COCOA PRICE EVOLUTION AND ELASTICITY OF PRICE TRANSMISSION

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ABSTRACT - This paper investigates the price behavior of cocoa and the elasticity of price transmission between its external and internal prices. The analysis was made using regressions, tables, and graphs. The results indicate a large decline in cocoa prices after 1978, and that the percent relation between external and internal prices did not change as consequence of Brazil's export tax elimination. Cocoa's unidirectional elasticity of price transmission is one, which means that internal prices are instantaneously determined by external prices.

Key words: cocoa, prices, elasticity.

INTRODUCTION

The cocoa crop is grown in many regions of world where the weather conditions are predominately warm and wet. For a long time, the cocoa crop has been concentrated in the South American and African continents; and recently, it has been expanding throughout Southeastern Asia. According to the INTERNATIONAL COCOA ORGANIZATION (ICCO), the Ivory Coast is the world's largest producer, producing 850 thousand tons, 36.5% of the world production.

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Cocoa is mainly used by the food industry as raw material for chocolate products. The world's major buyer is the U.S.A., which, during the agricultural production year of 1993/1994[3], contracted for 543.2 thousand tons of cocoa which corresponds to 23.4% of world production (ICCO, 1996).

The cocoa price is set in the New York Coffee, Sugar and Cocoa Exchange (CSCE); and most Brazilian cocoa is sold there.

One of cocoa's characteristics is that it price and production levels oscillate greatly causing constant changes in its production value. This situation has given rise to cycles of prosperity and recession in the regions of production. Lafleur (1982), studying the international price behavior of cocoa from 1951 to 1979, found a complete cycle of 24 years; and the last peak of the cycle occurred in 1977. Since that year, the price of cocoa has decreased, initiating a new cycle with different features and adverse effects on the producers. This price decrease has brought about a sector crisis, particularly in those countries with higher production costs.

According to Menezes & Carmo-Neto (1993), the price decline has threatened some cocoa entrepreneurs and reduced their numbers. This fact could affect the percent ratio of the producer price level to the international price, the elasticity of price transmission between international and domestic prices, and the period of time necessary for that transmission to occur.

The objective of this paper is to investigate the cocoa price evolution, the relationship between the international market and the domestic market, and the elasticity of price transmission between international and domestic prices.

METHODOLOGY

The Study's Region and the Data

The study was carried out in the southeast of the Brazilian state of

[3] The cocoa international agricultural production year covers the period from October 1 to September 30.

Bahia, home to that state's cocoa producing region. That region encompasses 55,838 km2, and represents 9% of Bahia's area. The regions 1991 population was 1,918,910, 15.9% of the State population (Nascimento et al., 1994).

The regional economy is a mono-culture based on the cocoa crop; although, there has been some expansion of shared crops, animal production, and an incipient industrialization process. The most important cities in the region are Itabuna and Ilhéus, and the later has seen increased popularity as a tourist site.

The international price data used in this work was gathered from the ICCO, expressed in the U.S. dollar, and corrected for inflation using the United States' Consumer Price Index (CPI). The producer price level was obtained from publications by the Comissão Executiva do Plano da Lavoura Cacaueira (CEPLAC). The monetary data was converted into the Brazilian "Real" as of December, 1995, using the Brazilian General Price Index (IGP-DI). The indexes were obtained from publications of "Financial Statistics" by the Getúlio Vargas Foundation and Suma Econômica. The later also provided the data on the average exchange rates.

Analysis of the international price

The study presents and analyzes graphics derived from the average monthly U.S. dollar real cocoa prices which prevailed in the March, May, July, September, and December New York CSCE futures market during the period from January, 1975 to December, 1995. The agents who operate in this market make their decisions based on their expectations regarding the future supply and demand for the product. In addition, the relative prices were analyzed grounded on their average, applying the following formula:

$$PR_t = (P_t / \overline{P}_t)100, \qquad (1)$$

where:

PR_t = relative price over time t;

P_t = price over time t;

$\overline{P}_t$ = average price.

Analysis of price at the farm level

The time series of real prices received by the cocoa producers in the State of Bahia, from January, 1975 to December, 1995 was examined applying a graphic technique. The study also includes a relative price analysis using equation (2), where Pt turns out to be the average monthly price at the farm level.

