

TESTING THE EXOGENEITY SPECIFICATION UNDERLYING THE MONETARY APPROACH TO THE BALANCE OF PAYMENTS: A STUDY CASE FOR PAKISTAN

*Ghulam Shabbir

Abstract

This study examines the exogeneity assumptions underlying the monetary approach to the balance of payments. These assumptions include the exogeneity of the determinants of the demand for nominal money balances (domestic price level, interest rate, inflation and level of real income) and domestic credit component of money supply with respect to foreign reserve flows. When we use the reduced form expression of the monetary model and if the exogeneity assumptions underlying the monetary approach to the balance of payments are incorrect, then exogeneity makes a difficult task to interpret the results. To test the exogeneity of the determinants of the demand for nominal money balances and domestic credit with respect to foreign reserve, two tests are carried out by estimating the unrestricted and restricted for Pakistan. In the first test, data is used at level and in second test first difference is used. The motivation underlying the second test is to reduce the possibility of spurious simultaneity. The results constitute positive evidence for the monetary approach to the balance of payments on theoretical specification as well as on empirical. The result presented in this paper suggests that the assumptions of the monetary approach to the balance of the payments regarding exogeneity are correct both in short run as well as in long run. The null hypotheses for exogeneity of price level, real income, interest rate and inflation are accepted. On the other hand the null hypothesis for the exogeneity of domestic credit is rejected for general model but accepted for linear model. The contradiction in domestic credit results may be result of spurious simultaneity. It is suggested that exogeneity test such as performed in this study, are an important step which should be performed as a part of any test of the monetary theory of the balance of the payments, or any theory for the matter.

* Lecturer, Government College of Science, Faisalabad.

Introduction

There is no general consensus on the validity of the monetary approach to the balance of payments despite its importance, both in explaining the inflationary epidemic (Johnson, 1972b) and as a theoretical basis for policy recommendations (Rhomborg and Heller, 1977). The reason behind it, is the controversy over the accuracy of the exogeneity assumptions underlying the monetary approach to the balance of payments. These assumptions include the exogeneity of the determinants of the demand for nominal money balances (domestic price level, interest rate, inflation¹ and level of real income) and domestic credit component of money supply with respect to foreign reserve flows.

If the exogeneity assumptions regarding the monetary approach to the balance of payments are incorrect then the task to interpret the results become difficult. To borrow Geweke's words, "the otherwise identifying restrictions imposed on structural equations may not be sufficient to identify those equations, estimation procedure will be inconsistent and the model can not adequately portray the dynamics of the system it seek to describe".

Historically exogeneity was simply assumed as some thing not amenable to test. However, Geweke (1978) has demonstrated that the specification of exogeneity is a hypothesis with testable implications. The purpose of this paper is to test formally the exogeneity hypothesis underlying empirical tests of the monetary approach to the balance of payments specifically, and the

¹ In LDC's where the range of alternative assets are limited, substitution may take place between goods and money; therefore it is more appropriate to represent the opportunity cost by both the interest rate and the implicit return on goods, the rate of inflation. [Faiz Bilquees 1989, PP. 198]

theoretically specification of the model in general using Geweke's method for Pakistan.

The plan of this paper is as follows. In section II, a monetary model of the balance of payments is presented and its exogeneity restrictions are highlighted. In section III, the formal test of exogeneity is discussed and in IV, the results of the tests using data from Pakistan are presented. Section V contains some conclusions.

Exogeneity assumptions of the monetary model

A popular expression of the monetary model of the balance of payments which is presented in one form or another at various places in literature (e.g. Johnson, 1972a; Kemp, 1975; Magee, 1976; Aghevli and Khan, 1976; Kreinin and Officer, 1978; Victor, 1977; Borts and Hanson, 1977; Hans, 1976; Manual, 1976; Bilquees, 1989; Uddin, 1985) is as follows;

$$(R / R + DC) \Delta \log R = \Delta \log P + \beta_1 \Delta \log y - \beta_2 \Delta \log I - \beta_3 \Delta \log \pi - (DC / R + DC) \Delta \log DC \quad \text{--- (1)}$$

Where R is the international reserve component of a country's money supply, P is the domestic price level, y is the level of real income, i is the domestic interest rate, π is the inflation and DC is the domestic credit. $\beta_1 \beta_2 \beta_3$ are the elasticities of money demand with respect to real income, interest rate and inflation respectively.

