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MONEY, THE RATE OF DEVALUATION AND INTEREST RATES IN A SEMI-OPEN ECONOMY: COLOMBIA 1968-1982

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ABSTRACT

In this paper an empirical model for analyzing the behavior of nominal interest rates in a semi-open economy is developed. The model explicitly incorporates both the role of open economy factors (i.e., world interest rates, expected rate of devaluation) and domestic monetary conditions in explaining interest rates movement. The model is tested using quarterly data for Colombia for 1968-1982. The results obtained indicate that the semi-open characterization is adequate for the case of Colombia, and that world interest rates, the rate of devaluation and domestic monetary conditions have affected domestic nominal interest rates during the period under consideration. The results also indicate that unanticipated increases in the nominal quantity of money have exercised a negative effect on nominal interest rates in Colombia.

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I. Introduction

Most empirical studies on interest rates behavior have made extreme assumptions regarding the degree of openness of the economy under consideration. Generally, it has been assumed that the economy in question is either completely closed to the rest of the world, or that it is fully open, and that there are no controls to capital movements. In reality, however, most cases — and especially those of developing countries — correspond to an intermediate situation, where the capital account of the balance of payments is partially open, and there exist some controls to capital movements. Under these circumstances it would be expected that in the short-run the domestic rate of interest will respond both to external factors (i.e., world interest rates) and to internal monetary conditions, (i.e., excess supply or demand for money). The purpose of this paper is to develop an empirical model to analyze the behavior of nominal interest rates in a small semi-open economy. The model specifically considers the role of open economy factors — world rate of interest and expected rate of devaluation, for example —, and the role of more traditional domestic monetary conditions in explaining interest rates behavior.

The model is tested using quarterly data for Colombia for 1968-1982. Colombia is a semi-open economy, with a growing domestic capital market partially integrated to the international financial markets. In that sense, then, the behavior of the interest rate in Colombia cannot be explained by conventional models that assume a fully open or completely closed economy.[1]

The analysis presented in this paper is useful for evaluating two key policy issues that are of great importance in semi-open developing economies. First, the model directly addresses the question of the relationship between the rate of devaluation and the nominal interest rate. The importance of this question stems from the fact that many times the monetary authorities in semi-open developing countries are reluctant to adjust the exchange rate because of the possible effects that this measure will have on domestic interest rates. Second, the model will be useful to determine the effects of changes in monetary policy -- both anticipated and unanticipated — on domestic interest rates. The empirical analysis of the relation between the rate of devaluation and the domestic interest rate is particularly important in the Colombian case, where a crawling peg exchange rate system has been in effect since 1967.[2] Recently, however, a number of observers have pointed out that the real exchange rate is overvalued and have recommended to accelerate the rate of devaluation of the Colombian crawling peg. [See, for example, Fedesarrollo (1983), Ocampo (1983).] The analysis presented in this paper, then, will be useful to determine the effect of a faster rate of crawling on the domestic nominal interest rate.

The paper is organized in the following form: Section II presents an empirical framework for analyzing the determination of nominal interest rates in a small semi-open economy. In Section III empirical results obtained from estimating the model using quarterly data for 1968 through 1982 for Colombia are presented. In Section IV the analysis of the role of monetary factors in determining the behavior of the interest rate in Colombia is taken one step further. In this section the role of actual vs. unanticipated changes in nominal money is investigated. This section also includes a brief discussion on the role of expected inflation in the semi-open economy framework used in this paper. Finally, in Section V some concluding remarks are presented.

II. Money, the Rate of Devaluation, and Interest Rates in a Semi-Open Economy

In a fully open economy, where economic agents are risk neutral and foreign and domestic bonds are perfect substitutes, the internal and external interest rates are linked through the interest parity condition (1) (this ignores taxation, see Levi 1977):

$$i_t = i_t^w + D_t^e \tag{1}$$

where

i_t = domestic nominal interest rate

i_t^w = foreign (world) nominal interest rate, on instruments that have the same maturity as the domestic papers

D_t^e = <u>expected</u> rate of devaluation of the domestic currency between period t and the period corresponding to the maturity of the financial instruments. The subscript t refers to the fact that this expectation is formed in period t. Then, if d_t is the actual rate of devaluation in period t, and the maturity of the financial instruments is one period, $D_t^e = E_t(d_{t+1})$, where E is the expectations operator.

If in the economy in question there are no impediments to capital movements, equation (1) will tend to hold both in the short- and in the long-run. The empirical evidence available suggests that a revised version of equation (1) — which replaces D^e by the forward premium, incorporates transaction costs, and considers off-shore interest rates — holds closely for the case of industrialized countries [see Frenkel and Levich, 1975 and 1977].

