Causal Relationship between Domestic Credit and International Reserves: The Experience of Developing Countries

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I.

Recently, *Blejer* (1979) tested the direction of causality between domestic credit and international reserve components of several developed countries monetary base. The objective was to establish support for one of the basic tenets of the monetary approach to the balance of payments (MBOP), that an exogenous expansion of domestic credit leads to an endogenous outflow of foreign exchange reserves. His results supported the direction of causality running from domestic credit to international reserves. However, Blejer's analysis suffered from many shortcomings. First, he used only one test of causality, namely, *Sims* (1972), when infact, there are three such tests available. Second, his estimation method failed to take account of problems associated with potential serial autocorrelation in the residuals of the Sims regressions. This could easily have biased the results. Third, since contemporaneous coefficients for all countries he studied were significant, it is not clear whether the relationship between domestic credit and international reserves is mainly contemporaneous. Lastly, in order to ascertain the true direction of causation, it is advisable to use as much disaggregated data series as are available because of possible bias introduced by aggregation. Keeping in this view, it would have been more appropriate for Blejer to have used monthly rather than quarterly data series. *Feige* and *Johannes* (1981) retested the MBOP for six countries taking into account the above noted drawbacks in Blejer's work. Their sample was, however, restricted to the developed nations, so in this paper the nature of relationship between the components of the monetary base is studied for four developing countries, India, Malaysia, Mexico and Taiwan. The widest range of techniques available are employed on monthly data series.

The MBOP has been widely tested on data from several developing countries[1] and the IMF bases its financial programme and policy recom-

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mendations for the member countries on principles that are consistent with it.[2] The empirical results were construed to support the MBOP when negative correlation between domestic and foreign assets was detected. But this does not provide evidence in support of the proposition that causality does indeed run from domestic to foreign assets. Empirical determination of the direction of causality requires implementation of tests geared to testing for causation. Such empirical analysis is important not only because it throws further light on the central proposition of the MBOP, but also because it could assist the national and international policy makers.

The paper is organised as follows. In the next section, the domestic and foreign asset relationship embodied in the MBOP is stated. Sections III and IV present the causality tests and the results, respectively. The concluding comments are given in the last section.

II. The MBOP

The commonly empirically studied reserve-flow equation of MBOP is the following reduced-form version.

$$(1)\quad [R/(R+D)]\,\Delta \log R = \Delta \log P + \alpha\,\Delta \log Y - \beta\,\Delta \log i - \Delta \log m - [D/(R+D)]\,\Delta \log D$$

where R is the level of the country's international reserves; D is the domestic component of the monetary base; P is the domestic price level; Y is the real income; i is the interest rate; and m is the domestic money multiplier. According to (1), expansion of domestic credit in excess of domestic demand for nominal balances will result in a balance of payments deficit as the public gets rid of the excess supply of money by raising its expenditure over income. Therefore, the direction of causality suggested by (1) is from domestic credit to foreign reserves.

However, it is conceivable that the causality may run from foreign reserves to domestic credit (*Blejer* (1979)). This is likely when central banks actively sterilize the impact of exogenous changes in foreign reserves on the domestic money supply.[3] It could also exist when commercial banks in order to prevent fluctuations in domestic credit volume borrow from the central bank when confronted with a loss of reserves through an outflow of international reserves.

[1] For instance, see *Kreinin* and *Officer* (1978) for a survey and *Aghevli* and *Khan* (1977).

[2] See *Rhomberg* and *Heller* (1977), *Crockett* (1981) and IMF (1981, ch. 7).

[3] This may occur when authorities pursue an interest rate stabilization policy.

III. Causality Tests

We employ three commonly used tests of causality, *Granger* (1969), *Haugh* (1976) and *Sims* (1972). We do not discuss the theory underlying these tests as it has been well documented elsewhere.[4] Only a brief description of the tests is presented.

In *Haugh* test prewhitened data series are cross correlated and two statistics, S and S^* computed. The statistic S is defined as

$$S = N \sum_{k=-m}^{m} \hat{r}^2(k) \tag{2}$$

where N is the number of observations, k is the number of leads or lags and r are the cross-correlations for k leads and lags.

When k is large relative to the number of observations, then S^* is estimated.

$$S^* = N^2 \sum_{k=-m}^{m} \frac{\hat{r}^2}{(N - |k|)} \tag{3}$$

Under the null hypothesis of independence, S and S^* are asymtotically distributed as chi-square with $2m + 1$ degrees of freedom.

