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COMMODITY EXPORT PRICES AND THE REAL EXCHANGE RATE IN DEVELOPING COUNTRIES: COFFEE IN COLOMBIA

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ABSTRACT

In this paper a model that analyzes the interaction between changes in commodity export prices, money creation, inflation, and the real exchange rate in a developing country is developed. The model is then tested using data for Colombia. A number of experts have argued that the fluctuations of Colombia's real exchange rate have been mainly determined by world coffee price changes, with more observers emphasizing the consequences of coffee price changes on money creation and inflation. The results obtained indicate that coffee price changes have indeed been closely related to money creation and inflation. Also, coffee price changes have been negatively related to the rate of devaluation of the crawling peg. These results indicate that in Colombia, the real appreciation resulting from coffee price increases has been accommodated, partially by money creation and partially by an adjustment in the nominal exchange rate.

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COMMODITY EXPORT PRICES AND THE REAL EXCHANGE RATE IN DEVELOPING COUNTRIES: COFFEE IN COLOMBIA

by

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I. INTRODUCTION

Changes in commodity export prices will generally have an important effect on real exchange rate behavior. Under most conditions, a commodity export boom will result in a real appreciation of the domestic currency, with the extent of this appreciation depending, among other things, on whether the change in export prices is perceived as being temporary or permanent. Most recent work on the interaction between commodity export prices and real exchange rates has focused on the long-run real effects of changes in export prices, analyzing how resource-based export booms will affect the real exchange rate, wages, employment and output in the long run. [1] However, changes in commodity export prices can also have important short-run monetary effects, which will spill over to the real exchange rate. For example, a resource-based export boom will typically result in a balance of payments surplus and in the accumulation of international reserves. If this increase in reserves is not fully sterilized, the monetary base will increase, and inflation will tend to result. This increase in the price level will, in general, be one of the mechanisms through which the real appreciation will actually take place. It is possible, however, that the short-run increase in

the rate of inflation exceeds what is required to bring about the equilibrium real appreciation generated by the export boom; in this case, the real exchange rate will appreciate in the short run by more than what real factors only would indicate. [2] These short-run monetary effects of commodity export booms have recently been important in a number of developing countries, including Indonesia, Kenya and Colombia.

In spite of the importance of understanding the mechanisms through which changes in commodity export prices are transmitted into real exchange rate changes, very few empirical studies have tackled this subject. [3] In this paper a model that analyzes the interaction between commodity export prices, money creation, inflation and the real exchange rate is developed and tested. The empirical analysis focuses on the effects of changes in coffee prices on the real exchange rate in Colombia. A number of experts have argued that fluctuations in Colombia's real exchange rate have been mainly determined by world coffee price movements, with most observers emphasizing the consequences of coffee price changes on money creation and inflation. Since 1967, Colombia has had a crawling peg exchange rate system, where the rate of devaluation of the peso is determined according to the behavior of a set of indicators, which, presumably, includes the world price of coffee. Also, for a long time Colombian authorities have tried to implement policies aimed at reducing the effects of (temporary) changes in coffee prices on the real exchange rate. [4]

The paper is organized in the following form. In Section II, the behavior of the real exchange rate and coffee prices in Colombia is briefly reviewed. In Section III, a model that explicitly takes into account the monetary and inflationary impacts of coffee price movements is presented and

estimated. The model also includes an equation for the rate of adjustment of the nominal exchange rate, or rate of crawl. The results reported in that section indicate that changes in (world) coffee prices have been positively related to money creation and inflation, and negatively associated with the rate of devaluation of the nominal exchange rate in Colombia. In Section IV, some concluding remarks are presented. It is argued in this section that the approach taken in this paper is useful for analyzing other cases where commodity export prices and the real exchange rate have been closely related.

II. COFFEE AND THE REAL EXCHANGE RATE IN COLOMBIA: AN OVERVIEW

The performance of the Colombian economy has been traditionally linked to the behavior of the world coffee market. [5] A number of authors have argued that changes in the world price of coffee have been transmitted into Colombia mainly through the effect that they have on the real exchange rate. (Weisner 1978, Urrutia 1981, World Bank 1984.) Increases (decreases) in the world price of coffee have generated real appreciations (depreciations) of the Colombian peso. These variations in the real exchange rate, in turn, have affected the degree of competitiveness of the non-coffee tradables sectors, with a real appreciation generating losses of competitiveness or exchange rate deprotection. For example, the recent coffee bonanza of 1975-1979 resulted in a sharp real appreciation, which negatively affected the ability of the domestic sector to compete in international markets. Earlier episodes of sharp increases in the price of coffee (1950, 1954 and 1956, for example) have also been related to steep appreciations of the peso (Weisner 1978, World Bank 1984.). In Table 1, data on real exchange rates, coffee prices, and terms of trade in Colombia between 1952 and 1982 are presented. Table 2, on the other

Table 1. COFFEE PRICES, RATE OF DEVALUATION AND THE REAL EXCHANGE RATE IN COLOMBIA: 1952-1982 (1980=100)

Year	(A) Real Price of Coffee	(B) Terms of Trade	(C) Effective Real Exchange Rate	(D) Bilateral Real Exchange Rate with Respect to US Dollar
1952	75.94	-	47.11	62.20
1953	83.08	-	44.21	57.14
1954	110.82	-	40.88	52.70
1955	87.32	-	41.66	53.28
1956	98.53	87.65	39.95	51.65
1957	79.19	84.89	47.74	69.80
1958	71.40	72.18	81.40	104.08
1959	61.21	60.97	76.40	97.27
1960	61.55	63.04	77.23	97.23
1961	59.04	61.63	73.45	90.03
1962	56.91	57.80	75.82	91.50
1963	56.35	52.28	76.81	89.35
1964	70.35	63.21	65.96	76.11
1965	76.39	64.40	73.72	87.28
1966	73.14	51.15	84.97	96.97
1967	62.64	60.21	86.46	96.56
1968	64.34	62.01	94.17	104.99
1969	66.89	61.57	95.09	105.29
1970	83.40	75.02	100.84	108.79
1971	71.00	70.11	106.50	111.34
1972	75.72	73.71	111.81	112.48
1973	83.51	78.49	113.18	113.88
1974	69.60	81.92	111.10	120.10
1975	68.41	75.76	119.85	126.65
1976	126.49	106.29	116.11	123.63
1977	181.95	147.45	101.04	104.52
1978	125.29	110.06	102.85	101.67
1979	112.47	98.38	101.29	99.89
1980	100.00	100.00	100.00	100.00
1981	67.52	84.36	91.62	95.16
1982	72.34	81.87	87.56	98.99

Notes: The real price of coffee is defined as the US$ coffee price deflated by the US$ import price index. The effective exchange rate was computed using trade weights and taking into account Colombia's ten major trade partners. The partners (and weights) are: US (0.507); UK (0.047); France (0.037); Germany (0.163); Italy (0.033); Netherlands (0.044); Japan (0.058); Sweden (0.032); Spain (0.035); and Venezuela (0.045). According to the definitions of real exchange rate used in this paper an increase in the index reflects a real depreciation, whereas a decline in the index represents a real appreciation. The raw data were taken from the IFS.

Table 2. RATE OF DEVALUATION, MONEY, INTERNATIONAL RESERVES AND INFLATION IN COLOMBIA: 1968-1982

	(A) Rate of Devaluation (%)	(B) Rate of Growth of High-Powered Money (%)	(C) Rate of Growth of International Reserves (US $) (%)	(D) Rate of Inflation (%)	(E) Real Price of Coffee (1980=100)
1968	12.3	23.9	-	5.7	64.3
1969	6.3	25.7	37.3	9.6	66.9
1970	6.5	19.1	-3.1	6.5	83.4
1971	8.1	12.9	-0.5	7.8	71.0
1972	9.7	16.5	64.0	12.6	75.7
1973	8.1	24.3	67.0	18.9	83.5
1974	10.3	22.8	-16.5	21.6	69.6
1973	18.7	21.2	10.2	20.7	68.4
1976	12.2	29.6	131.8	18.4	126.5
1977	6.0	34.2	58.7	28.6	182.0
1978	6.3	39.7	35.4	16.3	123.5
1979	8.8	33.0	62.5	22.1	112.5
1980	11.1	25.5	25.7	23.5	100.0
1981	15.3	23.5	-0.6	24.3	67.5
1982	17.6	18.4	-19.6	24.5	72.3

Sources: Columns (A) through (D): IFS; Column (E): Table 1.

hand, contains data on money creation, international reserves growth, the rate of devaluation and inflation for 1968-1982. In Figures 1 and 2, two alternative indexes of the real exchange rate and coffee prices are depicted.

