countries are Katafono (2001), Jayaraman and Ward (2003), Rao and Singh (2005a and b), Singh and Kumar (2006a and b) and Rao and Kumar (2006a).

To limit the scope of this paper, we only examine the stability of demand for money in Tonga with the GETS and JML approaches. This paper is organized as follows: Section 3 is our specification for estimating the demand for money function for Tonga. Section 4 detail our empirical results based on the GETS and JML approaches. Conclusions with limitations are stated in the final Section 5.

3. SPECIFICATION AND DATA

The demand for money equation is specified where demand for real narrow money (*M1*) is a function of real income and the nominal rate of interest. Our basic specification is as follows:

$$\ln(M/P)_t = \beta_0 + \beta_1 \ln(Y/P)_t - \beta_2 R_t + \varepsilon_t \qquad (1)$$

where M is nominal narrow money, P is the GDP deflator, Y is the nominal GDP measured at factor cost, R is the nominal weighted average interest rate on short-term deposits and ε is an *iid* error term. The demand for money is positively related to real income and negatively to the nominal rate of interest. Further, the demand for money is treated as the demand for real balances, implicitly assuming that the function is homogenous of degree one in the level of prices. We expect that the income elasticity is close to unity and the interest rate elasticity is significant with correct negative sign. However, in developed countries income elasticities are expected to be much lower than unity due to better financial systems. For a comprehensive survey of income elasticities for developed and less developed countries, see Sriram (1999).

This study is based on the annual data extending over the period 1978 to 2004. Definitions of the variables and sources of data are in Appendix. We tested for the presence of unit root in our variables. The Augmented Dicky-Fuller (ADF) tests are used for testing for the order of the variables. The ADF tests have been applied for both levels and their first differences with an intercept and trend. The time trend is included because it is significant in the levels and first differences of the variables. The computed test statistics for the levels and first differences of the variables are given in table 1 below :

Table 1: ADF Unit Root Tests

Lags	$\ln(M/P)_t$	$\ln(Y/P)_t$	R_t	$\Delta\ln(M/P)_t$	$\Delta\ln(Y/P)_t$	ΔR_t
[1,1,2,0,4,1]	2.182	3.807	2.132	4.863	2.125	4.293

Notes:

1. $\ln(M/P)_t$, $\ln(Y/P)_t$ and R_t represent log of real money, log of real income and nominal interest rate respectively.
2. The respective 5% critical value for ADF test is 3.594.
3. Lag lengths for the variables are selected using AIC and SBC criteria. For example [0,1] indicates that lag 0 and 1 are significant in 1^{st} and 2^{nd} variables, respectively.
4. The sample period is 1978-2004.

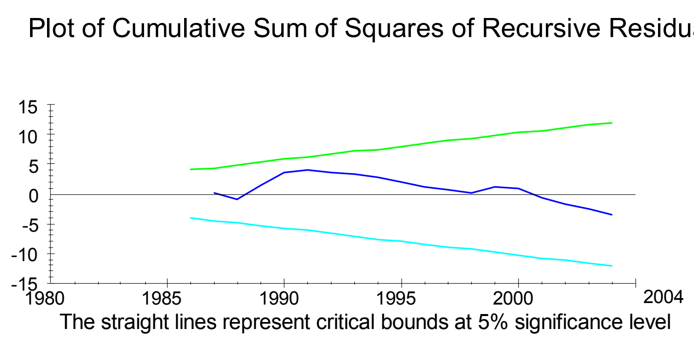
The null hypothesis of unit root cannot be rejected at the 5% level for the level variables ie. $\ln(M/P)_t$, $\ln(Y/P)_t$, and R_t. Alternatively, the null that their first differences have unit roots is clearly rejected. Therefore, the level variables are $I(1)$ and their first differences are stationary. Microfit 4.1 is used for all estimations.

