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APPLICATION OF THE ALTERNATIVE TECHNIQUES TO ESTIMATE DEMAND FOR MONEY IN DEVELOPING COUNTRIES

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ABSTRACT

In this paper, we applied alternative time series techniques and obtained similar summaries of demand for money relations for twelve developing countries. This indicates that adequate attention should be paid to the purpose of research and interpretation of results rather than to econometric techniques. We also find that income elasticities are close to unity for almost all of our sample countries and the interest rate elasticities are well determined and significant. Further, it is shown that demand for money in these countries is temporally stable and therefore the respective monetary authorities may target money supply as opposed to the rate of interest.

JEL Classifications: C22, E41
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INTRODUCTION

In empirical studies, controversy still persists on the relative merits of alternative time series techniques. While some prefer the systems based method of Johansen (JML), others are comfortable with the simpler single equation methods like the LSE-Hendry's General to Specific (GETS) and the Phillip-Hansen's Fully Modified OLS (FMOLS) approaches.[1] However, as Smith (2000) has pointed out, statistical techniques are only tools to summarize data and therefore they cannot answer difficult questions that need economic insights. According to Smith there are three stages in applied works viz., purpose, summary and interpretation. A similar view is also taken by Rao (2007). It is noted that often applied economists neglect the first and third stages and pay too much attention to the econometric techniques. We show that alternative estimation methods give similar and consistent summaries of data. Therefore, we take the view that while it is desirable to use a few alternative methods of estimation, adequate attention should also be paid to the purpose and the need for preparing alternative summaries and their interpretations.

In this paper, we have used the money demand relation to provide some empirical support for this conjuncture. The three aforesaid techniques have been employed to estimate the short and long run relationships between the demand for narrow money and its determinants in 12 developing countries. Our sample countries with acronyms in brackets are; Fiji (FJI), Vanuatu (VNT), Samoa (SAM), Solomons (SOL), India (IND), Indonesia (IDN), Philippines (PHL), Thailand (THA), Kenya (KEN), Malawi (MWI), Jamaica (JAM) and Rwanda (RWA).

Having obtained the parameter estimates we also examine if the income and interest rates elasticities differ significantly across these countries as some like India and Indonesia are very large with a large volume of transactions and others like Fiji, Samoa, Solomons and Vanuatu are small island countries. There are also medium sized countries like the Philippines, Thailand and Kenya.[2] It would be interesting, therefore, to examine if the demand for money depends on the size of the country and the volume of transactions. This is of interest because, compared to the developed countries, cash is often used as the medium of exchange in the day to day transactions in many developing countries. Further, since the long and short run estimates are at hand, we also test if the money demand relations remains stable in light of the financial reforms in all these countries. This is important for policy because central banks in many developing countries have switched to interest rate as opposed to targeting the money supply. This is partly due to trailing the developed and advanced countries in targeting the rate of interest after the financial reforms. Further, the unit root and cointegration literature has made significant impact on modeling dynamic economic relationships especially on the demand for money.

The outline of our paper is as follows. In the next section, we study some recent empirical works on money demand in developing countries. In Section 3, we specify the functional form and present our estimates of demand for money of the sample countries with the aforesaid techniques. In Section 4, we examine the temporal stability of the money demand functions and its policy implications and conclusions are given in Section 5.

EMPIRICAL STUDIES ON MONEY DEMAND IN DEVELOPING COUNTRIES

This section briefly reviews some recent empirical works for Pacific Islands and Asian and African developing countries.[3] Studies on demand for money in Fiji are limited.[4] Rao and Singh (2005a) have applied alternative time series approaches of GETS and JML with annual data for Fiji from 1971 to 2002. Their results suggest that demand for money (*M1*) in Fiji is stable and well determined. The implied income elasticity in JML is not significantly different from unity as their Wald test on the null of unit income elasticity was not rejected at the 5% level. The implied long run semi-interest rate elasticity is also plausible with correct negative sign. These observations are further justified by their GETS estimates. Later Rao and Singh (2005b) have used Hendry and Krolzig's PcGets software and arrived at the same conclusions about the income and interest rate elasticities.[5] In a more recent study, Rao and Kumar (2007) used the Gregory and Hansen procedure to test the stability of the demand for narrow *M1* in Fiji for the period 1970 to 2002. Their findings assert that a stable demand for *M1* persists in Fiji even in presence of structural breaks in the model.[6]

India has a handful of studies on money demand, see for example Moosa (1992), Rao and Shalabh (1995), Das and Mandal (2000), Ramachandran (2004), Rao and Singh (2005c) and Bahmani-Oskooee and Rehman (2005). Recently, Rao and Singh (2005c) estimated the demand for *M1* for India with annual data from 1953 to 2003. Using the JML technique they obtained the cointegrating equation which implies that in the long run the income elasticity of *M1* is about 1.2 and the interest rate elasticity at the mean rate of 7.65% is about -0.18. Moreover, they found that the demand for money is temporally stable in India and therefore monetary targeting by the Central Bank of India is feasible.[7] In another recent study, Bahmani-Oskooee and Rehman (2005) used quarterly data from 1973 to 2000 to estimate the demand for money for seven Asian countries: India, Indonesia, Malaysia, Pakistan, Philippines, Singapore and Thailand.[8] Using ARDL approach they achieved implausible income elasticities for India, Philippines and Thailand (much lower than unity). This could be because they did not adjust their quarterly data for seasonal fluctuations. Further their *CUSUM* stability tests showed that the demand for *M1* is stable in all the selected countries. However using *CUSUM SQUARES* stability tests, the money demand functions for India, Malaysia and Pakistan showed some instability.

Price and Insukindro (1994) using Engle Granger procedure found income elasticity of *M1* as 1.3 for Indonesia. Similar findings on income elasticity for Indonesia is attained by Bahmani-Oskooee and Rehman (2005). Anglingkusumo (2005) used JML technique to estimate demand for *M1* for Indonesia for the period between 1981(Q1) to 2002(Q4). The major finding of this study is that demand for *M1* is stable in Indonesia. Other studies on money demand for Indonesia are Dekle and Pradhan (1997), McNelis (1998), James (2005) and Narayan (2007). The recent studies by James (2005) and Narayan (2007) argue that financial liberalization plays a key role in determining money demand and its fluctuations in Indonesia.

Dekle and Pradhan (1997) used JML technique to estimate demand for *M1* for Thailand for the period 1978 to 1995. They obtained plausible income elasticity of around 1.1. The income elasticities obtained by Valadkhani and Alauddin (2003) and Bahmani-Oskooee and Rehman (2005) are implausibly low for Thailand. In a more recent study, Sumner (2009) used ARDL procedure with annual data from 1967 to 2002 and found that the demand for money is stable overtime in Thailand.