In principle, changes in the price of coffee will affect the real exchange rate through at least two channels. First, an increase in the price of coffee will result in a higher disposable income, and in an increase in the demand for tradable and nontradable goods. To the extent that the price of other (non-coffee) tradables is given by their world price and the exchange rate, this income effect will result in a higher relative price of non-tradables, and in a real appreciation of the peso. Second, and more important in the Colombian case, an increase in the price of coffee will tend to generate a balance of payments surplus, and an accumulation of international reserves. If this increase in international reserves is not fully sterilized, the monetary base will also increase, and inflation will tend to result with the consequent further appreciation of the peso. [6] For example, as the data in Table 2 show, the 1975-79 coffee bonanza generated a steep increase in international reserve holdings and in money creation. Regarding this particular (1975-79) episode, Urrutia (1981) has said:

> "The increase in coffee prices started to produce increases in money supply which were... not neutralized rapidly enough ... But by 1976 all conceivable measures were taken to restrict money supply growth and to compensate for the growth in the monetary base caused by the growth in international reserves... All these measures, however, were insufficient, and money supply increased by 34.7 percent." (page 217).

Since World War II, the Colombian authorities have tried to use several schemes to reduce the impact of changes in coffee prices on the real exchange rate and on the rest of the economy. The main objective of the government during this period has been to reduce the undesirable short-run effects that temporary changes in coffee prices have on the degree of profitability, production and employment in the rest of the economy. [7] For many years returns from coffee exports have been subject to a lower net rate of exchange. Also, in the past, the degree of import protection was altered depending on the behavior of coffee prices; it was reduced as a consequence of increases in the price of coffee, and raised when the world price of coffee declined. In addition, several monetary measures -- including steep increases in the banking system reserves requirements -- have been implemented when the price of coffee has risen. For example, during the 1975-79 coffee bonanza, a novel mechanism, supposedly to reduce the monetary impact of the higher coffee price, was implemented. In 1977, the maturity of the certificates of exchange -- which are government certificates received by exporters when they surrender their foreign exchange -- was significantly lengthened. In that way, the monetary effect of the coffee boom was delayed, but not avoided. [8] (Weisner 1978.)

Many experts have indicated that the adoption of a crawling peg system in 1967 responded to the need to reduce the dependence of the real exchange rate on coffee prices fluctuations. (Weisner, 1978, Urrutia, 1981, Ocampo, 1983.) However, since the inception of the crawling peg system, the decision on the rate at which the peso should be devalued has been highly influenced by coffee prices. For example, according to Weisner (1978), once the crawling peg was adopted, one of the main problems was to decide "at what

Figure 1

REAL AND REAL EFFECTIVE EXCHANGE RATES
IN COLOMBIA: 1948-83

(1980=100)

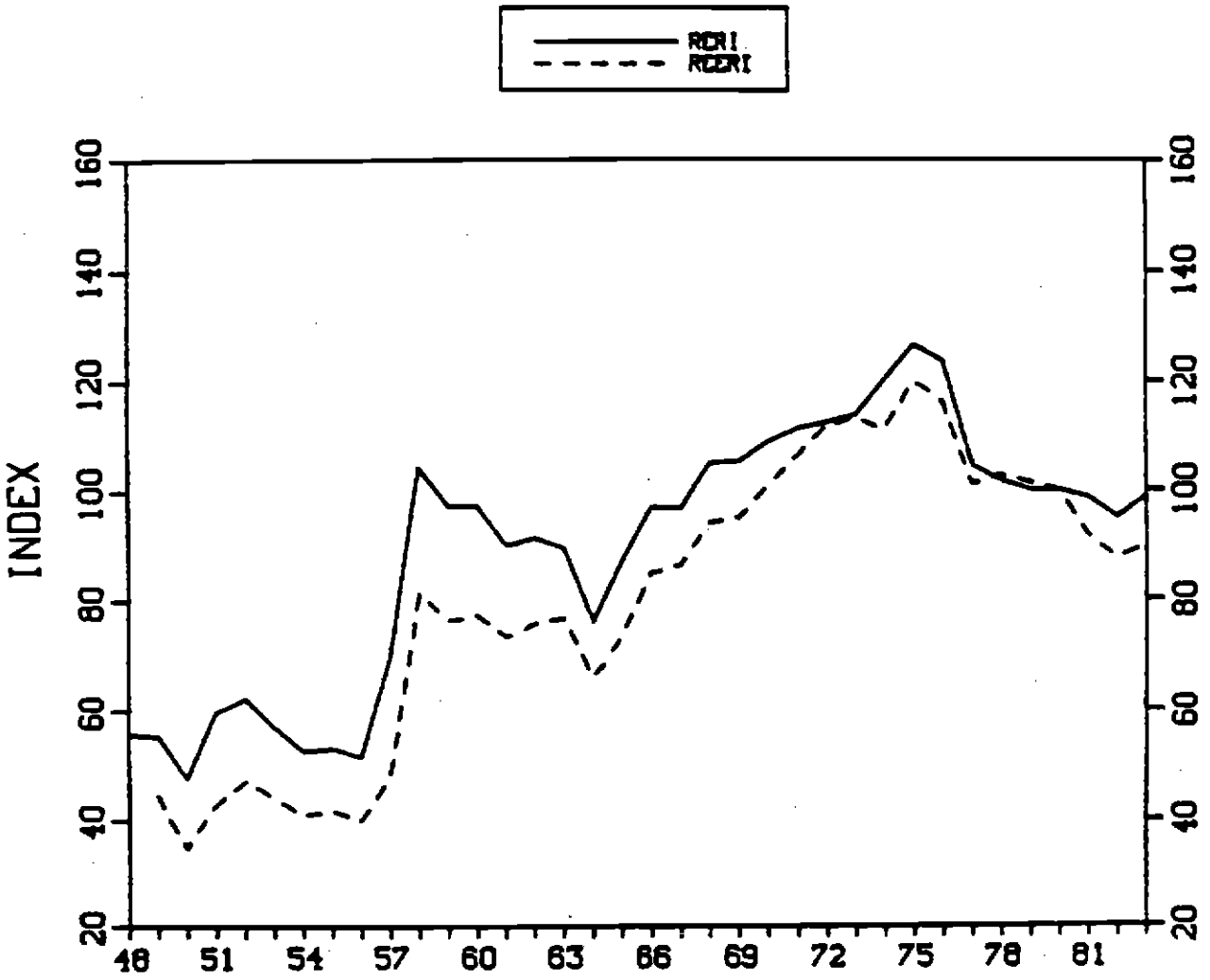
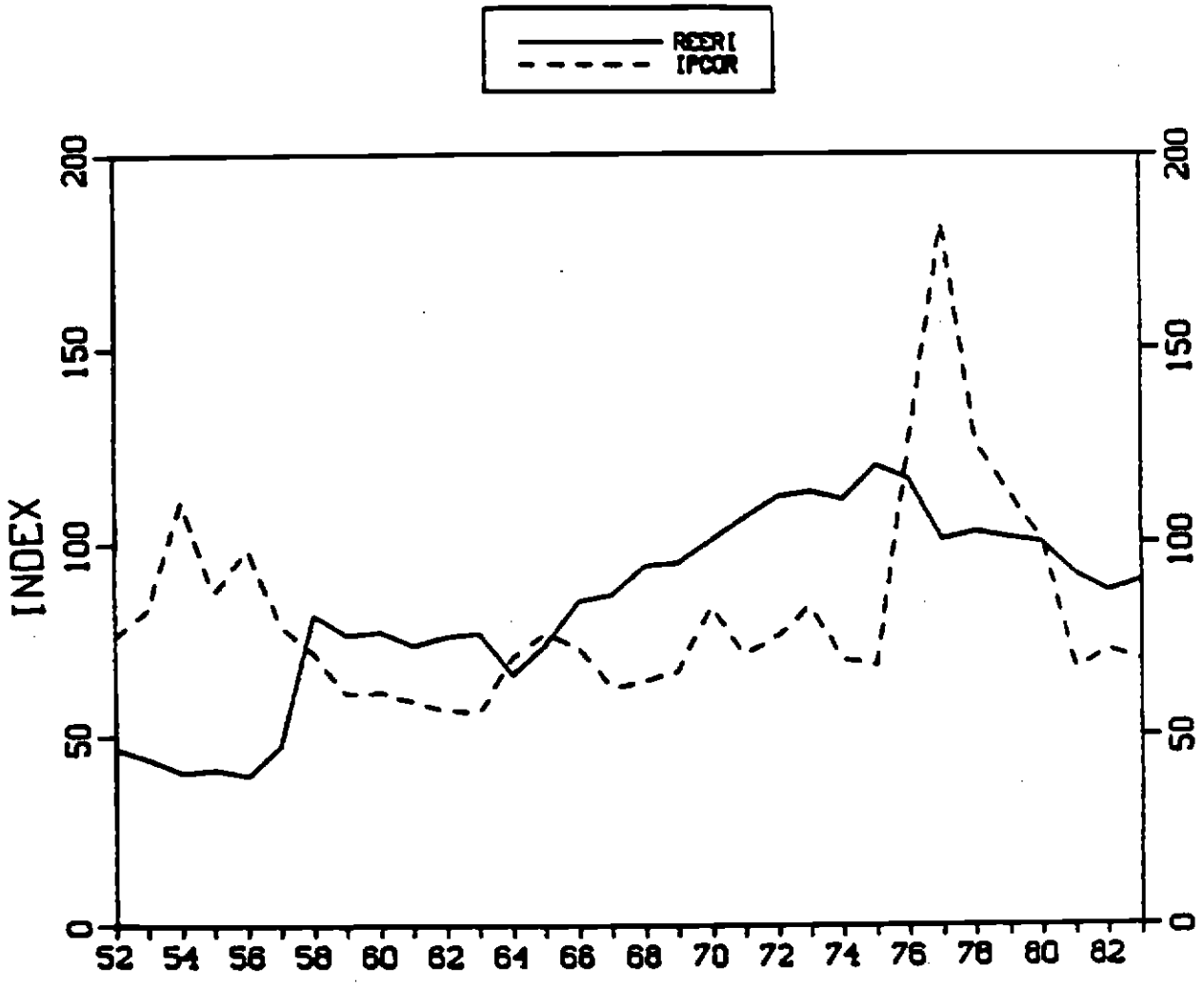