Since *Haugh* test is strictly valid only as a test of independence or dependence between series, *Granger* and *Sims* causality tests are needed to determine the direction of causation. The Granger procedure consists of estimating two regressions.

$$\Delta D_t = \sum_{k=1}^{m} a_k \Delta D_{t-k} + \sum_{j=0}^{n} b_j \Delta R_{t-j} + u_t \tag{4}$$

$$\Delta R_t = \sum_{k=1}^{m} c_k \Delta R_{t-k} + \sum_{j=0}^{n} d_j \Delta D_{t-j} + v_t \tag{5}$$

For ΔR not to cause ΔD, all b_j for $j > 0$ must be zero, while for ΔR not to cause ΔD, at all, all b_j for $j \geq 0$ must be zero. For ΔD not to cause ΔR, all d_j for $j > 0$ must be zero. ΔD does not cause ΔR at all, if all d_j for $j \geq 0$ equal zero.

The *Sims* test is based on the regressions.

$$\Delta D_t = \sum_{i=-n}^{m} p_i \Delta R_{t-i} + e_t \tag{6}$$

[4] For instance, see *Feige* and *Pearce* (1979) and *Feige* and *Johannes* (1981).

$$\Delta R_t = \sum_{i=-n}^{m} q_i \Delta D_{t-i} + f_t \tag{7}$$

ΔD does not cause ΔR, if p_i for $i < 0$ equals zero and ΔD does not cause ΔR at all if p_i for $i \leq 0$ are all zero. Analogously, ΔR does not cause ΔD, if q_i for $i < 0$ are all zero, while ΔR does not cause ΔD at all, if q_i for $i \leq 0$ are all zero.

IV. Data and Empirical Results

The causality tests have been carried out on monthly seasonally unadjusted changes in the domestic credit and reserve components of the monetary base in India, Malaysia, Mexico and Taiwan. The period ranges from March 1963 to July 1971 for all countries with the exception of Malaysia and Mexico. The series for Malaysia commence from April 1966 and that of Mexico end in November 1970.[5] The data have been obtained from several editions of the International Financial Statistics (IFS).[6] These countries were selected because empirical evidence in favour of MBOP already exists for them (*Aghevli* and *Khan* (1977)).[7] Secondly, these countries represent varying degrees of openness to world trade. Malaysia and Taiwan are the most open of these economies, with Mexico being moderately open, and India being the least open. The degree of openness is relevant because MBOP is applicable more to open economies.

The estimated autocorrelation functions for the components of monetary base of Malaysia and Taiwan indicated that no prefiltering was required. However, ARIMA filters were judged to be necessary for Indian and Mexican series (presented in Table 1). The S and S^* for each country (Table 2) suggested that the null hypothesis that ΔD and ΔR are independent can be rejected at 0.05 or 0.10 level of significance. Except for Mexico, S and S^* are significant (in Table 2) for all leads and lags of upto 12. For Mexico, dependence is observed only at the short lags. These results, therefore indicate that dependence exists between ΔR and ΔD for all four countries.

The *Granger* and *Sims* regressions were run to determine the nature of the relationship between the components of monetary base. The Granger

[5] The period of study has been determined by the availability of data and by the fact that the exchange rates were fixed during this period.

[6] Reserves are taken to be official international reserves (line 1, IFS) converted to domestic currency units. Domestic credit is defined as the monetary base (line 14, IFS) minus reserves.

[7] In fact, their results for the chosen countries suggested a strong support for the MBOP.

Table 1: ***Box-Jenkins*** **Models for Changes in Domestic Credit and International Reserves**[a)]

Country	Series	Model	Diagnostic Check on Residuals	
Mexico	Dom. Credit	$(1 - B^{12})(1 - 0.21\ B^{12})\ \Delta D = U_D$ (-1.43)	$Q = 27.84$	$d \cdot f = 24$
	Intern. Res.	$(1 - 0.19\ B^2 - 0.34\ B^5)\ \Delta R = U_R$ $(-1.80)\qquad(-3.36)$	$Q = 30.53$	$d \cdot f = 27$
India[b)]	Dom. Credit	$(1 - B^{12})\ \Delta D = (1 - 0.57\ B^{12})\ U_D$ (-5.89)	$Q = 20.86$	$d \cdot f = 24$

Note: The t values are given in parentheses under each coefficient.
a) For Malaysia and Taiwan both the ΔD and ΔR series were white noise.
b) Since the first differences for International Reserves were found to be white noise no filter was required.