The exogeneity assumptions underlying the monetary approach to the balance of payments are:

1. The domestic component of money supply is exogenous. (Whitman, 1975; PP. 496)
2. The prices and interest rate are determined exogenously when a country is small. (Aghevli and Khan, 1976; PP. 275)

3. Growth rate of real income is also exogenous. (Swoboda, 1977; PP.16)

These exogeneity assumptions are quite controversial. Some accept that equation (1)¹ is valid in the long run but others do not. There is still a question of whether or not, equation (1) is applicable in short run but numerous empirical studies implicitly assumed. The most controversial assumption is at No. 1, namely the assumption of domestic credit exogeneity, for it implies that government does not sterilize reserve flows via some appropriate change in domestic credit.² The exogeneity of the price level, interest rate and real income have also been questioned. As Bolts and Hanson (1977) write, "perhaps the strangest assumption underlying the monetary model of the balance of payments is that, the determinants of the money demand are exogenous".³ Given the need to resolve the validity of the monetary model for the balance of payments, it is imperative that the exogeneity specification underlying the theoretical model and in particular the empirical tests of the theoretical model be tested formally rather than remain a mere assertion.

The exogeneity of domestic credit with respect to foreign reserves in several European countries has been tested by Blejer (1979) using the Bivariate methods proposed by Sims (1972). The problem with Blejer's results was that the Bivariate test ignores the potential importance of the other variables typically associated with the monetary models. The omission of potentially relevant variables in these exogeneity tests creates the problem of specification error in regression analysis and the

¹ Which is a reduced form

² The assumption is defined at length in Johnson (1972) and Polak (1977).

³ Magee (1976) also questioned the exogeneity of these variables.

potential effects are examined in Skoog (1976). To avoid this specification error in regression analysis, Johannas (1981) used a multivariate test. The same test is used in this paper which is not carried out by any one who used the monetary approach of to the balance of payments for Pakistan [Bilquees, (1989); Uddin, (1985)].

An Empirical Test of the Exogeneity Specification

The exogeneity test used in this paper are based on the work of Geweke (1978) and used by Johannes (1981). Consider the "Complete Dynamic Simultaneous Equations Model (CDSEM)".

$$\begin{matrix} B(L) & Y_t + & \Gamma(L) & X_t = & \xi_t \quad \dots (2) \\ (g \times g) & (g \times 1) & (g \times k) & (k \times 1) & (g \times 1) \end{matrix}$$

Where $B(L)$ and $(L\Gamma)$ are matrices of polynomials in the lag operator L ¹, which purports to be a complete description of the interaction between "k" exogenous variables (i.e. x_t represents observations at time t on k putative exogenous variables) and g endogenous variables Y_t . Geweke argued that a testable implication of the hypothesis is, x_t is exogenous "since x_t is (By assumption) determined outside the CDSEM... a proper specification of the determinants of x_t will not include any values of y_t (Geweke, 1978). In other words, in the regression of x_t on past x_t and past y_t i. e.

$$X_t = \sum_{s=1}^{\infty} F_s X_{t-s} + \sum_{s=1}^{\infty} G_s Y_{t-s} + \xi_t \quad (4.3-2)$$

Where

$$\begin{aligned} X_t &= \text{Exogenous Variables (P, y, i, } \pi \text{ and DC)} \\ y_t &= \text{Endogenous Variables (R)} \end{aligned}$$

¹ The lag operator L is defined by $LZ_t = Z_{t-1}$ for some time series Z_t ...

- F_s = Coefficients of lagged exogenous variables X_t
 G_s = Coefficients of lagged endogenous variables y_t
 ε_t = Error term.

There "exists a CDSEM with exogenous X_t and endogenous y_t and no other variables, if and only if $G_s = 0$ for all $s > 0$ " (Dent and Geweke, 1979).