Figure 2

REAL EXCHANGE RATE AND REAL PRICE OF COFFEE: 1952-83

(1980=100)



pace to devalue when coffee prices rise" (page 203). This problem has been compounded by the existence of a trade-off between the rate of nominal devaluation and inflation. In practice there has been an inverse relationship between the rate of devaluation of the peg and coffee prices. This relation can be seen in Table 2. The high coffee prices of 1976-79, for example, were accompanied by a significant slow-down of the rate of devaluation; when the price of coffee began to fall in 1980-82, the rate of the crawl was rapidly accelerated. This inverse relationship between world coffee prices and the nominal rate of devaluation constitutes another mechanism -- in addition to the money creation inflationary effect -- through which higher (lower) coffee prices have been translated into a lower (higher) real exchange rate.

Even though these measures -- changes in the level of protection, variations in maturity of the exchange certificates, and so on -- have helped reduce the degree of volatility of the real exchange rate, they have not eliminated its close dependence on the price of coffee. However, since coffee prices are not the only determinants of the real exchange rate, during some periods its movement has mainly responded to other variables. For example, between 1968 and 1973, changes in the real exchange rate were to a large extent the result of the reduction of the degree of import protection and of the imposition of an export promotion scheme. (Diaz-Alejandro, 1976.) The opening-up of the Colombian economy carried out during this period resulted in a smooth real depreciation of the peso.

III. COFFEE, MONEY, INFLATION AND THE REAL EXCHANGE RATE IN COLOMBIA

In this section, a model that can be used to analyze the way in which coffee prices, money creation, inflation and the real exchange rate interact is presented and estimated. A central purpose of the model is to formally test whether, as it has been casually discussed by a number of authors, changes in coffee prices have indeed been related to money creation and inflation in Colombia. Also, the extent to which the manipulation of the rate of devaluation of the exchange rate has responded to coffee price changes is empirically investigated. The model is quite simple and its structure allows us to concentrate on the problem at hand without being sidetracked into other issues. An obvious cost of this strategy is that the adoption of such a simple structure results in the necessity of imposing some simplifying assumptions.

III.1 The Model

The model concentrates on the effects of changes in (world) coffee prices on money creation, inflation and exchange rate adjustment. The model, presented in equations (1) through (11), assumes that there are three goods in the economy -- coffee (c), nontradables (N) and other (i.e., non-coffee) tradables (T). It is also assumed that, as it has been the case in Colombia since 1967, this economy has a crawling peg exchange rate system, where the nominal exchange rate is adjusted periodically according to the behavior of a set of indicators. Regarding the capital account, it is assumed that due to the existence of capital controls it is exogenously given.

$$\hat{M}_t = \omega \hat{R}_t + (1-\omega) \hat{C}_t \quad (1)$$

$$\hat{C}_t = c_o + \phi DEH_t + z_t \quad (2)$$

$$\hat{R}_t = \theta [\hat{M}^d_t - \hat{M}_{t-1}] + \psi \hat{P}^c_t \quad (3)$$

$$\hat{M}^d_t = \hat{P}_t + \eta \hat{y}_t \quad (4)$$

$$\hat{P}_t = (1-\delta) \hat{P}_{Nt} + \delta \hat{P}_{Tt} \quad (5)$$

$$\hat{P}_{Tt} = \hat{E}_t + \hat{P}^*_{Tt} \quad (6)$$

$$\hat{P}^c_t = \hat{E}_t + \hat{P}^{c*}_t \quad (7)$$

$$\hat{P}_{Nt} = \hat{P}_{Tt} + \lambda[\hat{M}_t - \hat{M}^d_t] + \rho \hat{y}_t \quad (8)$$

$$\hat{E}_t = \gamma_o \hat{P}_t - \gamma_1 \hat{P}^{c*}_t - \gamma_2 \hat{y}_t - \gamma_3 \hat{P}^*_{Tt} + \gamma_4 x_t \quad (9)$$

$$\hat{y}_t = g_t + \tau(\hat{P}^{c*}_t - \hat{P}^*_{Tt}) \quad (10)$$

$$e_t = (E_t P^*_{Tt})/P_t \quad (11)$$

As usual, the "hat" operator (^) denotes percentage change. The following notation is used:

$\hat{M}_t$ = rate of growth of nominal money in period t

$\hat{R}$ = rate of change of international reserves (in pesos)

$\hat{C}$ = rate of change of domestic credit

DEH_t = Fiscal deficit in t as a proportion of the stock of high powered money in t-1

P^c = domestic price of coffee

E = nominal exchange rate, defined as units of domestic currency per unit of foreign currency

y_t = real income in t

P = domestic price level

P_T = domestic price of tradables

P_N = price of nontradables

P_T^* = world price of tradables

P_t^{c*} = world price of coffee

$\hat{P}_T^*$ = world rate of inflation

z_t = other variables influencing domestic credit policy

x_t = other variables influencing the rate of devaluation of the crawling peg

e = real exchange rate.

And where ω, ϕ, θ, ψ, η, δ, λ, ρ, τ and γ are parameters.