Studies on money demand for Jamaica are Ghartey (1998), Bynoe (2002) and Atkins (2005). Atkins (2005) used JML technique to estimate demand for broad money (*M2*) for Jamaica from 1962 to 2002. All the coefficients are statistically significant but the sign for rate of interest and inflation are contrary to expectations. The income elasticity of *M2* is 1.56 is significant but slightly high. Using *CUSUM* and *CUSUM SQUARES* stability tests, they found that there exists stable demand for *M2* in Jamaica.

SPECIFICATION AND ESTIMATES

We use the standard Keynesian specification of demand for money in which demand for real narrow money is a function of real income and the nominal rate of interest. The interest rate measures the opportunity cost of holding money. Thus, our basic specification is:

$$\ln\left(\frac{M_t}{P_t}\right) = \beta_0 + \beta_1 \ln Y_t + \beta_2 R_t + \varepsilon_t \tag{1}$$

where M is narrow money consisting of currency in circulation and demand deposit, P is the GDP deflator, Y is real GDP measured at factor cost or market price, whichever is available, R is the nominal short-term interest rate on time deposits and ε_t is an *iid* error term. The exchange rate variable is ignored because currency substitution or having foreign currency accounts is limited in all these developing countries. Definitions of the variables and sources of data are in the Appendix 1.

In what follows, we report the implied long-run elasticities and dynamic equations of demand for money for the sample countries and compare their results. However, before we detail our results, it is important to give a brief description of the alternative techniques.

The LSE-Hendry's GETS approach was developed before the present developments in time series methods. It does not conflict with the Cowles Commission approach since GETS is only an alternative but more attractive method of dynamic specification. It takes the view that it is hard to determine an equilibrium relationship with disequilibrium data collected from the world that is seldom in equilibrium. In addition, economic theory provides little guidance on how the dynamic adjustments take place. In the past, this gap was reconciled by the arbitrary lag specifications like Partial Adjustment Models and Almond lags, but these have limitations. As Rao (2007) explains, GETS determines the dynamic structure by using the data so that it is consistent with the underlying data generation process. Consequently, in GETS, a very general dynamic lag structure between the dependent and explanatory variables consisting of their lagged levels and first differences is estimated.[9] This overly long general unrestricted model (GUM, for short) is reduced into a manageable parsimonious version by applying the standard variable deletion tests while ensuring that the residuals satisfy the underlying classical assumptions. A good exposition of GETS can be found in Charemza and Deadman (1997). However, although this may sound simple, GETS is computationally demanding if the GUM has a large lag structure.[10]

The Johansen cointegration (JML) is a variant of the VAR approach. However, unlike VAR, in JML, all coefficients are identified and close attention is paid to the underlying economic theory. It is also the most widely used approach in applied time series studies and the routines are found in most econometric software. In JML, pre-testing of variables for unit root is important and all variables are assumed to be endogenous before exogeneity is confirmed with formal tests. The test for the existence of the cointegrating vector(s) are conducted with a procedure that allows for (un)restricted intercept and restricted/no trend options for the VAR. In the JML, the null of no cointegration can be rejected/not rejected with the computed eigenvalue and trace test statistics which are detailed in standard econometric texts or software manuals. The exogeneity tests for block Granger Non-Causality with the null that the coefficients of the lagged values of dependent variables are insignificant in the equations of independent variables are conducted. The computed test indicates if there is endogeneity bias, i.e whether the dependent variable Granger causes the independent variable(s).[11] Identification is tested by regressing the first difference of each variable on the one period lagged residuals normalized on respective variables. It is confirmed if respective ECMs are significant with correct negative signs in their own equations. Once cointegration is established, the dynamics is estimated in the second step.

The Phillip-Hansen's FMOLS procedure is developed to account for possible correlation between the regressors and the residuals as the asymptotic distribution of OLS is non-standard. Therefore, inferences based on the usual t-tests may be invalid without this adjustment. Similar to JML, the FMOLS is a two step procedure but is less flexible than GETS and JML. In the first stage, the cointegrating coefficients are estimated in levels of the I*(1)* variables. Thus, pre-testing is also required in FMOLS. Standard econometrics software manual has the routines for this procedure. However, there is some flexibility in selecting the lag lengths of the VAR, but the Microfit manual suggests the Parzen lag structure. One may also try with smaller lags and increase them systematically by keeping track of the estimated coefficients and stop varying the lags when there are no significant changes in the estimates. The dynamic equation is obtained in the second stage.

If there are no serious endogeneity problems, GETS and JML results should be consistent with FMOLS. While these three approaches, GETS, JML and FMOLS are similar, GETS is based on single equation approach with the presumption of a unique cointegrating vector and exogeneity of the explanatory variables as implied by the underlying economic theory. Such assumptions are also made in FMOLS and it is simpler to implement than GETS or JML. In contrast, the JML is a systems based approach and it offers a more unified framework for estimating and testing cointegrating relationships in the context of ECMs. However, sometimes, JML yields unsatisfactory cointegrating relationships and therefore, it is important to apply more than one method often to check for consistency between them. Our experience has shown that information from GETS is useful for the JML procedure. Also, in a three equation system there could be more than one but at most two cointegrating vectors (CVs). In such a situation, the choice of the relevant CV should be made with reference to the underlying economic theory and by evaluating the signs and magnitudes of the respective implied long-run coefficients. However, if both CVs are plausible, a two equation system must be estimated by imposing cross-equation restrictions. This calls for a VAR approach which is computationally demanding when data points are limited. Nonetheless in all approaches, GETS philosophy is applied in estimating the dynamic structure.

In Table-1, we report the cointegrating coefficients obtained with alternative approaches of GETS, JML and FMOLS, respectively. The GETS implied long-run estimates are in the first three columns. The next three are for JML and FMOLS, respectively, which are obtained after we subjected the variables to unit root tests. The test results are in Appendix. Note, that the implied income ($\beta_1 Y_t$) and semi-interest rate elasticities ($\beta_2 R_t$) are similar for all countries across all the three approaches. Except for the Philippines where income elasticity is around 1.25, we obtained unit income elasticities for all other countries. The Wald tests on the null of unit income elasticities were not rejected at 5% for all countries.[12] The implied semi-interest rate elasticities vary from country to country, but have the expected negative sign and are significant. The sample average of the implied long-run interest rate elasticities, at their mean rates are;
-0.256 in GETS, -0.369 with JML and -0.298 with FMOLS. The income elastiticies indicate the financial systems in these countries are less efficient than the developed nations and the interest rate elasticities indicate a weak linkage to the bonds market which in many of these economies is in the embryonic stage. These results are comparable to Sriram (1999) for developing countries, Oskooee and Rehman (2005) for Asian economies, Rao and Singh (2005a & 2005c) for Fiji and India, respectively, Pradhan and Subramanian (2003) for India and Hafer and Kutan (2003) for Philippines.