4. EMPIRICAL RESULTS: THE GETS APPROACH

In this section, we discuss our results obtained with the GETS approach where demand for real narrow money is estimated with a lag structure of 4 periods. Using standard variable deletion tests, these were later reduced to manageable parsimonious versions as reported in Table-2. $\Delta^2 \ln P_t$ captures the effects of the growth in expected inflation and it has a negative coefficient. In Table-2, the equation GETS(1) is the initial parsimonious version and GETS(2) is the constraint. The two crucial implied long-run elasticities for income and the rate of interest are significant with correct signs and expected magnitudes. In GETS(1), we tested for unit income elasticity with the Wald test and it could not reject the null that it is unity at the 5% level. The Wald test computed $X^2_{(1)}$ test statistic with p-value in parenthesis is 1.957 (0.162) is insignificant. Further, the coefficients ΔR_t and ΔR_{t-2} are close and opposite in sign. Likewise, the coefficients of $\Delta \ln(M/P)_{t-3}$ and $\Delta \ln(Y/P)_{t-2}$ are close but with same sign. When we tested for the constraint with the Wald test, these constraints were accepted at the 5% level[5]. The equation GETS(2) are with these constraints.

Our preferred GETS equation for Tonga is GETS(2). The implied constraint income elasticity for Tonga is unity and interest rate elasticity at mean interest rate of 5.92 is -0.12. The adjusted R^2 is about 0.79 and a regression between the actual and fitted values of the change in logarithm of real money gives an intercept of zero and a slope of 1. The SER is reasonable and the X^2 summary statistics indicate that there is no serial correlation X^2_{sc}, functional form misspecification X^2_{ff}, non-normality X^2_n and heteroscedasticity X^2_{hs} in the residuals. Our preferred equation GETS(2) is tested for temporal stability and neither the *CUSUM* nor *CUSUM SQUARES* test showed any instability. This implies that the demand for money function is stable in Tonga. The plot of the stability test *CUSUM SQUARES* is given in figure 1 below[6].

Figure 1: Stability Test for Demand for Money (GETS)



[5] The Wald test computed $X^2_{(1)}$ test statistics and p-values in parenthesis are 1.211(0.271) and 0.807(0.369) respectively.
[6] The CUSUM tests are not reported to conserve space, but are available from the author upon request.

THE JML APPROACH

The stationarity tests of $\ln(M/P)_t$, $\ln(Y/P)_t$ and R_t using the ADF test indicated that they are unit root in levels but are stationary in their first differences. The optimum lag lengths of the VARs were tested with a 4^{th} order model. The Akaike Information Criteria (AIC) and Schwartz Bayesian Criteria (SBC) criteria were used to select the lag length of the VAR and both indicated lag length of 1 period. The test for determining the number of cointegrating vectors is conducted with the Johansen maximum likelihood procedure in Microfit 4.1. First, no intercept or trend option is used where the maximal eigenvalue and trace test statistics for the null that there is no cointegration are 19.255 and 27.535 respectively. The 95% critical values, respectively, are 17.68 and 24.05. For the null that there is one cointegrating vector, the corresponding computed values, with the critical values in the parentheses are 7.531 (11.03) and 8.280 (12.36) respectively. Therefore, the null hypothesis that there are no cointegration is rejected but the null that the number of cointegrating vectors is one is not rejected. The implied cointegrating vector (CV) normalized on $\ln(M/P)_t$ is given below.

$$\ln(M/P)_t = \underset{(11.53)^*}{1.047} \ln(Y/P)_t - \underset{(2.57)^*}{0.038} R_t \qquad (2)$$

The estimated income elasticity is around unity and the implied interest rate elasticity is also significant and plausible. These are consistent with our GETS estimates given in Table-2.

We proceed further for identification tests. Here the first difference of each variable is regressed on their respective one period lagged residuals. When the CV is normalized on real money, its residuals are denoted as $ECMM_t$. Similarly, $ECMY_t$ and $ECMR_t$ are the residuals of CVs normalized on income and the rate of interest, respectively. The cointegrating vector represents long run demand for money function since only the $ECMM_{t-1}$ term is significant with correct negative sign in $\Delta\ln(M/P)_t$ equation. The $ECMY_t$

and $ECMR_t$ were insignificant in their respective regressions. The computed coefficients for each of these lagged *ECM*s and their *t*-ratios in parenthesis are reported in the diagonals of the 3 x 3 matrices in Table-1A in the Appendix.