Equations (1) through (4) represent the monetary side of this simple model. Equation (1) states that the percentage change in the nominal quantity of money is a weighted average of the rate of growth of domestic credit and of international reserves. Equation (2) gives the rate of growth of domestic credit. It is assumed that, as has been the case in Colombia since World War II, domestic credit creation is closely linked to the fiscal deficit. (Weisner 1978, Edwards 1983, World Bank 1983, 1984.) With respect to the deficit it is assumed, in this version of the model, that it is exogenous. This, however, is not the most appropriate assumption for the case of Colombia, where there is some evidence that the deficit and the price of coffee have been negatively related; lower coffee prices have usually resulted in larger deficits, stemming (partially) from an increase in the

government's financial assistance to coffee growers. [9] It is also assumed that domestic monetary policy can be influenced by other factors besides the fiscal deficit. These factors are summarized by the term z_t. Equation (3) depicts the behavior through time of international reserves. According to this expression, reserves movements respond to two elements. First, an excess (flow) demand or supply for money will be (partially) reflected in accumulation or decumulation of reserves. Second, changes in the (domestic) price of coffee in period t will be translated, in the same period, into corresponding changes in reserves. [10] The novelty of this formulation is that, contrary to most monetary models of open economies, it explicitly allows for international reserves shocks to be a source of money creation in the short run. In the long run, however, $\hat{P}^c_t = 0$ and $\hat{M}^d_t = \hat{M}_t = \hat{M}_{t-1}$, reserves will not change (i.e., $\hat{R}_t = 0$) . Equation (4) presents the rate of change of the nominal quantity of money demanded, where for simplicity it is assumed that the real demand for money is a function of real income only. This assumption, however, is relaxed below where the expected rate of inflation is also included as an argument in the demand for money equation. [11] η is the elasticity of the (real) demand for money with respect to real income. Combining equations (1) through (4), the following equation for the rate of growth of money in period t is obtained:

$$\hat{M}_t = -\omega\theta\, \hat{M}_{t-1} + \omega\theta\, \hat{P}_t + \omega\theta\eta\, \hat{y}_t + \omega\psi\, \hat{P}^c_t + (1-\omega)\, \hat{C}_t \qquad (12)$$

Since ω and θ are smaller than one but positive, the convergence of (12) will be oscillatory. According to equation (12), then, a positive coffee price shock (i.e., $\hat{P}^c_t > 0$) will result in a short-run increase in the

rate of growth of money. However, it is easy to verify from this equation that in the steady state (i.e., when $\hat{M}_t = \hat{M}_{t-1}$ and $\hat{P}^c_t = 0$) this economy will reach monetary equilibrium: $\hat{M}_t = (1-\omega)\,\hat{C}_t = \hat{M}^d_t$.

Equations (5), (6) and (8) form the inflation block. According to (5), the domestic rate of inflation is a weighted average of the rate of change of tradables and nontradable domestic prices; this equation assumes that the price of coffee is not included in the price level. According to equation (6), the rate of change of the domestic price of non-coffee tradables is equal to the rate of devaluation plus the world rate of tradables inflation. Equation (8), on the other hand, states that the rate of change of the price of nontradables will depend on the rate of change in the price of tradables, on changes in real income, and, in the short run on the excess flow supply for nominal money in period t. [12] Combining (4), (5), (6) and (8) the following expression for the rate of inflation is obtained:

$$\hat{P}_t = \frac{(1-\delta)\lambda}{1+\lambda(1-\delta)}\,\hat{M}_t + \frac{1}{1+\lambda(1-\delta)}\,(\hat{E}_t + \hat{P}^*_{Tt}) - \frac{(1-\delta)(\lambda\eta-\rho)}{1+\lambda(1-\delta)}\,\hat{y}_t \qquad (13)$$

Notice that in equation (13) the coefficients of nominal money creation and peso denominated world inflation $(\hat{E} + \hat{P}^*_{Tt})$ add up to one. On the other hand, the coefficient of real income growth can be either negative or positive, depending on whether $\lambda\eta \gtrless \delta$.

Equation (9) is the rule of adjustment of the nominal exchange rate, or rule of crawl. It is assumed that the rate of devaluation in period t will depend on the rates of domestic and foreign inflation, on the rate of growth of real income, on the world price of coffee and on other variables, like commercial policies, captured by x_t. The values of the γs parameters will determine the type of crawl rule chosen by the authorities. If $\gamma_0 = 1$,

$\gamma_3 = -1$ and $\gamma_2 = \gamma_1 = \gamma_4 = 0$, equation (9) becomes a strict PPP rule of crawl. It will be assumed in this paper that $0 \leq \gamma_0 \leq 1$. If $\gamma_1 = 0$, the authorities don't take into account the behavior of world coffee prices to determine the rate of the crawl. On the contrary, a positive γ_1 means that the authorities recognize the effect of changes in coffee prices on the real exchange rate, and try to (partially) accommodate them through adjustments in the nominal exchange rate. Since growth in real income will generate (through equation (8)) a positive pressure on the price of nontradables, $\hat{y}_t$ has been incorporated in equation (9) as a possible determinant of the rate of the crawl. In this way, the government is allowed to accommodate the real appreciation resulting from higher growth through the manipulation of the rate of devaluation. Equation (10) is the rate of growth of real income, and it is formed of two components: a term that is independent from world coffee prices behavior (g_t) and a term that depends on coffee prices -- $\tau(\hat{P}^{c*}_t - \hat{P}^{*}_{Tt})$. An increase in the world real price of coffee generates a higher real income. Finally, equation (11) is the definition of the real exchange rate. This particular definition of e has been chosen, since it has a close empirical counterpart. Alternatively, the real exchange rate could be defined as $(E_t P^{*}_{Tt}/P_{Nt})$. All the qualitative effects discussed in this section will also hold for this definition of the real exchange rate.

The model works in the following way. An increase in the (real) world price of coffee results in higher real income (through equation (10), and in an increased demand for nontradables. This higher demand, in its turn, affects, through equation (8), the relative price of nontradables. This is the <u>spending</u> effect of a commodity export boom. (Corden 1982, Edwards and Aoki 1983.) Independently of monetary or nominal exchange rate behavior, the

higher price of coffee generates a real appreciation. Let's turn now to the money side. The higher price of coffee, with its resulting higher real income and price of nontradables, affects both the demand and the supply for money. From equation (4), a higher demand for nominal (and real) money will result. According to equations (3) and (1), however, after the export boom, the rate of growth of money creation will also be higher. Depending on the value of the parameters involved, a higher price of coffee can result in either an excess flow supply or demand for money. The more plausible case of a resulting excess supply for money will be considered here. Through (8), this excess supply of money will impact the nominal price of nontradables, further appreciating the real exchange rate. [13] What is the role of the rule of crawl in this story? Two things will happen according to equation (9). First, as a result of the higher coffee price, the rate of the crawl will be slowed down in period t, helping to accommodate the real appreciation generated by the spending effect. This will happen through two channels: $-\gamma_1 \hat{P}^{c*}_t$ and $-\gamma_2 \tau \hat{P}^{c*}_t$. Second, there will be a tendency to (partially) compensate the nominal exchange rate for the higher rate of inflation, through $\gamma_0 \hat{P}_t$. The final effect will be a real appreciation resulting, partially, from the slowing down of the rate of the crawl and partially from higher inflation. If the liquidity or money creation effect generated by the higher price of coffee is large enough, the real appreciation can be larger in the short run than in the long run.