TABLE 1. ALTERNATIVE ESTIMATES OF EQUILIBRIUM ELASTICITIES

	GETS			JML			FMOLS		
	β_0	β_R	β_Y	β_0	β_R	β_Y	β_0	β_R	β_Y
FJI	-1.28	-0.03	0.93		-0.05	1.06	-1.20	-0.05	0.96
	(0.84)	(3.58)	(4.73)		(3.61)	(4.38)	(1.25)	(5.90)	(7.68)
VNT	4.16	-0.01	0.91	4.51	-0.01	0.93	4.42	-0.01	0.94
	(147.5)	(2.53)	(7.18)	(12.45)	(2.04)	(12.41)	(20.12)	(2.85)	(20.68)
SAM	0.11	-0.11	0.97		-0.11	1.01	0.11	-0.11	0.97
	(0.05)	(3.62)	(2.80)		(10.17)	(48.37)	(0.19)	(16.27)	(7.55)
SOL	0.08	-0.05	1.13		-0.05	1.18	0.13	-0.04	1.18
	(0.81)	(2.73)	(6.04)		(1.93)	(32.37)	(0.07)	(3.53)	(2.87)
IND	-8.32	-0.03	1.17	-7.92	-0.02	1.13	-7.66	-0.02	1.11
	(15.41)	(1.78)	(24.48)	(20.23)	(1.99)	(37.12)	(28.97)	(2.55)	(51.07)
PHL	0.45	-0.04	1.24	0.47	-0.05	1.25	0.68	-0.05	1.21
	(0.86)	(7.01)	(11.57)	(0.47)	(2.77)	(6.87)	(2.06)	(14.88)	(17.39)
THA	1.63	-0.03	1.09	1.93	-0.04	1.02	1.67	-0.04	1.06
	(5.42)	(4.80)	(17.88)	(5.56)	(4.68)	(14.15)	(29.52)	(29.28)	(90.70)
IDN	7.23	-0.01	1.01	6.54	-0.01	1.12	7.39	-0.01	1.01
	(64.60)	(2.32)	(36.61)	(19.10)	(2.48)	(22.18)	(157.2)	(10.40)	(82.48)
KEN	2.97	-0.03	1.04		-0.10	1.27	3.05	-0.02	1.09
	(27.15)	(2.59)	(7.93)		(2.09)	(7.26)	(22.40)	(2.49)	(16.73)
JAM	5.56	-0.01	1.14	6.02	-0.01	1.03	6.12	-0.01	1.01
	(11.14)	(2.00)	(9.59)	(21.67)	(2.45)	(16.42)	(44.24)	(6.36)	(32.49)
RWA	1.89	-0.03	1.00		-0.07	1.02	2.09	-0.09	1.09
	(60.95)	(3.65)	(2.55)		(6.29)	(20.81)	(7.14)	(9.40)	(16.30)
MWI	1.26	-0.01	1.07		-0.01	1.06	0.04	-0.01	1.02
	(0.17)	(2.51)	(21.82)		(1.89)	(43.07)	(0.15)	(2.10)	(17.86)

Notes:
The income and semi-interest rate elasticities are given as βY and βR, respectively and all are significant at 5%, except for in the JML βR for SOL and MWI are significant at 10% level. The absolute t-ratios are in brackets. Sample periods are: FJI:1976-2002, VNT:1978-03, SAM: 1982-02, SOL:1978-02, IND:1873-02, PHL:1981-02, IDN:1975-04, THA:1982-04, KEN:1971-04, JAM:1978-03, RWA:1984-03 and MWI:1981-04. Based on Ericsson and MacKinnon (2002) tests for finite samples, the null of no cointegration was rejected at 5% in GETS and FMOLS for all the countries, except for SOL (in FMOLS) and IND (in GETS) where it was rejected at 10% level. However, the test indicated no cointegration for SOL and MWI in GETS. Nevertheless, the Eigenvalue and Trace tests in JML indicated cointegration for all countries at conventional levels. Details of these tests are available from the authors

However, as is required, we subjected the CVs obtained in JML to further tests. The identification tests indicated that the implied long-run relations represents demand for money functions, for each country, since only the one period lagged residuals normalized on ln (*M/P*) were significant with correct negative signs in their respective Δln (*M/P*) equations. Further, the Enders (2004) weak exogeneity tests implied that the dis-equilibrium in the respective money markets do not significantly contribute to the explanation of ln *Y* and *R* in all cases. Therefore, we treated real output and the rate of interest as weakly exogenous in the respective money demand equations.[13]

The dynamic money demand equations for each country for JML and FMOLS were estimated by using the general to specific philosophy to search for the best lag structure. Note in GETS, both the equilibrium relation and the dynamics are estimated in one step. However, it is not pragmatic to report all these estimates in this paper. Thus, we only report the JML dynamic specifications in Table 2, 3 and 4, as JML seems to be the widely used approach in applied works. This does not imply that JML is superior to others. The dynamic estimates in GETS and FMOLS are comparable to JML and in some cases gave marginally better results.[14] In all these tables, the chi-square tests (in order of presentation) are for the null of serial correlation, functional form mis-specification, non-normality in residuals and heteroscedasticity and none are significant at 5% level. The absolute t-ratios are in parenthesis below the coefficients and those reported below the chi-square tests are the p-values. Significance at 5% and 10% are indicated with * and **, respectively.

Table 2 includes estimates for Fiji, Vanuatu, Philippines, and Solomon's while Table 3 shows the dynamic estimates for Samoa, Jamaica, Thailand and Indonesia. Table 4 reports the results for India, Rwanda, Kenya and Malawi. In some of these estimates, notably, India and Rwanda, lagged growth of inflation rates seems to be significant. The unconstraint estimates are given as (i) and with some valid coefficient restrictions, which were subjected to Wald tests, are reported as (ii). For Fiji, *DUM1* captures the effects of the two political instabilities of 1987 and 2000. It has a positive coefficient because the coup is likely to increase holdings of precautionary balances. *DUM2* resembles the combined effects of two devaluations and the NBF crisis in Fiji which has negative effects. For Vanuatu and Philippines, *DUM2* represents the financial sector reforms. Similarly, *DUM1* in Rwanda represents financial sector liberalization and reforms. It worth noting that these financial reforms has positive impact as better and efficient financial systems allow improved availability of credit.