In the case of semi-open economies expression (1), however, clearly does not hold. Quite on the contrary, the recent experience of the countries of the cone of South-America (Argentina, Chile, Uruguay) suggests that in semi-industrialized, semi-open economies the divergences from (1) can be substantial. The case of Colombia also shows important deviations from equation (1) [see Blejer and Landau (1984), and Montes and Candelo (1982)].

Equation (1) can be modified in several ways in order to incorporate the fact that we are dealing with a semi-open economy. In particular, it is possible to write an expression that indicates that the domestic interest rate tends to equate the world rate of interest plus the rate of devaluation and a risk premium in the long-run, but that it can differ from it in the short-run. If we denote the risk premium in period t by β_t, equation (1) can then be replaced by the following expression:

$$\Delta i_t = \theta[(i_t^w + D_t^e + \beta_t) - i_{t-1}] \qquad (2)$$

where $0 < \theta < 1$.

Even though equation (2) captures an important characteristic of a semi-open economy — the fact that it takes time for the interest parity condition to hold —, it does not allow for domestic monetary conditions to play any role in the behavior of the domestic interest rate. In a semi-open economy, however, where capital movements are subject to a number of controls, it is conceivable that domestic monetary policy will have some effect on the short-run behavior of the interest rate. The possible role of the conditions prevailing in the domestic money market on interest rate behavior in a semi-open economy can be captured by the following expression:

$$\Delta i_t = \theta[(i_t^w + D_t^e + \beta_t) - i_{t-1}] - \lambda[\log m_{t-1} - \log m_t^d] \qquad (3)$$

where m_t is the real quantity of money in t, and where m_t^d is the quantity of money demanded in that period. This equation differs from equation (2) in that it explicitly allows for internal monetary disequilibria to affect interest rates movements. The parameter λ measures the importance of these disequilibria, and the negative sign reflects the hypothesis that an excess supply (demand) for real money will generate a decline (increase) in the nominal interest rate. An important property of (3) is that the extreme situations of fully open or completely closed economies are particular cases of this expression. If the economy under study is fully open to the rest of the world, we would expect that $\theta = 1.0$ and $\lambda = 0$. If, on the other hand, the economy is completely closed to foreign influences it would be expected that $\theta = 0$ and $\lambda > 0$. In the case of a semi-open economy, however, it would be expected that both θ and λ would be significantly different from zero.

III. Empirical Results

In this section results obtained from the estimation of a reduced form of equation (3) using quarterly data for 1968-1982 for Colombia are presented.[3] In the estimation it is assumed that the expected rate of devaluation of the Colombian peso in period $t+1$, as formed in period t (D_t^e), is equal to the actual rate of devaluation in period t (d_t). This corresponds to the (plausible) assumption that during 1968-1982 the rate of devaluation in Colombia can be represented by a random walk with a zero drift term. In fact, the time series analysis of the rate of devaluation for this period suggests that the random walk with zero drift hypothesis cannot be rejected.[4]

With respect to the risk premium (β_t) it is assumed, in order to simplify the analysis, that it can be represented by a constant k plus a normally distributed random term ε_t with zero mean and variance σ^2, $(\beta_t = k + \varepsilon_t)$.[5] Regarding the demand for money function, it is assumed that it has a conventional form:

$$\log m_t^d = b_o + b_1 \log y_t - b_2 i_t \qquad (4)$$

for y_t = real income.

Combining equations (3) and (4) and using the assumption for the risk premium β_t, the following reduced form is obtained:[6]

$$i_t = \gamma_o + \gamma_1(i_t^w + d_t) + \gamma_2 i_{t-1} + \gamma_3 \log m_t + \gamma_4 \log y_t + \omega_t \qquad (5)$$

where ω_t is an error term, and it is expected that $\gamma_1 > 0$, $\gamma_2 > 0$, $\gamma_3 < 0$ and $\gamma_4 > 0$. The expressions for the γ's in terms of the parameters of the structural equations (3) and (4) are: $\gamma_1 = \theta/(1+\lambda b_2)$; $\gamma_2 = (1-\theta)/(1+\lambda b_2)$; $\gamma_3 = -\lambda/(1+\lambda b_2)$; $\gamma_4 = \lambda b_1/(1+\lambda b_2)$.

Equation (5) was estimated using OLS and instrumental variables methods. The reason for using instrumental variables is that y_t might not be exogenous in a small semi-open economy like Colombia. Table 1 contains the results obtained from the estimation of the reduced form equation (5).

