The M1-M10 Relation in Barbados: Some Evidence on Causality

by

Mr. A. Wendell A. McClean
Economics Department
University of the West Indies
Cave Hill Campus

Presented at the Annual Review Seminar, Research Department,
Central Bank of Barbados
July 28-31, 1998

The M1-M0 Relation in Barbados: Some Evidence on Causality

By
A. Wendell A. McClean

1. Introduction

A conventional approach to money-supply analysis assumes an exogenous monetary base and postulates a money-multiplier relationship between the endogenous money supply and the monetary base[1]. This approach has been inspired by the logic of closed economy analysis and is applicable to the case of an open economy with a floating exchange rate regime. However, some researchers have applied the approach to a small economy with a fixed exchange rate regime[2].

This author has argued against the use of conventional money-multiplier analysis in the context of a small economy with a fixed exchange rate regime,[3] on the grounds that, in such an economy, the money supply and monetary base are both endogenous variables. McClean (1983) has argued that, under a fixed exchange rate regime, the money multiplier of closed-economy money-supply theory becomes a mere portfolio-balance relationship in which causality runs predominantly from the money supply to the monetary base. This view is predicated on the notion that the demand for money function takes precedence over the portfolio-balance relation that links demand for money and the monetary base. In this study, we provide some empirical evidence, for Barbados, on the causal relationship between the narrow money supply (M1) and the monetary base (M0), that supports this view.

The study is organised as follows: In Section 2, we explicate the M1-M0 relation. In Section 3, we

[1]This approach to money supply analysis is exemplified by Friedman and Schwartz (1963), Anderson (1967), Jordan (1969).

[2]e.g. Bourne (1976)

[3] See McClean (1981) , (1985)

present the results of pair-wise Granger causality tests. In Section 4 we report and interpret the results of a vector-error-correction model. The study concludes with a brief discussion of the implications of our findings for macroeconomic policy.

2. The M1-M0 Relation

The salient features of the M1-M0 relation may be depicted by a deterministic model of the genre typically used in basic money multiplier models. A decomposition of base money in accordance with usage constitutes the first equation of such a model,

$$M0 = C_P + R \tag{1}$$

Where: C_P is currency held by the non-bank public;
R is cash reserves of commercial banks.

The next equation decomposes R into excess reserves and required reserves, and allows for the possibility of different reserve requirements for different types of deposits.

$$R = \rho_1 DD + \rho_2 DS + \rho_3 DT + ER \tag{2}$$

Where: DD is demand deposits held by the non-bank public with commercial banks;
DS is savings deposits held by the non-bank public with commercial banks;
DT is time deposits held by the non-bank public with commercial banks;
ER is commercial banks excess reserves;
ρ_1, ρ_2, ρ_3 are the required reserve ratios pertaining to DD, DS and DT, respectively.

The next four equations postulate fixed proportionality relationships between DD and C_p, DS, DT and ER respectively.

$$C_P = \alpha DD \tag{3}$$

$$DS = \lambda_1 DD \tag{4}$$

$$DT = \lambda_2 DD \tag{5}$$

$$ER = \gamma DD \tag{6}$$

Equations 1 to 6 imply that,

$$M0 = [\alpha + \rho_1 + \lambda_1\rho_2 + \lambda_2\rho_3 + \gamma]DD \tag{7}$$

In the case of Barbados, the Central Bank has always applied the same reserve ratio requirement to every class of deposits. Hence, equation 7 may be reformulated as:

$$M0 = [\alpha + \gamma + \rho[1 + \lambda_1 + \lambda_2]]DD \tag{8}$$

Given the narrow definition of money,

$$M1 = C_P + DD \tag{9}$$

Equations 3, 8 and 9 imply that,

$$M0 = \frac{[\alpha + \gamma + \rho[1 + \lambda_1 + \lambda_2]]M1}{1 + \alpha} \tag{10}$$

In simple money-multiplier models, α, λ_1, λ_2 and γ are treated as fixed parameters, with the last assumed to be zero, in the simpler models. However, these parameters may more appropriately be regarded as following a stochastic process. In which case, simple multiplier theory may be reinterpreted as assuming that these parameters are I(0) variables.[4]

In the context of an endogenous monetary base, the money demand function is independent of and hence prior to the foregoing portfolio-balance relation. This situation is underscored by the fact that