Note for all the dynamic estimates reported above, the χ^2 summary statistics are insignificant at 5% level. For Fiji, Kenya and Thailand the functional form is significant at 10% but not at 5% level. The SEEs in all estimates are reasonable and the lagged ECM terms are strongly significant with correct negative signs. Regression between the actual and fitted values of the change in logarithm of real money show good fit of data.

TABLE 2. JML DYNAMIC ADJUSTMENT EQUATIONS

	FJI (i)	FJI(ii)	VNT(i)	VNT(ii)	PHL(i)	PHL(ii)	SOL(i)	SOL(i)
Intercept	-2.676 (6.05)*	-2.477 (7.31)*	-0.013 (0.75)	-0.013 (0.77)	-0.026 (1.12)	-0.026 (1.16)	0.307 (3.89)*	0.306 (4.03)*
ECM_{t-1}	-1.306 (6.06)*	-1.211 (7.39)*	-1.313 (6.20)*	-1.312 (6.39)*	-0.532 (3.35)*	-0.498 (4.53)*	-0.079 (3.49)*	-0.079 (3.64)*
$\Delta ln(Y/P)_t$			0.851 (6.56)*	0.853 (6.89)*	0.919 (1.75)**	1.050 (3.53)*	1.970 (4.05)*	1.973 (4.20)*
$\Delta ln(Y/P)_{t-1}$	-2.266 (5.58)*	-2.244 (6.26)*	-0.141 (1.06)	-0.146 (1.80 **				
$\Delta ln(Y/P)_{t-2}$	-0.789 (1.90)**	-0.711 (1.95)**	-0.151 (1.13)	-0.146 (c)	1.194 (2.14)*	1.050 (c)	-1.173 (2.60)*	-1.128 (2.93)*
$\Delta ln(Y/P)_{t-4}$	0.568 (1.92)**	0.251 (6.94)*					-1.034 (1.75)	-1.128 (c)
ΔR_t	-0.049 (3.40)*	-0.040 (5.12)*			-0.037 (5.57)*	-0.034 (7.44)*		
ΔR_{t-1}	0.035 (2.90)*	0.040 (c)						
ΔR_{t-3}							-0.078 (3.49)*	-0.079 (c)
$\Delta ln(M/P)_{t-1}$	0.274 (1.74)**	0.251 (6.94)*					-0.272 (1.63)	-0.268 (1.67)
DUM1	0.261 (6.79)*	0.251 (c)						
DUM2	-0.054 (2.43)*	-0.048 (2.33)*	0.113 (2.33)*	0.113 (2.39)*	0.132 (2.80)*	0.130 (2.84)*		
Adjusted R^2	0.803	0.816	0.776	0.788	0.720	0.732	0.535	0.566
SEE	0.065	0.063	0.077	0.075	0.072	0.069	0.084	0.081
X^2_{sc}	0.324 (0.57)	0.676 (0.41)	0.893 (0.35)	0.858 (0.35)	0.952 (0.33)	0.920 (0.59)	1.291 (0.26)	1.001 (0.31)
X^2_{ff}	3.325 (0.07)	3.063 (0.08)	0.259 (0.61)	0.262 (0.61)	0.324 (0.57)	0.290 (0.59)	0.015 (0.90)	0.050 (0.82)
X^2_n	0.371 (0.83)	0.500 (0.78)	1.085 (0.58)	1.071 (0.59)	0.155 (0.93)	0.322 (0.85)	0.545 (0.76)	0.640 (0.73)
X^2_{hs}	0.020 (0.89)	0.025 (0.90)	0.006 (0.94)	0.007 (0.93)	0.998 (0.32)	1.000 (0.32)	0.139 (0.71)	0.110 (0.74)

TABLE 3. JML DYNAMIC ADJUSTMENT EQUATIONS

	SAM(i)	SAM(ii)	JAM(i)	JAM(ii)	THA(i)	THA(ii)	IDN(i)	IDN(ii)
Intercept	0.085 (2.88)*	0.089 (3.69)*	-0.011 (0.23)	-0.010 (0.22)	1.378 (6.35)*	1.358 (5.67)*	0.179 (2.30)*	0.179 (2.34)*
Trend			0.004 (1.30)	0.004 (1.30)				
ECM_{t-1}	-0.857 (18.09)*	-0.850 (20.49)*	-1.126 (4.96)*	-1.105 (5.07)*	-0.682 (6.03)*	-0.667 (6.32)*	-0.390 (2.52)*	-0.389 (2.61)*
$\Delta ln(Y/P)_t$					1.997 (6.84)*	2.030 (7.28)*	1.359 (5.39)*	1.358 (8.77)*
$\Delta ln(Y/P)_{t-1}$					-2.190 (6.21)*	-2.309 (7.74)*		
ΔR_t	-0.073 (3.28)*	-0.065 (4.86)*			-0.013 (1.83)**	-0.009 (2.41)*	-0.005 (1.86)**	-0.005 (3.61)*
ΔR_{t-1}	0.060 (3.00)*	-0.065 (c)	0.005 (1.14)	0.007 (1.83)**			0.005 (1.93)**	0.005 (c)
ΔR_{t-2}	0.048 (2.37)*	0.045 (2.62)*	0.008 (1.78)*	0.007 (c)	0.008 (1.49)	0.009 (c)		
ΔR_{t-3}			0.009 (2.04)*	0.008 (2.36)*				
$\Delta ln(M/P)_{t-1}$	-0.151 (2.41)*	-0.176 (4.81)*						
$\Delta ln(M/P)_{t-2}$	-0.210 (3.25)*	-0.219 (4.11)*						
$\Delta ln(M/P)_{t-3}$	-0.186 (3.04)*	-0.176 (c)						
Adjusted R^2	0.951	0.957	0.487	0.508	0.833	0.842	0.751	0.760
SEE	0.097	0.091	0.080	0.079	0.061	0.052	0.065	0.064
X^2_{sc}	0.102 (0.75)	0.000 (0.99)	0.134 (0.72)	0.099 (0.75)	1.099 (0.29)	2.047 (0.15)	0.001 (0.99)	0.001 (0.99)
X^2_{ff}	1.627 (0.20)	1.905 (0.17)	2.509 (0.11)	2.343 (0.13)	3.734 (0.05)	3.453 (0.06)	0.092 (0.76)	0.089 (0.77)
X^2_n	0.420 (0.81)	0.531 (0.77)	0.050 (0.98)	0.082 (0.96)	3.282 (0.19)	2.923 (0.23)	0.591 (0.74)	0.595 (0.74)
X^2_{hs}	0.696 (0.40)	0.714 (0.40)	0.120 (0.66)	0.225 (0.64)	1.168 (0.68)	1.115 (0.73)	0.643 (0.42)	0.643 (0.42)