The values of Durbin's h reported in Table 1 indicate that the errors might be negatively correlated. For this reason procedures that correct for serially correlated disturbances were also used. For example, equation (5) was also estimated using the two-stages procedure suggested by Fair (1970) to deal with serial correlation in the presence of a lagged dependent variable. The results obtained show that the estimated first-order correlation coefficient $(\hat{\rho})$ is very small, and that the estimated coefficients reported in Table 1 are not significantly affected:

$$i_t = \underset{(-2.978)}{-1.849} + \underset{(2.043)}{0.380}\,(i_t^w + d_t) + \underset{(2.705)}{0.374}\, i_{t-1} - \underset{(-1.923)}{0.254} \log m_{t-1}$$

$$+ \underset{(3.646)}{0.412} \log y_t \qquad \text{S.E.} = 0.064; \quad \hat{\rho} = -0.06 \qquad (5.3)$$

Table 2 presents the estimated structural coefficients computed from equations (5.1), (5.2) and (5.3). One of the most important results reported in these tables refer to the estimated values of θ. This coefficient, which in all the estimations was statistically significant, measures the speed at which uncovered interest rate differentials will be corrected. As can be seen, $\hat{\theta}$ is fairly high, indicating that, with other things given, in one quarter almost one-half of a unitary discrepancy between $(i_t^w+d_t)$ and i_{t-1} will be corrected. This coefficient suggests, for example, that higher world interest rates will be quickly translated into higher interest rates in Colombia. This seems to have been the case in Colombia during the early 1980's where the higher world interest rates were rapidly reflected domestically.

The results obtained can also be used to simulate the effect of an increase of the rate of devaluation of the crawling peg on the nominal interest rate. This is an important policy question that usually arises in discussions concerning "unwanted" effects of accelerating the rate of devaluation. Consider, for example, the case of equation (5.1), and assume that in period 0 the domestic nominal interest rate is 40% and that the rate of devaluation of the crawling peg is 22% per annum. Assume now that in period 1 the rate of devaluation of the crawling peg is increased to 32%, and maintained at this higher level. In the case where all other variables remain constant, the evolution of the domestic interest rate, using the estimated parameters from equation (5.1), is given in Table 3. As may be seen, these results show a fairly fast speed of adjustment of the domestic interest rate to the higher rate of devaluation of the crawling peg. After one year 6.1 percentage points of the devaluation have already been reflected in the domestic interest rate.[7]

The results reported in equations (5.1), (5.2) and (5.3) also provide information regarding the role of monetary conditions on interest rate behavior. These estimates provide semi-elasticities, of the interest rates with respect to real money ranging from -0.171 to -0.254. In the next section the role of actual vs. unanticipated changes in nominal money on interest rate behavior in Colombia is explicitly investigated.[8]

The estimated equations also provide plausible estimates for the parameters in the demand for money equation in Colombia. As may be seen from Table 2, the estimated long-run income elasticity of the demand for money in Colombia ranges from 1.6 to 1.9. The semi-elasticity of the demand for money relative to the nominal interest rate, on the other hand, ranges from -0.954 to -1.231. These numbers roughly correspond to what has been previously estimated for Colombia [see, Montes and Candelo, 1982].

IV. Unanticipated Money and Interest Rates in Colombia

The analysis presented in the previous section uses actual real money to investigate the relationship between monetary conditions and nominal interest rates in Colombia. Most of the recent work in macroeconomics, however, has emphasized the importance of unexpected monetary shocks as opposed to actual changes in money.[9] In this section the role of unanticipated and actual changes in the nominal quantity of money in explaining the behavior of nominal interest rates in Colombia is investigated. This is done in the following way: First, in equation (5) $\log m_{t-1}$ is replaced by a measure of unexpected nominal money shocks (DMR). And second, in equation (5) $\log m_{t-1}$ is also replaced by the actual rate of growth of nominal money (DMN).

The series for unexpected changes in the nominal quantity of money were constructed as the residuals from the estimation of an autoregressive process of order 7 for changes in the nominal quantity of money. After running this AR process the corresponding residuals were checked to make sure that they were white noise.[10] The results obtained from the estimation of the interest rate equations that include unanticipated and actual nominal monetary shocks are presented in Table 4.