Relationship between the prices at the farm level and international prices

A ratio of the prices at the farm level and international prices was estimated as follows: initially, the international prices, measured in U.S. dollars, were converted into the domestic currency using the average nominal exchange rate, assuming that both series are evenly affected by Brazilian exchange rate policy. Those ratios were estimated by the equation(2):

$$Rpie_t = (Pi_t / Pe_t) . 100 , \qquad (2)$$

where:

$Rpie_t$ = Ratio of the domestic price and the international price in time t;

Pi_t = domestic price in time t;

Pe_t = international price in time t.

The coefficient of variation of the percent ratio between the price at the farm level and the price at the New York Coffee, Sugar, and Cocoa Exchange (CSCE) was also estimated in order to detect the degree of the relative dispersion. That coefficient was calculated as proposed by Spiegel (1969), applying the expression:

$$C.V. = \frac{100.S}{\overline{X}}, \qquad (3)$$

where:

C.V. = coefficient of variation;
S = sample standard deviation;
$\overline{X}$ = monthly average .

With the elimination of Brazilian export taxes on October, 1989 (Menezes & Carmo-Neto, 1993), we sought to determine if there was an alteration of the percent ratio between the price at the farm level and the international price, in domestic currency. To accomplish this, a t-test for the means of the two periods was carried out at 5% level of significance. The first t-test period was comprised of the 24 months immediately prior to the elimination of export taxes and the second t-test period was the 24 months after the termination of export taxes. The t-test for the mean difference was performed as proposed by Kazmier (1982), assuming that the variance of the population was known and equal. The following formulas were used:

$$t_c = \frac{(X_1 - X_2)}{Sp\sqrt{(1/n_1) + (1/n_2)}} \qquad (4)$$

$$S_p^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2} \qquad (5)$$

where:
t c = the estimated t-statistic;
X (i = 1,2) = the sample means;

S_p^2= mean variance;

S^2 = (i = 1,2) = sample variances;
n (i = 1,2) = the sample number of observations.

Analysis of the elasticity of the price transmission from international prices to producer prices

This study deals basically with a time series of New York CSCE Futures Market monthly prices, the monthly average prices at the farm level, and the currency exchange rate. According to Margarido (1995), it is necessary to transform the domestic and the international prices into the same currency and weight. The time series of price at the farm level was converted to nominal Cruzeiros before March, 1986, and the international price was multiplied by the monthly average Cruzeiro-US dollar exchange rate. The unit of weight used in this paper was a U.S. ton.

Cocoa prices are established at the New York CSCE and the London Futures Market (Amim,1993). Nevertheless, according to SOUSA(1991), the price at the farm level in Bahia is set by the New York CSCE Futures Market. Cocoa buyers in the region of production are closely linked with the New York CSCE Futures Market. This means that there is a low level, if any, of imperfection in international price transmission to the price received at the producer level.

Aguiar (1990) applied a causality test between the international and the domestic prices of soybean, using a model to determine the elasticity of the nominal price transmission with unidirectional causality. The domestic prices were explained by international prices with 12 lag periods of the international prices. These lags were included to appropriately detect the percentage of the international price variations transmitted to the producer price level and the period of time necessary to reach this price transmission. To Sims, cited by Aguiar (1990), said

that there is no accurate number of previously set lags, but that that number must be big enough to adequately capture the influence of international prices on domestic prices. Those lags, nevertheless, can not be excessive because of multi-collinearity problems. Therefore, it is important to verify the number of significant lags which define the price transmission equation. If the variables of that regression are expressed in a natural logarithm, the regression coefficients are the elasticities. Aguiar (1990) applied the F-test at a 5% level of significance to test the coefficients. That test is performed using successive estimations excluding the lags (1 to 12), (2 to 12), (11 to 12). That author included dummy variables in the transmission equation for seasonal adjustment.

Aguiar (1993) argues that the delay in price transmission is indicative of market failures, particularly in terms of information flow. In the case of cocoa marketing, where is daily information from the CSCE is widely accessed by the producers, the price transmission is expected to occur over a shorter period of time. Taking this into account, only eight lags were included in the model. Araujo et al. (1996), studying a price-forecasting model, concluded that the international price of cocoa did not show seasonal variations. Considering that result and the fact that the domestic prices demonstrate similar behavior, the dummy variables were not included in the model for seasonal adjustments. The model of unidirectional price transmission used in this research is shown in the equation below:

$$ln\,Ppro_t = ln\alpha_0 + \sum_{i=0}^{8} \alpha_{1i}\, ln\,Pex_{t-i} + \alpha_2 T + \varepsilon_t\,, \qquad (6)$$

Where:

$Ppro_t$ = Nominal price at the farm level in time t;

Pex_t =The nominal price, observed in The New York CSCE, expressed in the domestic currency, in time t;

T = trend;

αj (j = 0,1$_i$, 2) = regression coefficient;

ε_t = error term in tempo t.