TABLE 4. JML DYNAMIC ADJUSTMENT EQUATIONS

	IND (i)	IND(ii)	RWA(i)	RWA(ii)	KEN	MWI
Intercept	0.026	0.026	3.573	3.408	0.291	0.003
	(0.87)	(0.88)	(5.17)*	(5.38)*	(2.02)*	(2.15)*
Trend	0.001	0.001	-0.010	-0.009		
	(1.29)	(1.32)	(1.83)**	(1.68)		
ECM_{t-1}	-0.460	-0.457	-1.608	-1.461	-1.105	-0.235
	(3.14)*	(3.23)*	(5.14)*	(5.34)*	(2.10)*	(5.67)*
$\Delta ln(Y/P)_t$	0.625	0.630			1.054	
	(2.82)*	(2.94)*			(7.62)*	
$\Delta ln(Y/P)_{t-1}$			-1.009	-0.851		
			(4.17)*	(4.59)*		
$\Delta ln(Y/P)_{t-2}$			-0.844	0.851		2.670
			(4.18)*	(c)		(3.56)*
ΔR_{t-1}	0.015	0.016	0.086	0.080	0.613	
	(2.00)*	(2.10)*	(4.35)*	(4.57)*	(1.76)**	
ΔR_{t-2}			0.094	0.080		
			(3.91)*	(c)		
$\Delta ln(M/P)_{t-2}$			1.344	1.274		-0.563
			(4.41)*	(4.49)*		(3.21)*
$\Delta^2 \ lnP_{t-1}$	-0.351	-0.361	-1.510	-1.461		
	(2.62)*	(3.65)*	(4.58)*	(4.99)*		
$\Delta^2 \ lnP_{t-2}$	-0.368	-0.361				
	(3.15)*	(c)				
DUM1			0.490	0.435		
			(4.34)*	(4.46)*		
Adjusted R^2	0.520	0.540	0.542	0.572	0.647	0.627
SEE	0.029	0.028	0.066	0.064	0.095	0.032
X^2_{sc}	0.014	0.002	1.641	1.445	0.727	1.296
	(0.91)	(0.97)	(0.20)	(0.23)	(0.39)	(0.26)
X^2_{ff}	2.621	2.515	0.013	0.024	2.959	1.380
	(0.11)	(0.11)	(0.91)	(0.88)	(0.09)	(0.24)
X^2_n	1.320	1.414	0.735	0.981	1.808	0.631
	(0.52)	(0.49)	(0.69)	(0.61)	(0.41)	(0.43)
X^2_{hs}	0.132	0.115	0.408	0.320	0.307	0.165
	(0.72)	(0.74)	(0.52)	(0.57)	(0.58)	(0.69)

STABILITY AND POLICY IMPLICATIONS

We tested for temporal stability of the preferred estimates using the TIMVAR tests and neither the CUSUM nor the CUSUM SQUARES showed any instability. The stability test results (CUSUM SQUARES only) are reported in the Appendix.[15] These results together with Poole's (1970) conjuncture on the choice of appropriate monetary policy instrument implies that targeting the rate of interest may cause more volatility in income levels. For the respective monetary authorities in these countries, targeting money supply is optimal because their money demand relations are stable.

Many developing countries have started targeting the rate of interest without significant evidence that their money demand function has become unstable. For instance, Fiji has changed its monetary policy target from money supply to bank rate in 1997. Similar approach is also being taken by other small islands such as Samoa, Vanuatu and Solomons. Also, the impact of financial reforms is yet to reach the Asian developing countries. However, in countries such as Thailand, Indonesia, Philippines and India, the central banks are using bank rate and inflation rate as monetary policy tools. For African countries such as Kenya, Jamaica, Rwanda and Malawi, money supply targeting still plays major role in minimizing the output fluctuations.

Further, we argue that although there have been some financial innovations in these economies, the money demand relation has remained stable because it is hard to quickly change the nature of the day-to-day exchange patterns based on the use of cash.

SUMMARY AND CONCLUSIONS

In this paper, we have applied three alternative time series methods and obtained similar and consistent cointegrating coefficients for all the sample countries. This indicates more emphasis should be placed on the economic interpretation of results rather than the estimation methods because it is highly unlikely that alternative methods will give conflicting results. However, notwithstanding the relative merits/de-merits of each approach, one should adopt a method that is simple to implement and gives reasonable summaries of observed facts because ultimately, no single approach is capable of explaining all the reality that we aspire to unveil. In this respect, we must not lose sight of the purpose of research and interpretation of results. Third, our results show that the estimated income and interest rate elasticities are well determined and their signs and magnitudes are consistent with *prior* expectations. The income elasticities are unity in all the three approaches for all countries in our sample, except for the Philippines where it is slightly higher at 1.25, and the interest rate elasticities are small and negative varying slightly across countries. Finally, we found that demand for money in these countries is stable and therefore, money supply is the appropriate monetary policy target for central banks.

A few limitations of our work should be noted. We have ignored the structural breaks and their implications on unit roots and cointegration tests. Although, we are aware of endogenous break tests of Gregory-Hansen (1992) and Bai-Perron (2003), we are faced with practical problems in utilizing these tests with a limited number of annual observations relative to the number of such possible breaks, see Rao and Singh (2005a) for a discussion on the break point tests. Nonetheless, we have conducted the usual CUSUM and CUSUM SQUARES stability tests which indicate that all the estimated equations are stable. We are hopeful that our work will be useful especially to applied economists in selecting alternative techniques for further works on important relationships such as demand for money.

APPENDIX 1. DEFINITION OF VARIABLES

P = GDP deflator (2000=100). Data derived are from International Financial Statistics (IFS-2005).
Y = Nominal GDP at factor cost or market prices, whichever is available. Data are from IFS-2005.
R = The average short-term (maximum of 3 years) savings deposit rate. Data derived from the IFS-2005 and ADB database (2005).
M = Currency in circulation, including demand deposit and bills payable. Seasonally adjusted data obtained from IFS-2005.

Notes:
1. All variables, except the rate of interest, are deflated with the GDP deflator and are in natural logs.
2. Data are available for replication on request.