The hypothesis tested in this paper is that underlying equation (1) namely, that the domestic price level, real income, interest rate, inflation and domestic credit are all jointly exogenous with respect to reserve flows. In the test, there are nine lags on the price level, real income, interest rate and inflation variables, twelve lags on the domestic credit variable (to allow domestic policy to have a potential lag of a year) and six lags on the reserves variables.¹ Wald test is used to test the null hypothesis that $G_s = 0$ for all $s > 0$. Under the null hypothesis both tests are asymptotically distributed as a Chi-square with degree of freedom equal to the number of restrictions.

Empirical Results

The data used in this paper consist on yearly observations on variables in equation (1) for Pakistan. The variable used for R in (1) is the reserve component of IMF money ($R = \text{Gold} + \text{Foreign Exchange} + \text{SDR's} + \text{Reserve Position}$) and the variable used for DC is the domestic credit component of the same. Computer software E-Views is used for this study. By assuming the standard money supply rule:

$$M^s = h B = h(R + DC) \quad \text{--- (3)}$$

¹ Geweke (1978) suggests that the best compromise is that, "the number of lag X_t should be generous but only a few recent values of y_t out to be include".

Where h is money multiplier, B is the country's monetary base, R is the reserve component of that base and DC is the domestic credit component of that base. The variable used for real income is obtained as ($y = \text{GNP} / \text{GDP deflator}$). The variable used for growth rate of inflation is defined as $g \pi = [\log (\text{CPI}) - \{\log \text{CPI} (-1)\}]$ (Aghelvi and Khan, 1977). The data on all variables is taken from International Financial Statistics (Various issues) and adjusted on 1990 base.

To test the exogeneity of the determinants of money demand and domestic credit with respect to reserves, two tests are carried out by estimating unrestricted and restricted (omitting y_0 version of (3), for Pakistan. In the first test, first difference of R , P , y , i , π and DC are used. The motivation underlying the second test is that if the test data are defined as in (1) then share weights for R and DC will appear on both sides of (3) and it is possible that a spurious simultaneity might be introduced. One way to reduce the potential severity of this problem is to assume a linear money demand function.

$$M^d = P + a_1 y - a_2 i - a_3 \pi \text{ --- (4)}$$

For which the appropriate expression of the monetary model of the balance of payments is as specified below:

$$g R = g P + a_1 g y - a_2 i - a_3 \pi - a_4 g DC \text{ --- (5)}$$

The test results for both sets of data are displayed in the table. The results of the first test are displayed under the heading "General Model" and the results of second test under the heading "Linear Model". The Wald Test (F-Statistic and Chi- Square) is used to test the null hypothesis of exogeneity; i.e., that six coefficients on lagged reserves in all five equations (one for each putative exogenous variable) are jointly zero which are displayed

in column (3) and (4) of the table. The estimated value of F-statistic and Chi-Square are insignificant, except the domestic credit, which is significant in general model at 5% level of significance. Thus, the null hypothesis for exogeneity of price level, real income, interest rate and inflation is accepted. On the other hand, the null hypothesis for the exogeneity of domestic credit is rejected for general model but accepted for linear model. The contradiction in domestic credit results may be a result of spurious simultaneity as suspected by White (1975), Magee (1976), Bolts and Hanson (1977). The results worth mentioning are the results of the F-statistic of the null hypothesis that six coefficients on lagged reserve flows in each equation individually are zero. These F-statistics shed some light on which putative exogenous variables are causing the overall test to accept the exogeneity of the entire set.