The significance level of the complete model's parameters was determined using a t-test. Based on that statistical test, the final regression for price transmission was set up; and the non-significant lags were excluded from the model on the basis of a 5% significance level F-test[4]. The price variable, current or lagged, with non-significant parameters was dropped from the model; and a new regression was estimated. This procedure went on until an equation was derived which presented all significant parameters and a low level of multi-collinearity. The parameters of the final regression, except for (0 and (2, are the monthly elasticities of price transmission. This step-backward procedure is in conformity with the SAS INSTITUTE (1988). Many other researchers have used this technique, among them Almeida et al. (1988) who applied it to select variables and create a regression model to study the effect of lagged weather variables on cocoa growth.

Considering the problem of auto-correlation in the usual time series framework error term, the first order Durbin-Watson test (Kmenta, 1978) was performed. In the presence of auto-correlation, the regression coefficients were still unbiased, consistent, but not efficient. As a result, the tests of the hypotheses and the confidence intervals are no longer valid. The correction for auto-correlation was made using the Cochrane-Orcutt iterative process.

The Pearson correlation coefficient was applied to access the degree of the correlation among the explanatory variables (Spiegel, 1969) and to identify the presence of multi-collinearity.

[4] This test compares the two models by showing the effect of the elimination of each explanatory variable from the original model. According to the SAS INSTITUTE (1988), it takes the formula $F = \frac{\Delta SQR}{s^2}$, where F is the calculated F statistic, DSQR is the additional value to the sum of the squared error of the new regression and s^2 is the error variance of the original regression.

EMPIRICAL ANALYSIS

International Price

The evolution of cocoa's international price, shown in the Figure 1, reveals that after June, 1975 the price of cocoa began a sharp increase. In July, 1977, the price reached its highest level, US$ 10,747 per ton, 220% above the average price for the period (estimated at US$ 3.356). In 1977, as pointed out by the ICCO (1996), the relationship between year end cocoa stocks and processed cocoa reached the lowest value over the entire period of this study, only 17.8%, which, in part, explained these high price levels. Menezes & Carmo-Neto (1993) credit these high prices to the geographical dispersion of the cocoa crop. Government supported planted acreage increases began in many of the traditional producer countries; consequently, international prices have deviated from the their average, becoming even lower over time. On March, 1993 the cocoa's international price fell to US$ 991per ton, a reduction of 70.5% when compared with their mean value, and 90.8% lower relative to cocoa's July, 1977 price.

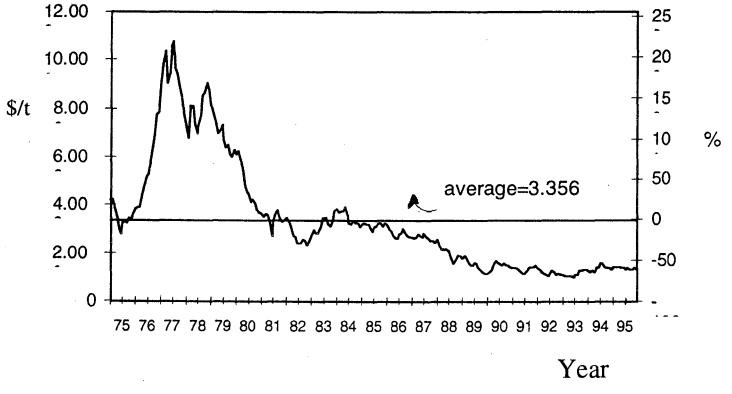

Figure 1 – Monthly average price of cocoa in the New York CSCE, from January, 1975 to December, 1995 and the percentage of the average during that period.