APPENDIX 2. TABLE 1. ADF UNIT ROOT TESTS

	Lags	$\ln M_t$	$\Delta\ln M_t$	$\ln Y_t$	$\Delta\ln Y_t$	R_t	ΔR_t
FIJI	[2,1,1,0,3,0]	2,354	5.908	1.422	9.073	0.777	6.328
VNT	[0,0,1,0,1,1]	1.172	5.667	1.171	3.844	1.158	6.555
SAM	[1,1,1,0,1,0]	1.479	3.756	2.186	4.218	1.378	4.472
SOL	[0,0,1,0,2,0]	1.403	5.228	1.503	3.324	1.222	4.098
IND	[0,2,1,0,1,3]	0.790	5.792	0.346	8.914	0.293	3.711
PHL	[0,0,1,1,3,3]	2.370	5.869	2.573	3.964	2.746	3.638
IDN	[2,1,2,1,2,0]	2.612	7.081	0.053	5.747	1.739	5.500
THA	[0,1,1,1,3,1]	1.311	5.245	1.679	4.618	1.653	4.020
JAM	[0,0,1,0,0,0]	1.778	6.407	2.563	3.618	1.467	7.945
KEN	[0,0,1,3,3,1]	1.519	7.976	2.239	6.075	0.360	4.313
RWA	[0,0,0,0,3,3]	2.032	4.611	1.964	4.772	0.826	3.904
MWI	[1,2,0,0,0,0]	1.254	3.756	2.598	7.328	2.263	3.719

Notes: *$\ln M_t$ and $\ln Y_t$ represent log of real money and real income, respectively. The respective 1% and 5% critical values for ADF test are 3.685 and 2.970. Lag lengths are for the respective variables selected with AIC and SBC criteria. For example [0,1] indicates that lag 0 and 1 are significant in 1st and 2nd columns, respectively. The sample periods are: India(1973-2002), Kenya(1969-2004), Fiji(1976-2002), Vanuatu(1978-2003), Indonesia(1975-2004), Jamaica(1980-2003), Samoa (1982-2202), Solomon(1979-2002), Philippines and Malawi(1979-2004), Thailand(1983-2004) and Rwanda(1982-2003).*

APPENDIX 3. TABLE 2. IDENTIFICATION AND EXOGENEITY TESTS

		Fiji			Vanuatu	
	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t
$ECMM_{t-1}$	-1.229 (8.28)*	-0.148 (1.56)	-1.353 (0.42)	-1.312 (6.39)*	3.255 (1.75)	22.431 (1.10)
$ECMY_{t-1}$		0.012 (2.62)*			-0.008 (0.03)	
$ECMR_{t-1}$			0.002 (0.39)			0.074 (3.14)*
		Samoa			Solomons	
	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t
$ECMM_{t-1}$	-0.857 (18.09)*	-0.105 (0.55)	-4.382 (1.53)	-0.483 (2.73)*	0.037 (0.82)	-1.874 (1.70)
$ECMY_{t-1}$		0.105 (1.53)			-0.008 (0.186)	
$ECMR_{t-1}$			-0.489 (1.53)			-0.073 (1.40)
		India			Philippines	
	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t
$ECMM_{t-1}$	-0.388 (2.35)*	0.219 (1.07)	-3.502 (0.54)	-1.120 (3.48)*	-0.159 (1.03)	-4.488 (0.85)
$ECMY_{t-1}$		-0.247 (1.07)			0.213 (1.09)	
$ECMR_{t-1}$			-0.079 (0.543)			-0.211 (0.88)

*Notes: Absolute t-ratios are reported below the coefficients. Significance at 5% & 10% are indicated by * and **, respectively. ln M_t and ln Y_t represent real log money and real income, respectively.. $ECMM_{t-1}$, $ECMY_{t-1}$ and $ECMR_{t-1}$ are the lagged residuals of the CVs normalized on money, income, and rate of interest, respectively for each countries. Although $ECMR_{t-1}$ is strongly significant in ΔR_t equation for Vanuatu, the sign is incorrect.*

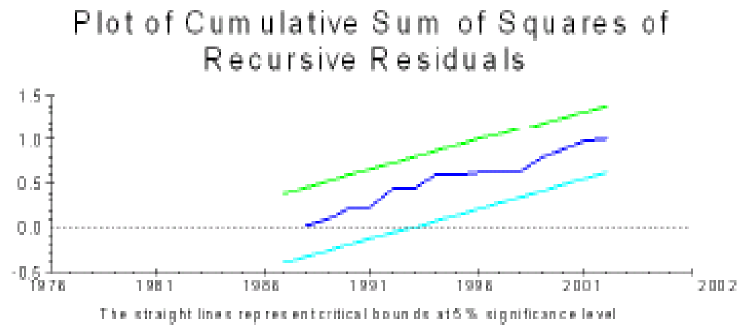
APPENDIX 4. TABLE 3. IDENTIFICATION AND EXOGENEITY TESTS

	Indonesia			Thailand		
	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t
$ECMM_{t-1}$	-0.439	-0.235	-9.500	-0.552	-0.049	-3.612
	(2.26)*	(1.72)	(0.52)	(2.02)*	(0.48)	(0.82)
$ECMY_{t-1}$		-0.260			-0.140	
		(1.72)			(0.82)	
$ECMR_{t-1}$			-0.121			-0.140
			(0.52)			(0.82)
	Jamaica			Kenya		
	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t
$ECMM_{t-1}$	-0.831	0.067	-7.480	-0.113	0.073	-0.265
	(3.66)*	(0.87)	(0.59)	(2.05)*	(1.48)	(0.21)
$ECMY_{t-1}$		-0.069			-0.093	
		(0.87)			(1.48)	
$ECMR_{t-1}$			-0.047			-0.027
			(0.59)			(0.21)
	Rwanda			Malawi		
	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t	$\Delta ln\ M_t$	$\Delta ln\ Y_t$	ΔR_t
$ECMM_{t-1}$	-0.353	0.685	5.057	-0.409	-0.090	2.581
	(2.05)*	(1.84)	(1.51)	(2.88)*	(1.37)	(0.33)
$ECMY_{t-1}$		-0.696			-0.960	
		(1.84)			(1.37)	
$ECMR_{t-1}$			0.372			0.020
			(1.51)			(0.33)