Equations (9), (12) and (13) can be solved for $\hat{M}_t$, $\hat{P}_t$ and $\hat{E}_t$ in terms of exogenous variables only. These solutions can then be combined with $\hat{P}^*_{Tt}$ to formally find the reduced form for the actual rate of change in the real exchange rate. An interesting property of this model is that under an

appropriate parameterization, it can generate time paths of the different variables that closely resemble what is observed. Under the simplifying assumptions that $\hat{P}^{*}_{Tt} = 0$, $z_t = 0$, and $\gamma_4 = 0$ the following expression for the actual change in the real exchange rate in period t is obtained:[14] (the reduced forms for $\hat{M}_t$, $\hat{P}_t$ and $\hat{E}_t$ are provided in Appendix I.)

$$\hat{e}_t = -\beta_o\pi_1(\gamma_o-1)\Delta^{-1}\hat{M}_{t-1} + \beta_o\pi_6(\gamma_o-1)\Delta^{-1}\,DEH_t$$

$$-A_1 g_t - [A_1 + A_2]\hat{P}^{c*}_t \qquad (14)$$

where

$$A_1 = [\gamma_2(1-\beta_0(\pi_2+\pi_4)-\beta_1)+\beta_2(\gamma_0-1)+\beta_0\pi_3(1-\gamma_0)]\Delta^{-1}$$

$$A_2 = [\gamma_1(1-\beta_0\pi_2)+\beta_0\pi_4(1-\gamma_0)-\gamma_1(\beta_1+\beta_0\pi_5)]\Delta^{-1}$$

and

$$\beta_o = \frac{(1-\delta)\lambda}{1+\lambda(1-\delta)} \quad ; \quad \beta_1 = \frac{1}{1+\lambda(1-\delta)}$$

$$\beta_2 = \frac{(1-\delta)(\lambda\eta-\rho)}{1+\lambda(1-\delta)} \quad ; \quad \pi_1 = \omega\theta$$

$$\pi_2 = \omega\theta \quad ; \quad \pi_3 = \omega\theta\eta$$

$$\pi_4 = \omega\psi \quad ; \quad \pi_5 = \omega\psi$$

$$\pi_6 = (1-\omega)\phi \quad ; \quad \Delta = 1-[\beta_o\pi_2+\gamma_o(\beta_o\pi_5+\beta_1)]$$

From equation (14) it is possible to find out, among other things, how an increase in the world price of coffee will affect the actual real exchange rate in period t. Let's first look at the term A_1. This term will capture the spending effect of a change in the price of coffee on the real

exchange rate. Since stability requires that $\Delta > 0$, the spending effect will, as expected, generate a real appreciation. [15] Let's now turn to the inflation and exchange rate effects of the higher price of coffee on the real exchange rate in t. This is captured by term A_2. As can be seen from this expression, there are three different channels, in addition to the spending effect, through which changes in coffee prices will affect e. Two of these channels indicate that a higher price of coffee will generate a real appreciation. [16] The third channel, however, suggests that $\hat{e}$ and $\hat{p}^{c*}$ are positively related. Let us first look at the forces that suggest that there is a negative effect of $\hat{p}^{c*}$ on $\hat{e}$: First, a higher world price of coffee results in an increase in international reserves and money growth in the same period (see Appendix I). Assuming that, as a consequence, an excess flow supply for money results, this will generate inflation and, with other things given, a real appreciation. Second, according to equation (13), an increase in the world price of coffee slows down the rate of the crawl. This also works towards generating a real appreciation, with other things given. The forces that tend to generate a real depreciation as a consequence of the increase in the world price of coffee are of a second order magnitude, and work through the following channel. The higher world price of coffee reduces the rate of the crawl and consequently, through equation (13), the domestic price of tradables and inflation. These lower rates of inflation and devaluation, in turn will tend to result in a lower rate of domestic money creation, through equation (12), and even lower inflation. This lower inflation, of course, will generate, with other things given, a real depreciation. However, given the second order nature of this effect, the strong presumption is that under normal circumstances (i.e., under plausible values of the parameters

involved), the appreciation effects will dominate. This is, however, an empirical issue, which will be resolved with the estimation of the model. [17]

It should be noticed that the model presented here has used some simplifying assumptions, including the exogeneity of DEH_t. It is also assumed that the exchange rates applied to coffee and to other external transactions change at the same rate. In Colombia, however, during some years a dual exchange rate system has been in effect, with coffee's net exchange rate changing at a somewhat different rate than the rest of the economy's exchange rate (Weisner, 1978).

The model presented above does not allow to distinguish between the effect of coffee price changes perceived to be permanent from those perceived to be temporary. There are several possible ways in which the model can be amended in order to allow for this distinction. The simplest way to do this is by incorporating expected inflation as an argument in the demand for money equation: [18]

$$\left(\frac{M}{P}\right)_t = y_t^{\mu} e^{-a\hat{P}_t^e} \qquad (15)$$

where $\hat{P}_t^e$ is the rate of expected inflation, defined as $E_t [\log P_{t+1} - \log P_t]$ and E_t is the expectations operator. It is assumed that expectations are rational and formed conditional on all the information available up to the period t. When equation (15) is used as representing the demand for money function, equation (14) for the change in the real exchange rate becomes equal to:

$$\hat{e}_t = - b_o\pi_1(\delta_o-1)\ D^{-1}\ \hat{M}_{t-1} + \beta_o\pi_6\ (\gamma_o-1)\ D^{-1}DEH_t$$

$$- B_1 g_t - [B_1 + B_2]\ \hat{P}^{c*}_t + (\gamma_o-1)\ b_3\ \hat{P}^{e}_{t+1} \qquad (16)$$

where the expected inflation term $\hat{P}^{e}_{t+1}$ is:

$$\hat{P}^{e}_{t+1} = d\ \sum_{k=0}^{\infty} b^k\ E_t(\hat{P}^{c*}_{t+1+k}) + \ldots \qquad (17)$$

and where the Bs are equal to:

$$B_1 = [\gamma_2(1-b_o(\pi_2+\pi_4)-b_1)+b_2(\gamma_o-1)+b_o\pi_3(1-\gamma_o]D^{-1}$$

$$B_2 = [\gamma_1(1-b_o\pi_2)+b_o\pi_4(1-\gamma_o)-\gamma_1(b_1+b_o\pi_5)]D^{-1}$$

and the d, D and the bs are equal to:

$$d = [b_o(\pi_4+\pi_3)-(\pi_5 b_o+b_1)(\gamma_1+\gamma_2)-b_2]\ ;\ D = 1-[b_o\pi_2+\delta_o(b_o\pi_5+b_1)]$$

$$b = \frac{(1-\delta)\lambda a}{1+(1-\delta)\lambda\ (1+a)} \quad ; \quad b_o = \frac{(1-\delta)\lambda}{1+(1-\delta)\lambda\ (1+a)}$$

$$b_1 = \frac{1}{1+(1-\delta)\lambda\ (1+a)} \quad ; \quad b_2 = \frac{(1-\delta)(\lambda n-\rho)}{1+(1-\delta)\lambda\ (1+a)}$$

The main difference between the new real exchange rate equation (16) and equation (14) is that in (16) an expected inflation term $\hat{P}^{e}_{t+1}$ appears. This is a crucial difference, since as can be seen in equation (17) $\hat{P}^{e}_{t+1}$ is a function, among other things, of all future expected changes in the price of

coffee. That is, once the role of expectations is incorporated into the model, the change in the real exchange rate will depend on the complete expected future paths of the price of coffee and other exogenous variables. Now, for example, if the change in the price of coffee is expected to be permanent, the change in the real exchange rate will correspond to that already discussed above (equation (14)). However, if the higher price of coffee is expected to last for one period only, $E_t(\hat{P}^{c*}_{t+1}) = -\hat{P}^{c*}_t$ and, as equations (16) and (17) show, the real appreciation in period t will be smaller than under the case of a permanent increase in the price of coffee. Another important characteristic of equation (16) is that it is not necessary for the price of coffee to actually increase to generate a real appreciation. If world coffee prices are expected to increase in the future, a real appreciation will now take place.

III.2 Estimation

In this section, the results obtained from the estimation of a slight variant of the model given by equations (9), (12) and (13) are presented. Since, from an empirical perspective it is difficult to make a distinction between temporary and permanent changes in the price of coffee, the results reported here do not take into account this difference. [19] The estimation was performed using annual data for 1952-1980, with an explicit distinction made between the pre-1967 period and the post-1967 period. The following variant of the money creation equation (12) was estimated (where the ν_is are error terms):

$$\hat{M}_t = \alpha_o + \alpha_1\hat{M}_{t-1} + \alpha_2\hat{M}_{t-2} + \alpha_3\hat{M}_{t-3} + \alpha_4 DEH_t + \alpha_5(\hat{E}_t + \hat{P}^{c*}_t) + \nu_{1t} \qquad (18)$$

The following version of the inflation equation (12) was estimated, where DUM is a dummy variable that takes a value of zero up to 1967 and a value of one from there onwards.

$$\hat{P}_t = \delta_o + \delta_1 \hat{M}_t + \delta_2 \hat{y}_t + \delta_3 (\hat{E}_t + \hat{P}^*_{Tt}) + \delta_4 DUM_t + \nu_{2t} \qquad (19)$$

Finally, the exchange rate devaluation equation was the following:

$$\hat{E}_t = \mu_o + \mu_1 \hat{P}_t + \mu_2 (\hat{P}_t DUM_t) + \mu_3 \hat{P}^*_{Tt} + \mu_4 \hat{P}^{c*}_t + \mu_5 DUM_t + \nu_{3t} \qquad (20)$$

The system given by equations (18), (19) and (20) was estimated using two and three stages-least-squares for 1952-1980. The results obtained are presented in Tables 3 and 4. As may be seen, these results are very satisfactory. Most of the coefficients have the expected signs and are significant at the conventional levels.