The Price at the farm level

The monthly average price paid to cocoa producers (Figure 2) increased from 1976 to July, 1977, when the price of cocoa reached R$ 10,664, 190.07% above the average of for whole period (R$ 3,676). From May, 1976 to September, 1980, cocoa prices remained greater than its average value. That period was considered the outstanding era for cocoa in Bahia. In November of 1982, following a period of decline which began in 1978, cocoa prices began a short period of increase although their levels remained below the preceding period of increase. In 1984, prices started moving steadily downward, threatening the production sector Cocoa price at the producer level reached a temporary bottom in 1994. The end of this last period of price decline coincided with the start of Brazils currency stabilization plan, the "Real Plan", which sought to anchor the exchange rate. The overvaluation of the "Real" gave rise to losses for cocoa exporters. Comparing the two previous Figures, one realizes that from July, 1994, when the economic stabilization plan was implanted, international prices have not exhibited significant changes; whereas, prices at the producer level have diminished sharply. In September of 1995, cocoa prices at the producer level reached their lowest point, R$ 945,00 per ton, 74.29% below their mean and 91.14% less than the peak value observed during the entire study period.

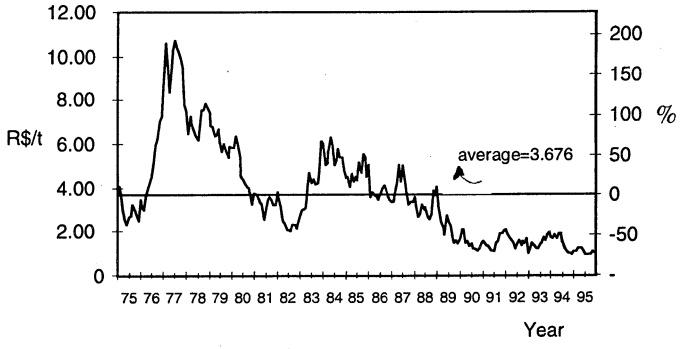

Figure 2 - Monthly average price of cocoa at the farm level, from January, 1975 to December, 1995 and the percentage to the average of the period.

Relationship between the prices at the farm level and international prices

The percent ratio of prices at the farm level to prices at the New York's CSCE is shown in Figure 3. The average percentage was 72.53% and the coefficient of variation was 11.7%. This degree of dispersion indicates that the deviations from the mean were relatively small. According to Menezes & Carmo-Neto (1993), the percentage of the FOB price at the farm level is, on average, 77.7%. That percentage would be even smaller if the estimation is based on the CSCE market price.

The period from May, 1988 to August, 1989 deserves special attention because it comprises the period that the percentage of the price paid to the producers stayed above its average for the longest period of time. For three months (November, 1988, January and June, 1989), the prices at the farm level were greater than the ones prevailing in the New York Coffee, Sugar, and Cocoa Exchange (Figure 3). This situation may be related to previous contracts signed by exporters during a period when the international price was dropping (Figure 1). In

October, 1989, the percentage of the price at the farm level was 69.11%. It is important to mention that during that period, the Brazilian export tax was suspended. The effect of the export tax suspension was modest; the percentage ratio farm to international prices increased in the proceeding month and held above average from January until July of 1990. After July, 1990, the price returned to its pattern, indicating that the removal of the export tax did not contribute to a long term increase in price received at the farm level.

The t-test reveals that the mean value during the two periods, with and without the export tax (Table 1), are statistically equal at 5% level of significance, suggesting that the removal of that tax did not benefit the producers and is consistent with the previous results based on Figure 3. This situation can be explained by a reduction in the number of buyers in the domestic market, since the sector crisis caused by the price decline caused many firms to leave the cocoa market (Menezes & Carmo-Neto, 1993).

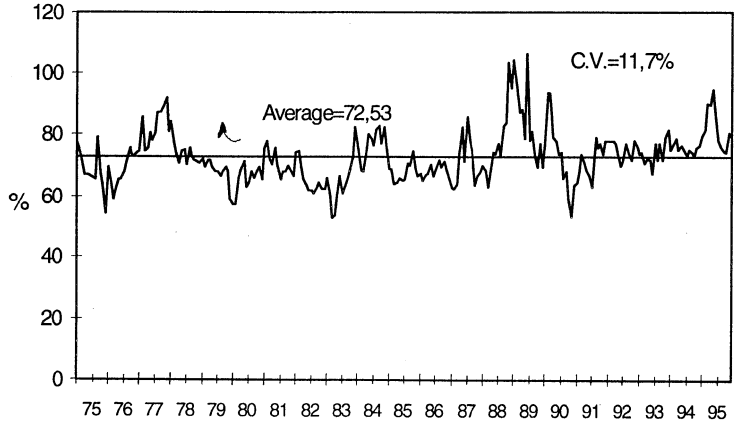

Figure 3 – Percent ratio between the cocoa price at the farm level in State of Bahia and the price at the New York CSCE.