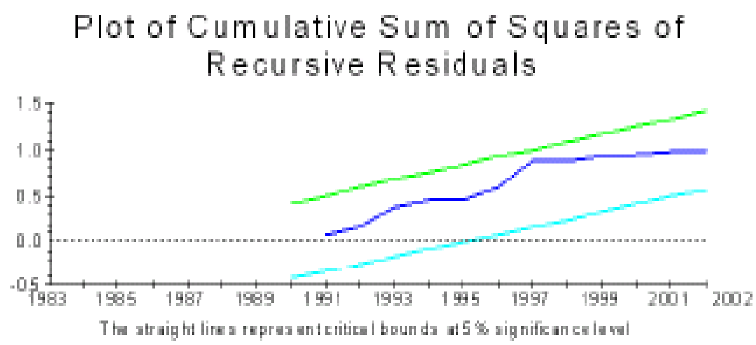
*Notes: Absolute τ-ratios are reported below the coefficients. Significance at 5% & 10% are indicated by * and **, respectively. $ln\ M_t$ and $ln\ Y_t$ represent real log money and real income, respectively. $ECMM_{t-1}$, $ECMY_{t-1}$ and $ECMR_{t-1}$ are the lagged residuals of the CVs normalized on money, income, and rate of interest, respectively for each countries. Although $ECMY_{t-1}$ is mildly significant in ΔlnY_t equation for Rwanda, it also has incorrect sign.*

APPENDIX 5. STABILITY TESTS (CUMSUM SQUARES)