The most interesting result from the estimation of the money creation equations is that they confirm the hypothesis that higher (domestic) prices of coffee have resulted in <u>short-run</u> increases in the rate of money creation. As discussed above, the mechanism through which this takes place, is the accumulation of international reserves that are monetized by the Central Bank. Also, estimates of the coefficients of the lagged $\hat{M}$s suggest that the effect of changes in coffee prices on money growth have some persistence through time. The estimation of the money growth equation (18), then, provides statistical support to the claim made by numerous authors (i.e., Weisner 1978, Urrutia 1981) that in Colombia the ability to perform monetary policy has been hampered by the dependence of money creation on the behavior of coffee prices.

Table 3. ESTIMATION OF MODEL FOR 1952-1980: TWO-STAGES-LEAST SQUARES

Equation No.		SEE	D.W.
(18.1)	$\hat{M}_t = -0.006 + 0.634\ \hat{M}_{t-1} + 0.123\ \hat{M}_{t-2} + 0.140\ \hat{M}_{t-3} + 0.222\ DEH_t + 0.079\ (\hat{P}^{c*}_t + \hat{E}_t)$ $(-0.177)\ (3.596)\ (0.691)\ (2.293)\ (3.354)\ (2.023)$	0.037	2.238
(19.1)	$\hat{P}_t = -0.006 + 0.705\ \hat{M}_t - 0.040\ \hat{y}_t + 0.311\ (\hat{E}_t + \hat{P}^*_{Tt}) + 0.010\ DUM_t$ $(-0.729)\ (2.669)\ (-0.363)\ (2.182)\ (0.314)$	0.060	2.231
(20.1)	$\hat{E}_t = -0.006 + 1.333\ \hat{P}_t - 0.850\ (\hat{P}_t\ DUM_t) - 0.060\ \hat{P}^*_{Tt} - 0.198\ \hat{P}^{c*}_t + 0.043\ DUM_t$ $(-0.119)\ (2.569)\ (-1.678)\ (-0.063)\ (-1.604)\ (0.469)$	0.108	1.728

Notes: The numbers in parentheses are t-statistics. SEE is the standard error of the regression. D.W. is Durbin-Watson statistic. The following instruments were used: lagged, twice lagged and three periods lagged and lagged DEH, world price of coffee, world inflation, lagged inflation, change in world price of coffee, the dummy and a constant.

Table 4. ESTIMATION OF MODEL FOR 1952-1980: THREE-STAGES-LEAST SQUARES

Equation No.		SEE	D.W.
(18.2)	$\hat{M}_t = 0.004 + 0.602\ \hat{M}_{t-1} + 0.145\ \hat{M}_{t-2} + 0.109\ \hat{M}_{t-3} + 0.180\ DEH_t + 0.096\ (\hat{P}_t^{c*} + \hat{E}_t)$ (0.130) (4.115) (1.014) (2.165) (3.218) (2.882)	0.034	2.280
(19.2)	$\hat{P}_t = -0.077 + 0.723\ \hat{M}_t + 0.005\ \hat{y}_t + 0.411\ (\hat{E}_t + \hat{P}^*_{Tt}) + 0.013\ DUM_t$ (-1,303) (3.331) (0.609) (3.596) (0.487)	0.057	2.175
(20.2)	$\hat{E}_t = -0.027 + 1.574\ \hat{P}_t - 0.732\ (\hat{P}_t\ DUM_t) - 0.463\ \hat{P}^*_t - 0.124\ P_t^{c*} + 0.031\ DUM_t$ (-0.637) (4.057) (-1.208) (-0.645) (-1.349) (0.419)	0.102	1.709

Notes: The numbers in parentheses are t-statistics. SEE is the standard error of the regression and DW is the Durbin-Watson statistic. For the instruments used see Table 3.

Also, these results support the hypothesis that the process of money creation in Colombia has been critically influenced by the behavior of the fiscal side of the economy. (Equations (18.1) and (18.2).) An increase in the fiscal deficit -- measured as a proportion of lagged base money -- in 10 percentage points has resulted, on average, in an increase in the rate of growth of money of approximately 1.8 to 2.2 percentage points. This finding points out that the separation of the fiscal and monetary sides in traditional macroeconomic analysis might not be fully applicable to LDCs. In developing countries -- and especially in Latin America -- fiscal deficits are usually financed by printing money; the LM and IS curves are not fully independent.

The estimation of the inflation equation (19) also yielded interesting results. With the exception of income growth and the dummy variable, the coefficients are significant and have the expected signs. The coefficient of $\hat{M}_t$ indicates that, with other things given, an increase in the rate of money creation by 10 percentage points has resulted in an increase of inflation of approximately 7 percentage points. On the other hand, according to the coefficient of $(\hat{E}_t + \hat{P}^*_{Tt})$ a higher rate of devaluation and/or higher world inflation, will be passed in almost one third to price increases. [20] As the model indicates, the price of the coefficients of $\hat{M}_t$ and $(\hat{E}_t + \hat{P}^*_{Tt})$ are not significantly different from one. However, the coefficient of real income growth was, in all runs, insignificant.

The exchange rate adjustment equation (20) yielded, in some sense, the less satisfactory results. The estimation indicates that for the post-1967 period -- after the crawling peg was adopted -- and with other things given, the exchange rate tended to be adjusted by less than the ongoing domestic rate of inflation. However, these results also confirm the hypothesis

that the Colombian authorities have taken into account the behavior of world coffee prices when deciding by how much to devalue the nominal exchange rate. Lower (higher) world coffee prices result in higher (lower) rates of devaluation of the crawl. Given the relatively poor results obtained from the estimation of (20) several alternative specifications of the exchange rate adjustment equation were also tried. Some of the results obtained are presented in Table 5, where $\hat{R}^r_t$ is the percentage change in the real value of international reserves measured in dollar terms. The nonsignificance of the coefficient of this reserves change variable confirms Urrutia's (1981) contention that the Colombian authorities do not directly take into account the level of international liquidity when deciding by how much to devalue the nominal exchange rate. The negative and insignificant coefficient of $\hat{M}_t$, however, is in some sense a surprise since it has been argued that changes in the nominal stock of money have been an important indicator when deciding the rate of devaluation of the peso (Urrutia 1981). Even though these regressions do not represent a significant improvement over those reported in Tables 3 and 4, they do confirm that the rate of devaluation has been positively related to the domestic rate of inflation -- with an average coefficient around one -- and negatively related to the behavior of the world price of coffee.