Regression results for testing exogeneity of the monetary model
Test Statistic for Null Hypothesis

$$G_s = 0, \text{ for all } s > 0$$

Wald statistic

<i>Regression</i>	<i>Model</i>	<i>F-Statistics</i>	<i>Chi-square</i>	<i>R²</i>	<i>D.W. Stat</i>
<i>g p</i>	General model	0.459 (0.511)	0.459 (0.497)	0.99	2.06
	Linear model	0.244 (0.631)	0.244 (0.620)	0.85	1.67
<i>G y</i>	General model	0.929 (0.355)	0.929 (0.335)	0.99	1.82
	Linear model	0.078 (0.785)	0.078 (0.779)	0.77	2.15
<i>G i</i>	General model	0.634 (0.227)	1.634 (0.201)	0.76	2.05
	Linear model	0.500 (0.495)	0.500 (0.479)	0.61	2.14
<i>G π</i>	General model	0.391 (0.544)	0.391 (0.531)	0.99	2.42
	Linear model	0.154 (0.702)	0.154 (0.694)	0.73	1.69
<i>g Dc</i>	General model	8.558** (0.03)	8.558** (0.03)	0.98	2.05
	Linear model	1.037 (0.365)	1.037 (0.308)	0.76	1.61

Where

g_p = Growth rate of domestic price level

g_y = Growth rate of real income

g_i = Growth rate of domestic interest rate

g_π = Growth rate of inflation

g_{dc} = Growth rate of domestic credit

****** = Significant at 5 % level

() value shows the probability

Conclusion

Before this, the empirical studies based on reduced form expression of the monetary model used for Pakistan have not tested the fundamental assumption underlying these reduced forms directly. It means that the variables on the right hand side of equation (1) are jointly exogenous with respect to reserve flows. The results presented in this paper suggest that the assumptions of the monetary theory of the balance of payments regarding exogeneity are correct, both in the short run as well as in the long run. These findings are contrast to Johannes (1981) but consistent with Blejir's (1979). The results constitutes a positive evidence for monetary theory of the balance of payments on theoretical specification as well as on empirical. It is concluded that exogeneity tests such as the ones performed in this paper are important step which should be performed as a part of any test of the monetary approach to the balance of payments, or any theory for that matter.

References

- Aghevli, B. Bijan and Mohsin S. Khan, (1976), "The Monetary Approach to the Balance of Payments Determination: An Empirical Test." In IMF (ed.) *The Monetary Approach to the Balance of Payments*, Washington, D.C.: *International Monetary Fund*, pp. 275-90
- Argy, Victor and Pentti, J. K. Kouri, (1974), "Sterilization Policies and the Volatility in International Reserves." In Robert Z. Aliber (ed), *National Monetary Policies and International Financial System* (Chicago: *University of Chicago Press*) pp. 209-230.
- Argy, Victor, (1977), "The Monetary Variables and the Balance of Payments." In the *Monetary Approach to the balance of Payments*, Washington, D. C: *International Monetary Fund*, pp. 185-230.
- Berndt, Ernst R. and N. Eugene Savin, (1977), "Conflict among Criteria for Testing Hypothesis in the Multivariate Linear Regression model." *Econometrica* Vol. 45 pp. 1263-1278.
- Bilquees, F. (1989), "The Monetary Approach to the Balance of Payments: The Evidence on Reserves Flow from Pakistan." *Pakistan Development Review*, Vol. 38. No. 3, pp. 195-206
- Bisignano, Joseph (1975), "The Interdependence of National Monetary Policies" *Federal Reserve Bank of San Francisco Business Review* (spring) pp. 41-48
- Blejer, I. Mario (1979), "On Causality and The Monetary Approach to the Balance of Payments: the European Experience." *European Economic Review*, Vol. 12, No. 2, pp. 201-283.

Borts, G. H. and J. A. Hanson, (1977), "Monetary Approach to the Balance of Payments" Providence, *R. I. Brown University (Mimeographed)*.

Dent, Warren and John Geweke, (1978), "On Specification in Simultaneous Equation Model" Social System Research Institute Workshop Series Paper no. 7823, *University of Wisconsin-Madison*.

Genberg, A. Hans (1976), "Aspects of the Monetary Approach to the Balance of Payments Theory: An Empirical Study of Sweden." In Jacob A. Frenkel and Harry G. Johnson (eds.) *The Monetary Approach to the Balance of Payments*, George Allen Unwin Ltd.

Geweke, John (1978), "Testing the Exogeneity Specification in the Complete Dynamic Simultaneous Equation Model." *Journal of Econometrics*, Vol. 7, No. 2, pp. 163-185.