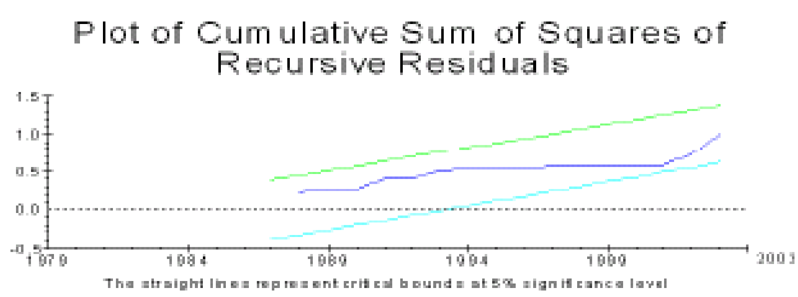
FIJI



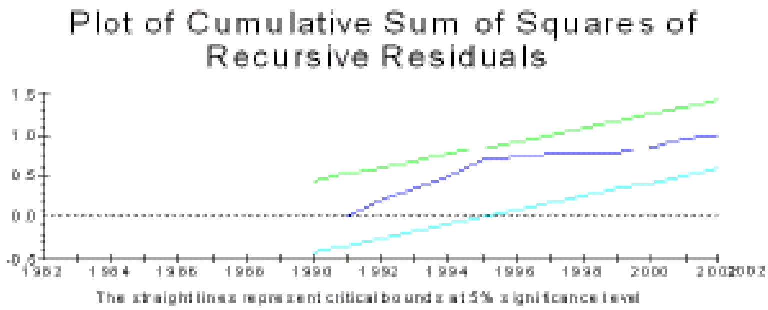
SOLOMONS



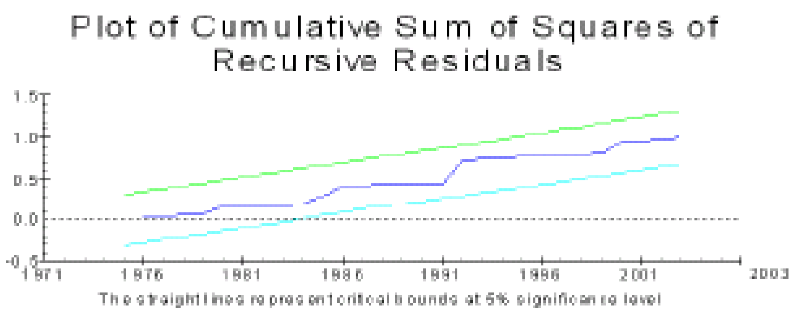
VANUATU



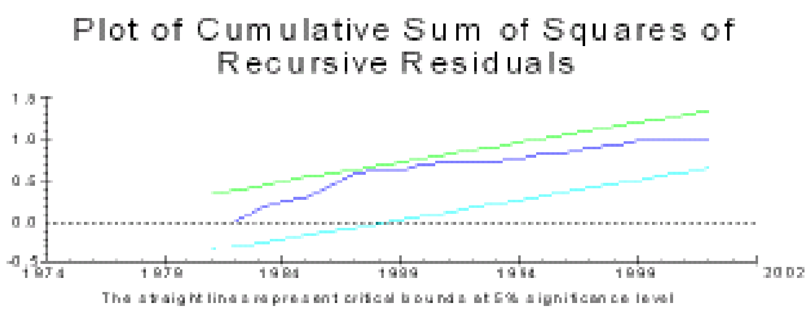
SAMOA



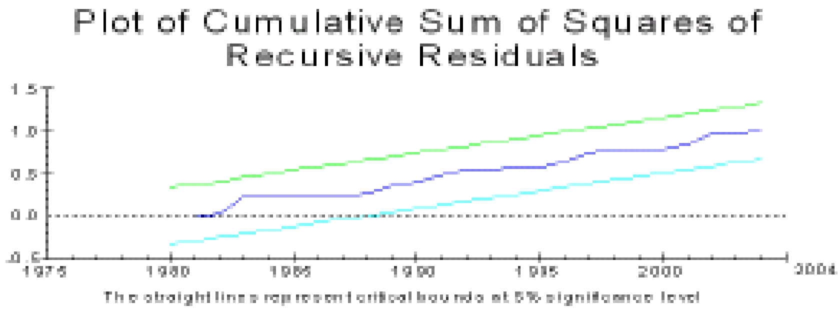
PHILIPPINES



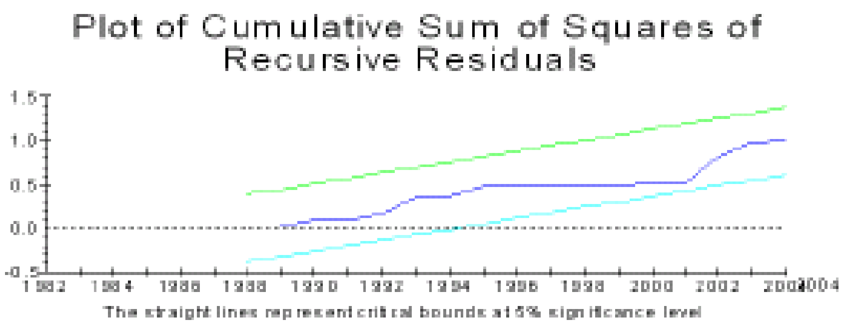
INDIA



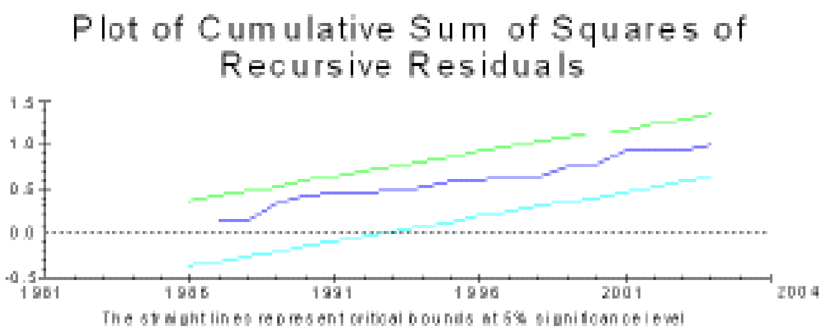
INDONESIA



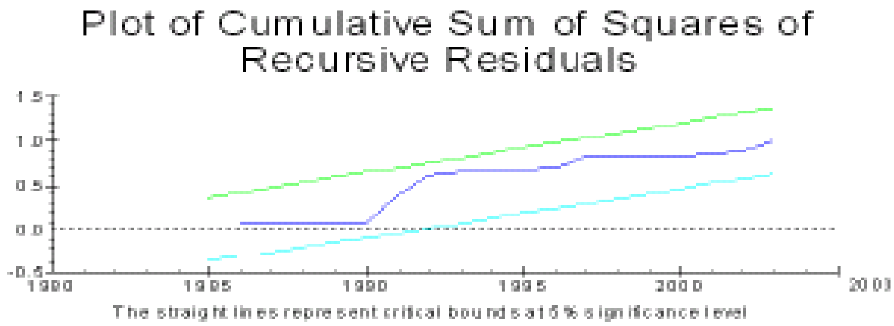
THAILAND



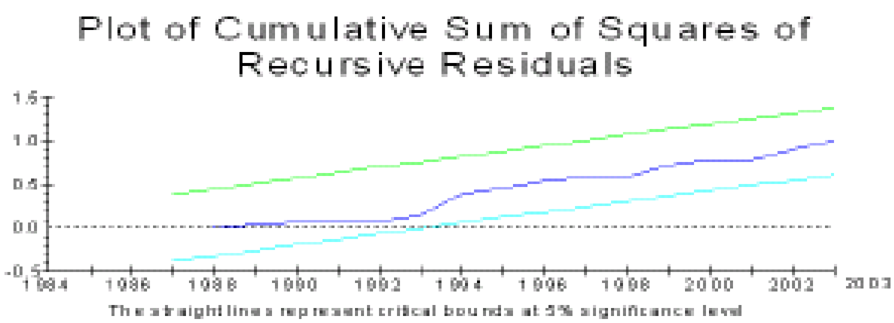
MALAWI



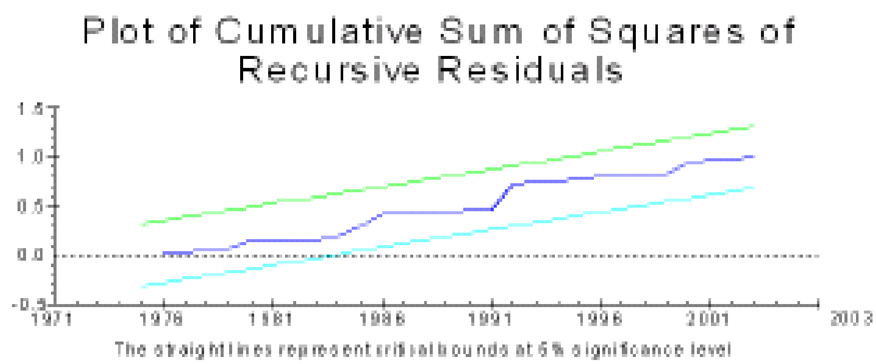
JAMAICA



RWANDA



KENYA



ENDNOTES

* The authors are grateful to Professor B. B. Rao for his encouragement and comments. However, errors are our responsibility.

[1] For an interesting methodological debate on the relative merits of alternative time series approaches, see discussion in Smith (2000).

[2] The selection of the countries that are large, medium and small are based on their geographic regions. It is obvious that large and medium sized countries would have high volume of money transactions than the small countries. Due to the data limitations, we did not choose other countries in the region.

[3] For a comprehensive survey on demand for money, see Sriram (1999).

[4] These are Jayaraman and Ward (2000), Katafono (2001), Rao and Singh (2005a and 2005b), Singh and Kumar (2006a and 2006b) and Rao and Kumar (2007). Studies prior to Rao and Singh (2005a) has limitations and these are well detailed in Rao and Singh (2005a).

[5] This automated software searches for the optimal dynamic lag structure by minimizing the path-dependency bias. In contrast, in the GETS estimation variable deletion tests are used to obtain the final parsimonious specifications and these procedures are not free from the aforesaid path-dependency bias. The dynamic structure obtained by Rao and Singh (2005b) with PcGets is not significantly from what is in Rao and Singh (2005a) but has marginally improved the summary statistics.

[6] Similar findings by Jayaraman and Ward (2000) that demand for money is stable overtime in Fiji.

[7] Similar findings by Das and Mandal (2000) and Ramachandran (2004) that demand for money is stable overtime in India.

[8] They have used the index of industrial production as the scale variable and proxy for real income (GDP). They have assumed that the real demand for money (*M1*) is a function of the index of industrial production , rate of inflation, and the exchange rate. It is worth noting that there is no rate of interest, but the rate of inflation and the exchange rate are used. Inflation rate is not a bad proxy for the nominal rate of interest but inclusion of the exchange rate is hard to justify in the demand for money for developing countries because holdings of foreign exchange is not a realistic option.

[9] However, a standard but somewhat unjustified criticism against GETS is that it specifies an unbalanced equation with both I*(0)* and I*(1)* variables. In response, Hendry repeatedly states that if the economic theory is correct, the levels part of GETS should be cointegrated and the linear combination should be stationary. Thus, the unit root literature has little implications for GETS.

[10] In this respect, Hendry and Krolzig's PcGets - an automatic model selection software- may be useful, see Rao and Singh (2005b) for an application of PcGets in demand for money in Fiji.

[11] As explained by Rao (2007), the Granger causality test is not a cause and effect test but a test of precedence and in itself does not indicate causality used in the more common sense.

[12] Details of Wald test are avoided to conserve space, but are available from the authors upon request.

[13] In the identification tests, both the one period lagged residuals normalized on income and the rate of interest were insignificant in their respective regressions. Details of these tests are in Appendix 3 and 4.

[14] These are not reported here to conserve space but are available from the authors upon request. Excluding the 22 JML dynamics equations reported above, there are 30 other equations for FMOLS and GETS.

[15] The CUSUM results are not reported to conserve space, but are available from the authors upon request.

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