Further, endogeneity tests are conducted as pointed out by Enders (2004). Here three different *ECM* equations are estimated to test the endogeneity. In each of the implied equation, $ECMM_{t-1}$ term being included as one of the independent variable. We found that the $ECMM_{t-1}$ is only significant with the correct negative sign in the equation where the dependent variable is $\Delta\ln(M/P)_t$. The t-ratios for the ECM_{t-1} are along the first row in the matrix, see Table-1A in the Appendix. Since the dis-equilibrium in the respective money markets do not significantly contribute to the explanation of $\ln(Y/P)_t$ and R_t, we can treat $\ln(Y/P)_t$ and R_t as being weakly exogenous variables[7].

Now we estimate the dynamic money demand equation adopting the lag search procedure used in the GETS equation in the second stage. We arrived at the parsimonious JML equations reported in Table-2. The coefficient of the lagged error term have correct sign and are significant at the conventional level. This implies the presence of negative feedback mechanism. The growth in expected inflation is significant with correct sign. The equations JML(1) is unconstraint and JML(2) is constraint version. We then tested if the coefficients of $\Delta\ln(Y/P)_{t-2}$, $\Delta\ln(Y/P)_{t-4}$ and $\Delta^2 \ln P_{t-1}$ in JML(1) are close and the null is accepted as the Wald computed $X^2_{(1)}$ statistics (with p-value in parenthesis) of 2.155 (0.14) is insignificant. Similarly, we tested if there was any difference in the signs and magnitudes of ΔR_t and ΔR_{t-3}. The constraint is also accepted as the $X^2_{(1)}$ is 0.003 (0.96) is insignificant. Therefore, JML(2) which is our preferred JML estimate for Tonga is estimated with these restrictions and the results show an improvement over JML(1). The X^2 summary statistics of both JML equations are reasonable.

[7] Consistent estimates between the GETS and JML indicates that endogeneity problem is not serious.

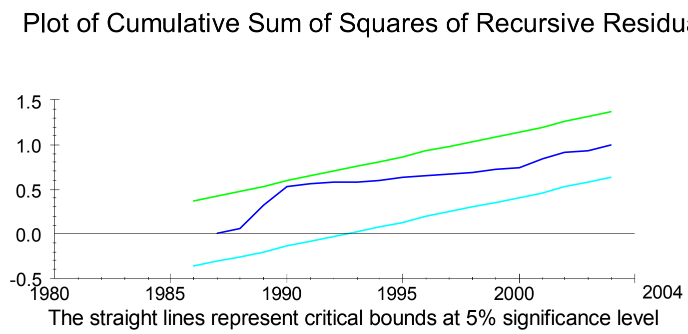
Table 2: Results obtained with GETS and JML[8]