Table 1 – Monthly averages of the percent ratio between cocoa prices at the farm level in the State of Bahia and the prices at the New York CSCE during two time periods, t calculated, and the level of significance.

Items	Value
P1[1]	71,1800
P2[2]	71,7600
t	-0,2467
Significance level	0,8060

[1] Correspond to the mean prices during the 24 months immediately before the removal of the export tax;

[2] Correspond to the mean prices during the 24 months immediately after the removal of the export tax.

Elasticity of Price Transmission from International Prices to Domestic Prices

The residues of the regression of the complete model exhibited strong auto-correlation ascertained by the Durbin-Watson test. The calculated d statistic was 0.496, which falls in the rejection region and indicated auto-correlated disturbance terms at 1% level of significance, invalidating the tests of hypotheses. The Cochrne-Orcutt iterative procedure was performed to correct the model for auto-correlation. After correction, the d statistic took on a value of 2.184; thus, it was located in the acceptance region of the null hypothesis that the disturbance terms are independent at the same level of significance. In the final regression, the coefficient of the current price at the New York CSCE (Pex) was statistically significant at a level smaller than 1%; whereas, the other coefficients, except for the constant term, were non significant. This suggested that price transference takes place without lagged time.

The step-backward procedure was applied to estimate the transference function. As shown in Table 2, only the explanatory variable Pex turned out to be statistically significant at a level smaller than 1%; and the coefficient was equal to 1.004 which gave rise to an unit elasticity of transmission. This means that the cocoa price variations in

the New York CSCE have been, on average, totally transmitted to the producers in the State of Bahia during the same month they occurred. The d statistic, equal to 2.179, falls in the region where the disturbance terms are independent at a 5% level of significance.

Table 2 – The price transference function from international prices (The New York CSCE) to the price at the producer level in the State of Bahia.

Explanatory Variables	Regression Coefficients	Calculated t Statistic	Significance Level
Constant term	-0,40853	-9,616	0.0001
Pex_t	1,00440	489,300	0.0001

Adjusted Coefficient of Determination = 0,9999
F-Calculated = 239.414; significance level = 0,00001
Standard Deviation of the residues = 0,0716
Durbin-Watson statistic (d) = 2,179

The analysis of the Pearson correlation coefficients of the Pext with its lagged values indicates the presence of a strong positive correlation between international prices and their lags, invariably greater than 99% with levels of significance higher than 1%. This may indicate the existence of large regressor variances. The elimination of international price variable lags from the model by applying the step-backward procedure corrected that problem.

A study by Margarido (1995) of international orange juice price transmission to the prices received at the São Paulo producer level from July, 1986 to June, 1992 found similar results. He found that the short-term parameters took on value equal to 1.0096, approximately unit elasticity; and, as in the case of the cocoa, on average about 100% of the international price variations were integrally transmitted to the producers during the same month. Conversely, Aguiar & Barros (1989) got different results in their study of the elasticity of international orange juice price transmission to the prices received by São Paulo producers from 1978 to 1985,. Aguiar and Barros concluded that during that period the international price variations were not transmitted to the producers during the same month, and only 56.4% of them were transmitted with a lagged month. An important difference between the studies by Aguiar & Barros and by Margarido is that the former

used time series of prices of different levels of processed product.

Figure 3 shows that the percent ratio of price received at the producer level to the international price exhibits low relative dispersion (C.V. = 11.7%) without extensive periods above or below its average. The removal of the export tax did not significantly change the percentage of the international price which was received by the producers (Table 1); therefore, the partition of periods for price transmission analysis was not needed.

CONCLUSIONS

The decline of cocoa prices has brought about important negative adjustments in the State of Bahia's cocoa producing region, a region whose economy is almost totally dependent upon cocoa production. This situation worsened with the Brazilian Government's July, 1994 implementation of a macroeconomic stabilization plan based on an exchange rate anchor. This caused domestic currency variations in cocoa prices which contributed to aggravate the cocoa crisis.

The ratio between the prices received in domestic currency at the producer level and international prices, did not change with the removal of the export tax, indicating that the producers were not benefited by the elimination of this tax.

The elasticity of price transmission from the international level to the domestic level was unity despite the elimination of the export tax.

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