Table 2

***Haugh* Test Results**

Country	$\|K\| = 1$	$\|K\| = 6$	$\|K\| = 12$	$\|K\| = 24$
Malaysia				
S	31.64*	40.68*	44.86*	57.91
S^*	31.65*	41.19*	46.09*	64.675+
Taiwan				
S	36.38*	44.16*	49.42*	77.99*
S^*	36.39*	44.54*	50.63*	85.42*
Mexico				
S	8.37*	14.73	29.64	48.57
S^*	8.40*	15.17	33.03	58.64
India				
S	25.10*	29.07*	37.55+	51.06
S^*	25.15*	29.34*	39.13*	56.67

+ Significant at 0.10 level.
* Significant at 0.05 level.

regressions (4) and (5) contained a constant and a trend in addition to other variables. Since seasonality was observed in the Indian and Mexican data series, monthly dummies were introduced to account for the seasonal patterns.[8]

The values for m and n were set equal to twelve for the countries studied.[9] The *Granger F* statistics are reported in Table 3 and 4. In Table 3, the null hypotheses that $b_j = 0$, for $j \geq 0$ and $d_j = 0$, for $j > 0$ are examined. The

Table 3

***Granger F* Test Results**

Country	$p_j = 0,\ j \geq 0$	$d_j = 0,\ j \geq 0$
Malaysia	3.38* (13,24)	3.16* (13,24)
Taiwan	5.15* (13,61)	3.59* (13,61)
Mexico	3.98* (13,42)	2.8* (13,42)
India	1.85+ (13,49)	3.19* (13,49)

+ Significant at the 0.10 level. Degrees of freedom in parentheses.
* Significant at the 0.05 level. Degrees of freedom in parentheses.

[8] The regression for India also contained a dummy for devaluation of the rupee in June 1966.

[9] The same lag lengths have been examined by *Blejer* (1979) for the *Sims* test and by *Feige* and *Johannes* (1981) for the *Granger* and *Sims*.

Table 4

***Granger* F* Test Results**

Country	$b_j = 0,\ j > 0$	$d_j = 0,\ j > 0$
Malaysia	0.67 (12,24)	0.29 (12,24)
Taiwan	1.84+ (12,61)	0.87 (12,61)
Mexico	2.31* (12,42)	1.70+ (12,42)
India	1.20 (12,49)	1.77+ (12,49)

Note: *Granger** excludes the contemporaneous coefficients.
+ Significant at the 0.10 level. Degrees of freedom in parentheses.
* Significant at the 0.05 level. Degrees of freedom in parentheses.

F statistics are significant at .05 or .10 level in both cases for all countries, implying that causality is bidirectional between ΔR and ΔD.

The contemporaneous coefficients (included in tests in Table 3) were significant in all *Granger* regressions. Hence, it cannot be ascertained whether the relationship between ΔD and ΔR is mainly contemporaneous in nature. In Table 4, therefore the *F* statistics were computed by excluding the contemporaneous coefficients. The results show that causality runs unindirectionally from international reserves to domestic credit for Taiwan, and from domestic credit to international reserves for India. However, for Malaysia while no causality in either direction is observed, in case of Mexico the relationship is bidirectional. If these relationships held instantaneously, then it would seem that in Taiwan, there is either a sterilisation of changes in international reserves or borrowing by the commercial banks of the nature discussed earlier. In Mexico, the relationship appears to be bidirectional. However, in India, an exogenous change in domestic credit causes a change in international reserves. Because it is not possible to empirically determine the direction of causality contained in a contemporaneous relationship the conservative result then is that domestic credit reserve relationship is bidirectional for the four countries.

The *Sims* regressions (6) and (7) were estimated using *Hannan* efficient estimation procedure recommended by Sims (1974) to overcome the problem of serial correlation in the residuals. The results displayed in Table 5 test the hypotheses that all $q_i = 0$, for $i \leq 0$ and all $p_i = 0$ for $i \leq 0$. Since all the *F* statistics are significant, we can reject the null hypotheses that there is no causality at all running from ΔR to ΔD and ΔD to ΔR.