As may be seen the coefficients of DMR_t are significantly negative as expected. Also, as expected, the coefficient of the actual rate of change of nominal money (DMN_t) are non-significantly different from zero. Generally speaking, these results show that while unanticipated changes in the nominal quantity of money have exercised a negative effect on nominal interest rates in Colombia, actual changes in nominal money (with other things equal) have tended to leave interest rates unaffected. Another important result from Table 4 is that the estimated coefficients of $(i_t^w + d_t)$ are not affected by the inclusion of DMR_t. This provides further support to the hypothesis that models of a semi-open economy are appropriate for explaining interest rate behavior in Colombia.

Up to now there has been no mention of the possible role of expected inflation in determining interest rate behavior in Colombia. The reason for this is that in the semi-open economy framework of this paper the traditional role of expected inflation is captured by expected devaluation D_t^e. As long as there is a close relationship between the rate of devaluation and inflation, as it has been the case in Colombia, the expected rate of devaluation will reflect the expectations of inflation.[11] However, in order to test for a possible independent role for the expected rate of inflation, the equations reported in Tables 1 and 4 were also estimated adding a proxy for expected inflation as a possible additional explanatory variables. However, in the results obtained the coefficient for the expected rate of inflation were in all cases very small and insignificant.

V. Concluding Remarks

In this paper an empirical model for analyzing interest rates behavior in a semi-open economy was presented. The model was tested for the case of Colombia using quarterly data for 1968-1982. The results obtained were remarkably good, and indicated that: (a) differentials between domestic nominal interest rates and world interest rates plus expected devaluation and risk premiums will tend to be corrected quite fast. (b) In one year an acceleration of the rate of devaluation of the crawling peg, will be translated in about 60% into a higher domestic rate of interest. (c) An excess supply for real money will exercise significant negative pressures on the nominal interest rate (i.e., there is a liquidity effect). (d) Unanticipated changes in the nominal quantity of money will also exercise a negative presure on nominal interest rates. On the other hand actual increases in the rate of growth of nominal money will leave the rate of interest unaffected.

Footnotes

[1]For a general discussion on the Colombian economy see Diaz-Alejandro (1976) and the various reports published by the World Bank. On the Colombian financial sector see, for example, Jaramillo (1982). On the regulations and controls to capital flows in Colombia see the various issues of the IMF's Annual Report on Exchange Rate Arrangements and Exchange Rate Restrictions.

[2]For descriptions of Colombia's exchange rate policies see, for example, Diaz-Alejandro (1976) and Wiesner (1978).

[3]During 1968-1982 the Colombian capital market has become increasingly dyanmic. The data on interest rates used in this study corresponds to the non-regulated (i.e., free) sector of the Colombian capital market (see Montes and Candelo, 1982). The empirical analysis presented here was also performed for different subperiods. The results obtained in these cases — available from the author upon request -- did not affect the conclusions reached in this paper.

[4]If the rate of devaluation follows a random walk with zero drift, $d_t = d_{t-1} + w_t$, where w_t is white noise. Then $D^e_t = E_t(d_{t+1}) = d_t$. The following result was obtained from the estimation of an AR representation for the rate of devaluation in Colombia using quarterly data from 1968-1982 (t-statistics in parenthesis).

$$d_t = \underset{(15.318)}{0.928}\, d_{t-1} + \underset{(0.010)}{0.001} d_{t-2}, \quad \text{D.W.} = 2.02$$

Notice that while the assumption of d_t following a random walk is appropriate for Colombia, it may be inadequate for other developing semi-open economies. Specifically it is possible that other developing economies are subject to the so-called "peso-problem".

[5]From a theoretical perspective the risk premium β_t will depend on variables like the stocks of outside government assets. Empirical studies on the subject, however, have generally failed to find this kind of relationship (see, for example, Frankel 1982). For this reason in this paper a more simple approach has been taken with respect to the representation of β_t.

[6]An important property of equation (3) is that even in the long-run the domestic rate of interest will <u>not</u> be necessarily equal to the world interest rate plus the rate of devaluation. In fact, according to (3) and the assumptions regarding D_t^e and β_t, in the long-run the domestic interest rate will be equal to:

$$i_t = (i_t^w + d_t) + [k + \varepsilon_t + w_t].$$

[7]An alternative exercise that can be performed is to simulate the effect of a higher rate of devaluation of the crawling peg under the assumption that $[\log m_{t-1} - \log m_t^d]$ remains constant. In this case, of course, the adjustment of the domestic interest rate is much faster. For example, for the numbers used in the exercise reported in Table 3, after one year the domestic nominal interest rate will be equal to 49.2%.