The point estimates obtained from the regression analysis of (18) through (20) can be combined to get an approximate idea of the way in which coffee price changes will affect the real exchange rate. For example, from the estimates reported in Table 3, the impact effect of world coffee prices on inflation, nominal devaluation and the real exchange rate, assuming all other exogenous variables given, are:

$$\hat{P}_t = \frac{(\alpha_5\delta_1+\delta_3+\delta_1\alpha_6)}{(\mu_1+\mu_2 DUM)(\delta_3+\alpha_5\delta_1)}\ \hat{P}_t^{c*} = 0.513\ \hat{P}_t^{c*};$$

$$\hat{E}_t = \frac{(\mu_1+\mu_2 DUM)\ \delta_1\alpha_6+\mu_4}{(\mu_1+\mu_2 DUM)(\delta_3+\alpha_5\delta_1)}\ \hat{P}_t^{c*} = -0.208\ \hat{P}_t^{c*}$$

$$\hat{e}_t = \frac{(\mu_1+\mu_2 DUM)\delta_1\alpha_5+\mu_4 - (\alpha_5\delta_1+\delta_3+\delta_1\alpha_6)}{(\mu_1 + \mu_2 DUM)(\delta_3 + \alpha_5\delta_1)}\ \hat{P}_t^{c*} = -0.721\ \hat{P}_t^{c*}$$

As may be seen these numbers are quite large, suggesting that, on impact and assuming other things given, a change in coffee prices will result in substantial changes in inflation, the rate of devaluation and the real exchange rate. In fact, these results suggest that immediately following an increase in world coffee prices most of the resulting real appreciation will materialize through the money creation and inflation channel. A possible problem with this exercise, however, is the assumption of other things given. As discussed above, coffee price movements are likely to be related to some of the variables which we have considered exogenous. In particular, coffee price movements will result in changes in real income, the fiscal deficit and world inflation. In addition, since no distinction between temporary and permanent changes has been used in the estimation, the results from this exercise should be interpreted with caution.

To summarize, in this section a model of the interaction between commodity export prices and the real exchange rate was developed and estimated for the case of Colombia. The model focuses on three building blocks: (a) money creation process $(\hat{M}_t)$; (b) domestic inflation $(\hat{P}_t)$; and (c) the rate of adjustment of the nominal exchange rate $(\hat{E}_t)$. These last two elements, plus the rate of foreign inflation $\hat{P}^*_{Tt}$ constitute, by definition,

Table 5. ESTIMATION OF EXCHANGE RATE ADJUSTMENT EQUATION: TWO-STAGES-LEAST SQUARES: 1952-1980

Equation No.		SEE	D.W.
(20.3)	$\hat{E}_t = 0.029 + 1.273\ \hat{P}_t - 0.961\ \hat{P}^*_{Tt} - 0.424\ \hat{P}_{t-1} + 0.967\ \hat{P}^*_{Tt-1} - 0.295\ \hat{P}^{c*}_t + 0.052\ \hat{R}^r_t - 0.054\ DUM_t$	0.115	1.856
	(0.539) (2.452) (-1.050) (-1.168) (1.251) (-2.243) (0.854) (-0.833)		
(20.4)	$\hat{E} = 0.223 + 1.258\ \hat{P}_t + 0.089\ \hat{P}^*_{Tt} - 0.225\ \hat{P}_{t-1} - 0.071\ \hat{P}^*_{Tt-1} - 1.364\ \hat{M}_t - 0.172\ \hat{P}^{c*}_t + 0.039\ \hat{R}^r - 0.041\ DUM_t$	0.113	2.220
	(1.812) (2.458) (0.081) (-0.603) (-0.914) (-1.769) (-1.617) (0.669) (-0.632)		

Notes: See Table 3

the elements that determine the behavior of the real exchange rate through time (i.e., $\hat{e}_t = \hat{E}_t - \hat{P}_t + \hat{P}^*_{Tt}$) . The model incorporated the traditional spending effect of a commodity export boom and explicitly took into account the monetary effects of changes in commodity prices. In particular, and contrary to most Dutch Disease models, the model developed in this section explicitly allows for changes in the price of coffee to affect, in the short run, the rate of growth of money. The results obtained from the regression analysis were, in some sense, surprisingly good, and confirmed the basic hypothesis that higher (lower) coffee prices result in higher (lower) rates of growth of money, and consequently in higher (lower) rates of inflation. Also the regressions show that the rate at which the authorities have adjusted the exchange rate in Colombia has been negatively related to coffee prices: higher (lower) coffee prices resulted in slower (faster) rates of devaluation.

IV. CONCLUDING REMARKS

With increasing regularity, the exchange rate is being pointed out as one of the most important economic variables in developing countries. In fact, nowadays it is almost impossible to discuss macroeconomic policy problems in LDCs without addressing exchange rate issues. From a policy perspective, one of the most important problems is determining whether the real exchange rate in a particular country is out of line with respect to its equilibrium value. [21] To the extent that the real exchange rate is in fact misaligned, policy actions geared towards reestablishing equilibrium will be called for. [22] From a policy viewpoint, then, a crucial aspect of real exchange rate analysis is to distinguish between equilibrium and

disequilibrium movements of these rates. Only in this way will it be possible to implement appropriate policy measures.

In spite of the obvious policy importance of analyzing the mechanism through which real exchange rate movements take place, very few empirical studies have tackled this problem. In this paper, the more specific problem of the effect of commodity export price changes on the real exchange rate has been investigated empirically. In Section III, a model that relates coffee price changes to money creation, inflation and the rate of devaluation was developed and estimated for Colombia. A virtue of this model is that it highlights two of the channels that have been traditionally pointed out in casual discussions on the effect of commodity price changes on the real exchange rate: money creation and inflation and the rate of adjustment of the nominal exchange rate (i.e., the rate of devaluation of the crawling peg).

The model shows that commodity export booms will generally generate short-run increases in money creation, inflation and a real appreciation. In fact it is possible that the real appreciation generated through this channel exceeds the "equilibrium" real appreciation resulting from the boom. If this boom is perceived as temporary, the real appreciation will be smaller, but could still be significant. An important question that arises within this context is whether there are mechanisms that would allow the authorities to reduce the impact of the changes in commodity export prices or the real exchange rate. Although the model presented in this paper suggests that some mechanisms could actually be made available, none of them is easy to implement or free of problems. First, open market operations could be used to sterilize the monetary impact of changes in coffee prices. A problem with this type of option in developing countries, however, is that local capital markets have

not reached the stage of development required to perform massive open market operations. A second alternative would be to manipulate commercial policy in a way to reduce the fluctuation of the real exchange rate. If commodity export prices, however, are highly volatile, this option will be to a large extent impractical. Finally, another alternative is to open the capital account, allowing the short-run excess liquidity generated by the export boom to be solved through outflows of capital. A problem with this measure, however, is that by fully opening the capital account, other sources of instability could result. [23]

The model presented in this paper was empirically tested for the case of coffee in Colombia. The results obtained indicate that coffee price changes have indeed been closely related to money creation and inflation. Also, coffee price changes have been negatively related to the rate of devaluation. These results indicate that in Colombia, the real appreciation resulting from coffee price increases has been accommodated, partially by money creation and inflation, and partially by an adjustment in the nominal exchange rate. The model used in this paper has been deliberately kept small and simple. As a result, it has been possible to clearly pinpoint the role of coffee in the inflationary and devaluation process. A cost of this approach, however, has been that some simplifying assumptions have been made. [24]

APPENDIX I

Solution of Model in Section III

Equations (10), (11) and (12) can be combined to find the reduced form solutions for $\hat{M}_t$, $\hat{P}_t$ and $\hat{E}_t$. Under the simplifying assumption that $\hat{P}^*_{Tt} = 0$ these solutions are:

$$\hat{M}_t = -\pi_1(1-\gamma_o\beta_1)\,\Delta^{-1}\,\hat{M}_{t-1} + \pi_6(1-\gamma_o\beta_1)\,\Delta^{-1}\,DEH_t + [\pi_4(1-\gamma_o\beta_1) - \gamma_1(\pi_2\beta_1+\pi_5)]\,\Delta^{-1}\,\hat{P}^{c*}_t - [\beta_2(\pi_2+\gamma_o\pi_5) + \gamma_2\,(\pi_2\beta_1+\pi_5) - \pi_3(1-\gamma_o\beta_1)]\,\Delta^{-1}\,\hat{y}_t \qquad (A.1)$$

$$\hat{P}_t = -\beta_o\pi_1\Delta^{-1}\,\hat{M}_{t-1} + \beta_o\pi_6\Delta^{-1}\,DEH_t - [\beta_2+(\pi_5\beta_o+\beta_1)\gamma_2 - \beta_o\pi_3]\Delta^{-1}\,\hat{y}_t + [\beta_o\pi_4 - \gamma_1(\pi_5\beta_o+\beta_1)]\Delta^{-1}\,\hat{P}^{c*}_t \qquad (A.2)$$