All contemporaneous coefficients in *Sims* regressions were found to be significant. When these coefficients are excluded (Table 6), the results for

Table 5

***Sims F* Test Results**

Country	$q_i = 0,\ i \leq 0$	$p_i = 0,\ i \leq 0$
Malaysia	5.70* (13,12)	8.06* (13,12)
Taiwan	13.56* (13,50)	17.22* (13,50)
Mexico	8.94* (13,42)	7.43* (13,42)
India	5.84* (13,49)	4.64* (13,49)

+ Significant at the 0.10 level Degrees of freedom in parentheses
* Significant at the 0.05 level. Degrees of freedom in parentheses.

Table 6

***Sims* F* Test Results**

Country	$q_i = 0,\ i < 0$	$p_i = 0,\ i < 0$
Malaysia	1.74 (12,12)	1.40 (12,12)
Taiwan	9.95* (12,50)	8.20* (12,50)
Mexico	5.23* (12,42)	3.04* (12,42)
India	2.53* (12,49)	3.02* (12,49)

Note: *Sims** excludes the contemporaneous coefficient.
+ Significant at the 0.10 level. Degrees of freedom in parentheses.
* Significant at the 0.05 level. Degrees of freedom in parentheses.

Malaysia and Mexico are similar to those of *Granger** test. In Taiwan and India, however, bidirectional causality is observed.

The conclusions that follow from these tests are (see Table 7): First, the *Granger* and the *Sims* tests indicate bidirectional relationship between domestic credit and international reserves for all four countries. Second, in all cases, there is a strong contemporaneous relationship between ΔD

Table 7

Comparison of the Tests

Country	*Haugh*	*Granger*	*Granger**	*Sims*	*Sims**
Malysia	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta D - \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta D - \Delta R$
Taiwan	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta R \rightarrow \Delta D$	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$
Mexico	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$
India	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta D \rightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$	$\Delta D \leftrightarrow \Delta R$

and ΔR. Third, exclusion of contemporaneous coefficients (*Granger** and *Sims**) show no causality for Malaysia and biredirectionality for Mexico. However, Granger* and Sims* give conflicting results for India and Taiwan.

V. Concluding Comment

In this paper, the nature of domestic credit/reserve relationship embodied in the MBOP approach was studied for four developing countries, India, Malaysia, Mexico and Taiwan. The results indicate that when instantaneous effects are also considered, the relationship between ΔD and ΔR for all countries is bidirectional. This type of relationship is fully consistent with the MBOP (*Blejer* (1979)). The sterilization and commercial bank scenarios could interact simultaneously with the direction of causality suggested by the MBOP to yield a bidirectional relationship.

Since it is uncertain whether the bidirectional causality is on account of the strong instantaneous effect, the contemporaneous coefficients were excluded in the next run of tests. The results from these tests (*Granger** and *Sims**) were not consistent across all countries. Only for two countries, definite conclusions could be derived. In Malaysia, for instance, the relationship between ΔR and ΔD appears to be essentially contemporaneous. A bidirectional causality is, however, observed for Mexico. The tests failed to resolve the nature of the non-instantaneous relationship in cases of India and Taiwan.

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Zusammenfassung

Der Kausalzusammenhang zwischen inländischem Kredit und internationalen Reserven: die Erfahrungen von Entwicklungsländern

Drei Kausalitätstests und zwar die von *Haugh, Granger* und *Sims* werden herangezogen, um die Art der kausalen Beziehungen zwischen den Komponenten der Geldbasis für Indien, Malaysia, Mexico und Taiwan festzustellen. Die gewonnene Schlußfolgerung lautet, daß eine wechselseitige Kausalität zwischen den Änderungen des inländischen Kredites und den Änderungen der internationalen Reserven besteht.

Summary

Causal Relationship between Domestic Credit and International Reserves: The Experience of Developing Countries

Three causality tests, *Haugh, Granger* and *Sims* are used to determine the nature of causal relationship between the components of monetary base of India, Malaysia, Mexico and Taiwan. The conclusion derived is that bidirectional causality exists between the changes in domestic credit and changes in international reserves for all four countries.

Résumé

La relation causale entre le crédit national et les réserves internationales: l'expérience des pays en voie de développement

Trois tests de causalité, *Haugh, Granger* et *Sims,* sont utilisés pour déterminer la nature de la relation causale entre les composantes de la base monétaire de l'Inde, de la Malaisie, du Mexique et de Taiwan. Des résultats de ces tests, on conclut qu'il existe une causalité réciproque entre les changements dans le crédit national et les changements des réserves internationales. Ceci est vrai pour tous les pays.