[8]An important characteristic of equation (3) is that it implies that in the long-run, for given i_t^w and d_t, changes in the real quantity of money will not affect i_t. Since this is a fairly strong implication, regressions that incorporated up to 12 lags of $\log m$ were also run. The results obtained show that only the contemporaneous and once lagged coefficients are significantly negative. Starting with $\log m_{t-2}$ the coefficients become positive. The sum of the 12 coefficients is not significantly different from zero (−0.171 with a standard error of 0.474.) It should be noticed, however, that in a more complete model that allows for a variable risk premium (β_t), changes in the real quantity of money could affect i in the long-run,

through its possible effect on β_t. As mentioned, however, at the present time the empirical analysis of the determinants of the exchange rate risk premium is an unresolved issue (see Frankel 1982).

[9]On the relation between unexpected monetary shocks and real output in Colombia see Hanson (1980) and Edwards (1983). Most previous empirical studies have not found a clearcut relationship between unanticipated nominal money growth and interest rates. See, for example, Darby and Stockman (1983) for a study of the OECD countries.

[10]An AR(7) was chosen to represent DMN_t becuase it was the lower order autoregressive process that generated white-noise residuals.

[11]In their recent article Montes and Candelo (1982) found a coefficient of 0.974 in an equation that relates the rate of devaluation to domestic inflation in Colombia during 1968-1980. Besides the equations reported in Table 4, equations that included both $\log m_{t-1}$ and DMR_t were run. In those cases the coefficients of DMR_t were also significantly negative.

Data Appendix

(a) For 1968-1980 all the data, except world interest rates were taken from Montes and Candelo (1982).

(b) The U.S. three month treasury bill interest rates were used as a proxy for "world" interest rates. The data for 1968-1982 was obtained from the International Financial Statistics.

(c) The data for the Colombian variables for 1981-1982 is compatible with the Montes and Candelo (1982) data and was provided by the Departamento Nacional de Planeacion.

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Table 1

Nominal Interest Rates Behavior in Colombia

Quarterly Data 1968-1982. Reduced Form Estimates

	Eq. (5.1) Ordinary Least Squares	Eq. (5.2) Instrumental Variables
Constant	-0.610	-0.629
	(-2.555)	(-2.623)
$(i_t^w+d_t)$	0.360	0.351
	(2.033)	(1.987)
i_{t-1}	0.430	0.391
	(3.329)	(2.968)
log m_{t-1}	-0.171	-0.240
	(-1.254)	(-1.980)
log y_t	0.324	0.388
	(3.174)	(3.557)
S.E.	0.063	0.063
Durbin's h	-3.14	-3.51

Notes: The numbers in parentheses are t-statistics. S.E. is the standard error of the regression. The following instruments were used in the estimation of (5.2): a constant, time, lagged (i_t+d_t), lagged and twice lagged real income, lagged i and lagged real money. See the Appendix for a description of the data and of the sources used.

Table 2

Estimated Structural Parameters

From Interest Rates Equations For Colombia

Equation	θ	λ	b_1	b_2
(5.1)	0.455	0.217	1.896	1.231
(5.2)	0.473	0.323	1.619	1.077
(5.3)	0.493	0.311	1.756	0.954

Table 3

Simulation Of The Effect Of A Higher Rate Of Devaluation

Of The Crawling Peg On The Domestic Interest Rate

[Equation (5.1)]

Quarter	Rate of Devaluation	Nominal Domestic Interest Rate
0	22%	40.0%
1	32%	43.6%
2	32%	45.1%
3	32%	45.8%
4	32%	46.1%

Table 4

Unanticipated and Actual Changes in

Nominal Money and Interest Rates in Colombia

	Eq. (5.4) Ordinary Least-Squares	Eq. (5.5) Instrumental Variables	Eq. (5.6) Ordinary Least-Squares	Eq. (5.7) Instrumental Variables
Constant	-1.013 (-4.028)	-1.102 (-4.272)	-1.002 (-3.773)	-1.084 (-3.980)
$(i_t^w + d_t)$	0.434 (2.412)	0.445 (2.464)	0.487 (2.559)	0.505 (2.626)
i_{t-1}	0.384 (2.870)	0.351 (2.593)	0.361 (2.543)	0.329 (2.283)
$\log y_t$	0.292 (4.110)	0.317 (4.353)	0.290 (3.857)	0.314 (4.066)
DMR_t	-0.675 (-2.418)	-0.686 (-2.454)	-	-
DMN_t	-	-	-0.179 (-1.154)	-0.233 (-1.102)
S.E.	0.062	0.062	0.065	0.065
h[D.W.][a]	-3.20	-3.40	[2.17]	[2.13]

[a]In equations (5.6) and (5.7) the biased D.W. statistic is reported, since Durbin's h is imaginary.

Notes: See Table 1.