and,

$$\hat{E}_t = -\beta_o\gamma_o\pi_1\Delta^{-1}\,\hat{M}_{t-1} - [\gamma_1(1-\beta_o\pi_2) - \beta_o\gamma_o\pi_4]\Delta^{-1}\,\hat{P}^{c*}_t - [(1-\beta_o\pi_o)\gamma_2 + \beta_2\gamma_o - \beta_o\gamma_o\pi_3]\Delta^{-1}\,\hat{y}_t + \beta_o\gamma_o\pi_6\,\Delta^{-1}\,DEH_t \qquad (A.3)$$

where:

$$\beta_o = \frac{(1-\delta)\lambda}{1+\lambda(1-\delta)} \quad ; \quad \beta_1 = \frac{1}{1+\lambda(1-\delta)}$$

$$\beta_2 = \frac{(1-\delta)(\lambda\eta-\rho)}{1+\lambda(1-\delta)} \; ; \quad \pi_1 = \omega\theta$$

$$\pi_2 = \omega\theta \qquad ; \quad \pi_3 = \omega\theta\eta$$

$$\pi_4 = \omega\psi \qquad ; \quad \pi_5 = \omega\psi$$

$$\pi_6 = (1-\omega)\phi \quad ; \quad \Delta = 1 - [\beta_o\pi_2 + \gamma_o(\beta_o\pi_5 + \beta_1)]$$

Stability requires that $|\pi_1(1-\gamma_o\beta_1)\Delta^{-1}| < 1$. Notice that in this Appendix, in order to simplify the presentation, the rate of growth of real output $\hat{y}_t$ has not been decomposed between its exogenous term g_t and its coffee price induced term $\tau\hat{P}_t^{c*}$.

APPENDIX II

DATA SOURCES

All data refer to annual averages.

E = Pesos per US$ nominal exchange rate, taken from IFS.

M = M_2 definition of money taken from IFS.

P = Consumer Price Index taken from IFS.

y = Real GDP taken from IFS.

P_T = Price of tradables in pesos. Constructed as the product of the U.S. Wholesale Price Index and the Colombian exchange rate.

P^{C*} = price of coffee in dollar terms. Constructed from data in the IFS.

DEH = Fiscal deficit, in nominal terms, scaled by the lagged quantity of high-powered money. From 1970 to 1980 data from DNP that corrects for the Cuenta Especial de Cambio is used. (These data were supplied by Colombia's Departamento Nacional de Planeacion.)

FOOTNOTES

1. Much of this work has been done in the context of Dutch-Disease models. On this type of models see, for example, the survey by Corden (1982).
2. On the monetary effects of commodity export booms, see, for example, Harberger (1983), Edwards and Aoki (1983), Neary (1984), and Neary and van Wijnbergen (1984). Notice that an export boom will also generate an increase in the demand for money. Inflation will result only if the liquidity effect of the commodity boom exceeds the increase in the quantity of money demanded. On this see Edwards and Aoki (1983).
3. Moreover, very few papers have discussed the mechanism through which real exchange rate changes actually take place following changes in commodity export prices. Under floating exchange rates, fluctuations in the nominal exchange rate are the main mechanism. Under fixed exchange rates, however, the real exchange rate adjustment will require a change in the price level (more exactly in the nominal price of nontradables) and in the stock of money. In a more general case, the adjustment could be distributed between inflation and nominal exchange rate changes. An important question, and one that has not yet been tackled, refers to defining the most efficient mechanism to bring about the real exchange rate adjustment. Another important problem, which has not been analyzed in detail, refers to the desirability of allowing the real exchange rate to appreciate when the commodity export boom stems from a <u>temporary</u> hike in export prices.

4. On the Colombian economy see, for example, Diaz-Alejandro (1976), Ocampo (1983), Weisner (1978), Kamas (1983), World Bank (1983a, 1983b). Some recent studies, however, have analyzed empirically the relationship between the terms of trade and the real exchange. See, for example, Diaz-Alejandro (1984), and Edwards (1984a).

5. Coffee represents approximately 55 percent of Colombia's foreign earnings from legal exports. It is important to notice that the presence of important illegal exports makes the empirical analysis of Colombia's external sector quite difficult. For obvious reasons there are no reliable data on the magnitude of these illegal transactions. On the importance of illegal exports in Colombia see Junguito and Caballero (1978).

6. The increase in the world price of coffee will result in a higher real income and consequently in a higher demand for money. Inflation will result only if the accumulation of reserves exceeds the increase in the demand for money (Edwards and Aoki, 1983). A number of authors have argued that in 1975-79 the resulting inflation largely exceeded what was required to accommodate the equilibrium real appreciation (Weisner, 1978, World Bank 1984).

7. To the extent that there are adjustment costs, rigidities and inflexibilities, short-run real exchange rate movement generated by temporary swings in commodity export prices can indeed result in adverse (i.e., welfare reducing) effects. See Edwards and Aoki (1983).

8. On the institutional arrangements used for coffee marketing and exporting in Colombia, see the detailed description in World Bank (1984).

9. On credits to coffee growers and fiscal deficits see Weisner (1978, p. 186). Another simplification in (4) is that it does not explicitly allow for sterilization by linking reserve changes to credit creation. However, to the extent that DEH_t is negatively related to coffee prices, an indirect channel to trigger (partial) sterilization is allowed. On sterilization in Colombia see Kamas (1983).

10. Notice that another simplifying assumption of this model is that it ignores the demand for international reserves. For the important role played by reserves demand in Colombia see Weisner (1978, Ch.1). See also Diaz-Alejandro (1976). For a discussion on the integration of the demand for reserves theory and monetary equilibrium, see Edwards (1984b).

11. A reason to ignore interest rates in the demand for money function is that there are no reliable data on interest rates in Colombia for the entire period considered in this study. See however, the discussion below. On interest rates behavior in Colombia since 1968 see Edwards (1985).

12. This equation can be derived from the equilibrium condition in the nontradable goods sector. See Edwards (1984c).

13. Notice that the assumption of an exogenously given capital account plays an important role here. If, on the contrary, there is perfect capital mobility, the incipient excess supply for money resulting from the higher coffee price would be rapidly eliminated through the capital account, without affecting the price of nontradables.

14. Equation (14) gives the actual short-run, and not necessarily the equilibrium long-run, change in the real exchange rate resulting from a change in coffee prices. In order to find the long-run effect, the real

side equations (10), (8), (7) and (11) have to be solved under the conditions of monetary equilibrium.

15. See Appendix I. Notice that the real appreciation will take place if the following (plausible) conditions hold: $\omega(\theta + \psi) < 1$; $\gamma_0 \leq 1$ and $\rho > \lambda\eta$. These are sufficient conditions.

16. Diaz-Alejandro (1984) reports results from regression of the level of the (log of the) real exchange rate and a set of explanatory variables for Colombia and other Latin American countries. For Colombia the coefficient of (the log of the) terms of trade was significantly negative (-0.56) as expected. See also Edwards (1984a).

17. From equation (13) it is also possible to find how changes in the other exogenous variables, like the fiscal deficit, affect the real exchange rate.

18. There are two other ways to introduce the difference between permanent and temporary changes of coffee prices: (a) changes in permanent income, instead of actual real income, can be used in equation (8); and (b) in the crawling peg equation the coffee price changes term can be split in two; one corresponding to changes perceived to be temporary, the other for changes perceived to be permanent.

19. See, however, Cumby and van Wijnbergen (1984).

20. These results are consistent with those obtained by Hanson (1982). See also Edwards (1984c). The money growth equations were also estimated for shorter periods of time. The results obtained confirm those reported in this paper. See Volume II of World Bank (1984).

21. For example, Cline (1983) has recently pointed out that in many LDCs real exchange rate misalignments contributed to the international debt crisis.

22. On real exchange rate disequilibria and policies to realign them see, for example, Williamson (1983), Artus and Knight (1984) and Edwards (1984a).

23. This is not necessarily the case. On the effect of opening the capital account of the balance of payments in developing countries, see Edwards (1984a) and Obstfeld (1980).

24. A possible interesting extension of this model would be to incorporate an explicit equation for the current account, deriving from it the equilibrium real exchange rate. Even though this is not a difficult thing to do theoretically, the empirical implementation would become much more difficult.

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