	GETS(1)	GETS(2)	JML(1)	JML(2)
Intercept	4.608 (4.50)*	5.235 (5.11)*	0.081 (2.03)*	0.086 (2.55)*
Trend	0.068 (5.63)*	0.066 (5.22)*		
λ	-0.731 (6.08)*	-0.680 (6.06)*		
$\ln(Y/P)_{t-1}$	1.169 (2.05)*	1.000 (c)		
R_{t-1}	-0.037 (4.99)*	-0.020 (4.55)*		
$\Delta\ln(M/P)_{t-3}$	0.456 (3.63)*	0.470 (4.02)*		
$\Delta\ln(Y/P)_{t-2}$	0.772 (2.33)*	0.470 (c)	1.170 (2.88)*	1.103 (3.57)*
$\Delta\ln(Y/P)_{t-4}$			-1.061 (2.60)*	-1.103 (c)
ΔR_t	0.106 (2.85)*	0.120 (3.98)*	0.141 (2.35)*	0.140 (3.02)*
ΔR_{t-2}	-0.175 (3.32)*	-0.120 (c)		
ΔR_{t-3}			0.138 (2.35)*	0.140 (c)
$\Delta^2 \ln P_t$	-1.475 (3.57)*	-1.417 (3.53)*		
$\Delta^2 \ln P_{t-1}$	-0.974 (2.20)*	-0.738 (2.14)*	-1.061 (2.19)*	-1.103 (c)
ECM_{t-1}			-0.146 (4.04)*	-0.141 (4.05)*
Adjusted R^2	0.786	0.785	0.702	0.715
SEE	0.077	0.077	0.092	0.092
X^2_{sc}	(0.105)	(0.781)	(0.403)	(0.439)
X^2_{ff}	(0.540)	(0.689)	(0.717)	(0.270)
X^2_{n}	(0.546)	(0.692)	(0.348)	(0.661)
X^2_{hs}	(0.456)	(0.477)	(0.264)	(0.752)

[8] λ is the speed of adjustment. Absolute *t*-ratios are below the coefficients and *p*-values for X^2 tests are in parenthesis. * and ** indicate significance at 5% and 10% levels, respectively. (c) is the constraint variable.

The plots of actual and predicted values of the change in the logarithm of real money indicate fairly good fit. A regression between the actual and fitted values showed that the intercept is zero and the slope is unity. The preferred equation JML(2) was tested for temporal stability and neither the *CUSUM* nor *CUSUM SQUARES* test showed any instability. Here we obtained similar result as GETS that demand for money is stable in Tonga. The plot of the stability test *CUSUM SQUARES* is given in figure 2 below[9].

Figure 2: Stability Test for Demand for Money (JML)



[9] The CUSUM tests are not reported to conserve space, but are available from the author upon request.

5. CONCLUSION

In this paper, we have estimated demand for real narrow money for Tonga. Both our GETS and JML estimates gave similar and consistent results. We found that the demand for money function in Tonga is temporally stable and well- determined. One of the implication of our findings is that money supply is the appropriate monetary policy instrument to be used by the National Reserve Bank of Tonga. The estimated income and interest rate elasticities are well- determined and their signs and magnitudes are consistent with *prior* expectations. Our results show that income elasticity is unity and the interest rate elasticity is negative and significant.

Finally, a few limitations of our work should be noted. First, there are limitations in the data as a result we are unable to take long sample period. Second, we have ignored structural breaks and their implications on unit root tests as implied by Perron (1989), as these are outside the scope of this paper. Our purpose of this paper was only to investigate stability of demand for money in Tonga. We hope our work is useful for further work on demand for money in Tonga.

Data Appendix

P = GDP deflator (1995=100). Data are derived from International Financial Statistics (IFS-2005).

Y = Nominal GDP at factor cost. Data are from (IFS-2005) and ADB database(2005).

R = The average of 1-3 years savings deposit rate. Data obtained from the (IFS-2005) and ADB database.

$M1$ = Currency in circulation and demand deposit. Data obtained from the (IFS-2005).

Notes:

1) All variables, except the rate of interest, are deflated with the GDP deflator and converted to natural logs.

2) Data are available for replication on request.

Table 1A: Identification and Exogeneity Tests

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	$\Delta \ln(M/P)_t$	$\Delta \ln(Y/P)_t$	ΔR_t
$ECMM_{t-1}$	-0.141 (4.05)*	0.125 (0.78)	0.173 (0.14)
$ECMY_{t-1}$		-0.156 (0.78)	
$ECMR_{t-1}$			0.007 (0.14)

Notes:

1. The *t*- ratios are reported below the coefficients. Significance at 5% is indicated by *.
2. $ECMM_{t-1}$, $ECMY_{t-1}$ and $ECMR_{t-1}$ are the lagged residuals of the CVs normalized on money, income and interest rate, respectively.

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