Guitian Manual (1976), "Balance of Payments as a Monetary Phenomenon" In Jacob A. Frenkel and Harry G. Johnson (eds.) *The Monetary Approach to the Balance of Payments*, George Allen Unwin Ltd.

International Monetary Fund, *International Financial Statistics*, Washington D.C.: IMF [Various Issues].

Johannes, M. James (1981), "Testing the Exogeneity Specification Underlying the Monetary Approach to the Balance of Payments." *The Review of Economics and Statistics*, Vol. 63, No. 1, pp. 29-34.

Johnson, G. Harry (1972a), "The Monetary Approach to the Balance of Payments" *Journal of Financial and Quantitative Analysis* 7, pp. 1555-1572.

Johnson, G. Harry (1977), "The Monetary Approach to the Balance of Payments Theory and Policy: Explanation and Policy Implications." *Economica*, Vol. 44, No. 174, pp. 217-229.

- Johnson, G. Harry (1977), "The Monetary Approach to the Balance of Payments: A Non-Technical Guide." *International Economic Journal*, Vol. 7, No. 4, pp. 251-68.
- Johnson, G. Harry (1977b), "A Monetarist View" In Harry G. Johnson (ed.), *Further Essay in Monetary Economics* (London, Allen and Udwin)
- Kemp, S. Donald (1975), "A Monetary View of Balance of payments" *Federal Reserve Bank of St. Louis review*, pp. 14-22.
- Khan, S. Mohsin (1974), "Experiment with a Monetary Model for the Venezuela Economy." *IMF Staff Papers*, Vol. 2, pp. 389-413.
- Khan, S. Mohsin (1976), "A Monetary Model of Balance of Payments: The Case of Venezuela." *Journal of Monetary Economics*, Vol. 2, No. 1, pp. 311-332.
- Koopmans, T. C. (1949), "Identification Problems in Econometrics Model Construction" *Econometrica*, Vol. 17 (April), pp. 125-144.
- Kreinin, Mordenchai E. and Lawrence H. Officer (1978), "The Monetary Approach to the Balance of Payments: A Survey Article" *Princeton Studies in International Finance* No.43.
- Magee, Stephen P. (1976), "The Empirical Evidence of the Monetary Approach to the Balance of Payments and Exchange Rates" *American Economics Review*, Vol. 66, pp. 163-170.
- Phaup, E. Dwight and Alan Kusinitz (1977), "Monetary Control under Fixed Exchange Rates" *Journal of Money, Credit and banking*, No. 2, pp. 552-561.
- Polak, J. J. (1977), "Monetary Analysis of Income Formation and Payments Problems" In *the Monetary Approach to the Balance of Payments* (Washington, D. C. IMF) pp. 15-64.

- Rhomberg, R. Rudolf and Robert H. Heller (1977), "Introductory Survey, the Monetary Approach to the Balance of Payments" *Washington, D. C. IMF*, pp. 1-14.
- Sims, A. Christopher (1972), "Money, Income and Causality" *The American economic Review*, Vol. 62, No. 2, pp. 351-365.
- Skoog, R. Gray (1976), "Causality Characterization: Bivariate, Trivariate and Multivariate propositions" *Staff Report 14, Federal Reserve Bank of Minneapolis*.
- Sohrab-Ud-Din (1985), "Monetary Approach to Balance of Payments: Evidence form Less Developed Countries." *Indian Economic Journal*, Vol. 33, No. 1, pp. 92-104.
- Swoboda, K. Alexander (1977), "Monetary Approach to worldwide Inflation: Theory and Recent Experience" *Washington D. C. The Brooking Institution*, pp. 9-50.
- Whitman, V. Marena (1975), "Global Monetarism and The Monetary Approach to the Balance of Payments." *Brooking Papers on Economic Activity* 3, pp. 491-536.
- Zecher, J. Rechard (1974), "Monetary Equilibrium and the International Reserves Flow in Australia." *Journal of Finance*, Vol. 29, No. 3, pp. 1323-30.