[4]The stationarity properties and the responsiveness of these parameters to other economic variables will be investigated in a separate study.

the model implies that the demand for M0 is a derived demand linked to the two components of M1. The demand for M0 may be decomposed into the non-bank public's demand for currency and the commercial banks' demand for reserves. The former is a component of the demand for money and the latter has been depicted in the foregoing model as a function of demand deposits, the other component of the demand for money. Hence, in the absence of institutional barriers that prevent the actual stock of M0 from adjusting to the desired level, M1 will exert causal predominance over M0. Hence, our model may be interpreted as implying that,

$$M0^* = h(M1^*, \bar{\rho}); \quad h_{M1}, h_{\rho} > 0 \qquad (11)$$

Where the * denotes demand.

3. Granger Causality

As a first step in our analysis, we checked on the stationarity properties of M1 and M0.[5] Augmented Dickey-Fuller tests (not reported) have indicated that M1 and M0 are both I(1) variables, and the Johansen test for co-integration has indicated that they are co-integrated. These findings validate Granger causality tests in the levels of the variables. The results for such tests are shown in Table 1. They indicate that, whereas lagged values of M1 contribute significantly to the explanation of M0 in the face of four lags of the dependent variable, lagged values of M0 do not contribute significantly to the explanation of M1, in the corresponding circumstances. That is, the results indicate uni-directional Granger causality, with M1 Granger causing M0.

[5]The data used in this study were obtained from the Central Bank of Barbados. All computations were done with Econometric Views Version 2.0.

Table 1: Pairwise Granger Causality Tests

Sample: 1974:1 1997:4 Lags: 4

Null Hypothesis:	F-Statistic	Probability
M1 does not Granger Cause M0	6.97169	6.9E-05
M0 does not Granger Cause M1	1.58203	0.18673
M0_DHPT does not Granger Cause M1_DHPT	2.33060	0.06262
M1_DHPT does not Granger Cause M0_DHPT	5.40116	0.00065
D(M1) does not Granger Cause D(M0)	6.04077	0.00026
D(M0) does not Granger Cause D(M1)	2.32616	0.06314

Note: M0_DHPT is the deviation of M0 from its Hodrick-Prescott trend.
M1_DHPT is the deviation of M1 from its Hodrick-Prescott trend.

As a further check, we conducted Granger causality tests on two stationary representations of these variables: the deviations from the Hodrick-Prescott trend and the first differences of the variables. These results are also reported in Tables 1. In each case, the results indicate uni-directional causation running from M1 to M0.

Because M1 and M0 are co-integrated, there is a channel through which either variable may exert an influence on the other that has not been necessarily captured by the forgoing tests. This channel pertains to the responsiveness of either variable to deviations from their equilibrium relationship. This issue is addressed in the next section.

4. Vector Error Correction Analysis

Table 2 reports estimates obtained from a vector error-correction model for M1 and M0, with ρ included as an exogenous I(0) variable. The lag length was optimized on the basis of the Scharwz Criterion. The results indicate that the equilibrium (error) correction mechanism enters the M0 equation significantly, with a negative sign, but is highly insignificant in the M1 equation. The magnitude of the coefficient also indicates that M0 is highly responsive to portfolio disequilibrium. Hence, the results indicate that, in the context of our model, M1 is at least weakly exogenous. That is, the causal relationship between M1 and M0 runs from M1 to M0.

Table 2: Vector Error Correction Estimates

Sample(adjusted): 1975:3 1997:4

t-statistics are in parentheses

Cointegrating Eq:	CointEq1			D(LOG(MO))	D(LOG(M1))
LOG(MO(-1))	1.000000		R-squared	0.431231	0.098305
			Adj. R-squared	0.351020	-0.028857
LOG(M1(-1))	-0.886542		Sum sq. resids	0.317457	0.262711
	(-64.4092)		S.E. equation	0.063796	0.058035
			Log likelihood	126.4206	134.9386
C	-1.059733		Akaike AIC	-5.380556	-5.569845
	(-6.93097)		Schwarz SC	-5.047248	-5.236538
Error Correction:	D(LOG(MO))	D(LOG(M1))	Error Correction:	D(LOG(MO))	D(LOG(M1))
CointEq1	-0.611621	0.085439	D(LOG(M1(-1)))	-0.414576	-0.063575
	(-4.37279)	(0.67148)		(-2.61859)	(-0.44142)
D(LOG(MO(-1)))	-0.045068	-0.007130	D(LOG(M1(-2)))	-0.448414	-0.194975
	(-0.38732)	(-0.06736)		(-2.83706)	(-1.35604)
D(LOG(MO(-2)))	0.165044	0.031257	D(LOG(M1(-3)))	-0.607014	-0.033004
	(1.45502)	(0.30292)		(-3.84129)	(-0.22959)
D(LOG(MO(-3)))	0.294664	0.060845	D(LOG(M1(-4)))	-0.217586	0.189847
	(2.61613)	(0.59381)		(-1.27327)	(1.22123)
D(LOG(MO(-4)))	0.288062	-0.020557	D(LOG(M1(-5)))	-0.022192	0.022090
	(2.43297)	(-0.19086)		(-0.13905)	(0.15215)
D(LOG(MO(-5)))	0.111734	-0.004906	LOG(RHO)	0.191532	-0.037974
	(1.04912)	(-0.05063)		(4.13315)	(-0.90080)

5. Conclusion

The foregoing results support the argument advanced in McClean (1981), (1983) and (1985) regarding the inapplicability of conventional money multiplier analysis to the case of a small, open economy with a fixed exchange rate regime.[6] They also serve to underscore the fact that closed economy notions of the causal relationship between money and inflation are misleading in the context of an open economy with a fixed exchange rate regime. Endogeniety of M1 and M0, coupled with the causal predominance of M1 over M0, implies that, from the perspective of equilibrium analysis, the causal relationship between M1 and the arguments of the money demand function runs from these arguments to M1. This in turn implies that, in the Barbadian economy, monetary policy should not be used to influence prices and income. Hence, our findings suggest that, in a small, open economy with a fixed exchange rate regime, monetary policy should be dedicated to the promotion of external balance.

This accords fully with the logic of the model of the Barbadian economy presented in McClean (1997). In that model, the equilibrium values of prices, income and the rate of interest are determined independently of money market considerations. Monetary disequilibrium has but a transitory effect on aggregate expenditure and net capital flows. Such effect being necessary and sufficient to induce a balance of payments response that would change the monetary base in the direction and to the extent necessary to restore monetary equilibrium. Any action by the Central Bank to increase the monetary base above current demand for base money would merely result in a reduction in the net foreign assets held by the Central Bank, as the actual monetary base reverts to the level desired by the commercial banks and the non-bank public.

[6] In McClean (1981), (1983) and (1985), there was no explicit reference to a fixed exchange rate regime. However, the discussion pertained to economies with fixed exchange rate regimes. Hence, this notion was implicit in the analysis.

Bibliography

Anderson, Leonall C., "Three Approaches to Money Stock Determination," Federal Reserve Bank of St. Louis *Review*, October 1967..

Bourne, Compton, "The Determination of the Jamaican Money Stock: 1961-1967," *Social and Economic Studies,* Vol.25, No. 4, December 1976.

Friedman, Milton and Anna J. Schwartz, *A Monetary History of the United States: 1867-1960,* Prince ton University Press, 1963, Appendix B.

Jordan, Jerry L., "Elements of Money Stock Determination," Federal Reserve Bank of St. Louis *Review*, October 1969.

McClean, A. Wendell A., "The Stability and Predictive Efficiency of the Traditional Money Multiplier in the Jamaican Context: A Comment on Bourne's Analysis," *Social and Economic Studies,* Vol. 30, No. 3, September 1981.

McClean, A. Wendell A., "A Conspectus of Economic Processes in a Small Open Economy; Barbados," *Barbados Economic Society Seminar*, December 1983

McClean, A. Wendell A., "Further Comment on the Conventional Money Multiplier", *Social and Economic Studies,* Vol. 34, No. 3, September 1985.

McClean, A. Wendell A., "Monetary Dynamics in Barbados: The Evidence From Co-integration Analysis and Error-Correction Modelling." In Worrell, D. and R. Craigwell (Editors), *Macroeconomics and Finance In the Caribbean: Quantitative Analyses,* Caribbean Centre for Monetary Studies, St. Augustine, Trinidad. 1997

July 17, 1998