PRICE FORMATION IN THE BRAZILIAN SOYBEAN AGROINDUSTRIAL CHAIN IN THE DECADE OF THE 1990s

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Abstract

This research analyzes the process of price formation in the soybean complex at the producer, wholesaler, and retailer levels in both the internal and external soybean and soybean derivates markets to note the effect of Brazil's economic opening and trade liberalization in the 1990s. The analysis was carried for two periods, from January 1982 to December 1989 and from January 1990 to December 1999. The areas defined for the study were the main soybean and soybean derivatives producer regions in the internal market and the external soybean market. Quotes from the Chicago Board of Trade (CBOT) were used as proxy for international prices. The Granger test was used to determine causal relationships between internal market prices and external market prices. After having determined the direction of causality, price transmission elasticities were then estimated. The results show that price transmission in the sector generally had dephasing [displacement] periods of one month or less; though, in just a few cases a price transmission of two or three months appeared. This indicates price transmission efficiency in the studied market levels and regions.

Key-words: soybean, Granger test, price transmission.

1. Introduction and Justification

The arrival of the 1990s brought important changes for the soybean agroindustrial complex in Brazil. On the external front, Brazil's

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economic opening brought this sector into closer contact with the dynamic forces of the global economy. Internally, these external effects combined with Brazil's economic deregulation and farm sector restructuring to affect the soybean agroindustrial complex in particular.

Brazil is the second biggest soybean producer in the world, with a yield of around 37 million tons or 22% of world production (USDA 2001). Argentina is the world's third largest soybean producer (25 million tons—15% of world production), the United States is the world's largest soy producer (81 million tons—48.5% of world production), and total world production in 2001 is estimated at 167 million tons (USDA 2001).

Soybeans have great importance among Brazilian farm products, not only in the internal market but also as a source of foreign exchange. Over the last decade, the exportation of soybeans, soy meal, and soy oil represented 9% of total Brazilian exportation and 30% of the country's agricultural exportation (ABIOVE, 2000).

Williams and Thompson (1988) point out that many of the Brazilian government's major policy initiatives in the 1980s revolved around the soy crop. The government sought to ensure a proper offer of soybean oil and meal for the internal market, promote the utilization of all soy processing capacity, and to increase export of excess soybean oil and meal rather than raw soybeans. Variations in prices arising at the local producer level (offer collisions) or the wholesale level (larger access to information and bigger market coverage) would tend to be transferred to retail soybean oil sales through the application of a production costs markup.

The goal of this work is to analyze the possible changes that occurred in the soybean and soybean derivatives markets in the 1990s. More specifically, the purposes are of this work are to 1) analyze price relationships among market levels in the soybean complex, 2) measure the transmission of price variations, and 3) determine the dephasing in months at which complete price adjustment occurs among producers, wholesalers, and retailers within both the internal and external soybean markets and among the main Brazilian production regions. The data gathered from this analysis can then be compared with the results from my similar study for the previous decade and the results obtained by

Aguiar (1990) to identify changes in the soybean complex's price structure between 1982 and 2000.

Analysis of these price relationships will give an indication of the degree of efficiency in the soybean complex's product distribution channels; thereby, broadening understanding of the price setting mechanisms. This new understanding should highlight the main causes for price variations and the market segments that lead these variations.

2. Econometric Models

The analyses will consider the periods from January of 1982 to December of 1989 and from January of 1990 to December of 1999 for soybeans, soy meal and soy oil and consider price quotes for both the internal and external markets.

2.1. Intensity and period of price transmission

The analysis of intensity of transmission is given by estimating price transmission elasticity. Price transmission elasticity concerns the impact of relative price variation at one market level on prices at another market level (Barros and Burnquist 1987). The time needed for the price adjustment at each market level is also important in terms of market efficiency. The time needed for the prices to achieve a new fit between market levels can be associated to information flows and consequently market efficiency.

2.1.1. Causality test

Granger's (1969) causality test considered there to be a causal relationship between variable X and variable Y, if and only if past values of X helped to forecast values of Y. The causal relationship among farm prices has been linked with market structure and government intervention.

Several works have sought to verify the direction of causal relationships among farm product prices at different market levels in Brazil, these include studies by Burnquist (1986), Barros & Martinez F.

(1987), and Aguiar and Barros (1989), among others. All these works used the causality test methodology proposed by Sims, which, instead of testing past values, tests future values for the variables.

The two equations that make up the causality test between soybean prices in Parana and Chicago (CBOT) are as follows:

$$Psch_t = \alpha_0 + \sum_{i=1}^{12} \alpha_{1i} Pspr_{t-i} + \sum_{k=1}^{12} \alpha_{2k} Psch_{t-k} + \sum_{j=1}^{12} \alpha_{3j} D_j + \alpha_4 T + \varepsilon_{1t} \quad (01)$$

$$Pspr_t = \beta_0 + \sum_{i=1}^{12} \beta_{1i} Psch_{t-i} + \sum_{k=1}^{12} \beta_{2k} Pspr_{t-k} + \sum_{j=1}^{12} \beta_{3j} D_j + \beta_4 T + \varepsilon_{2t} \quad (02)$$

Being

Psch: logarithm of soybean price in Chicago (CBOT);

Pspr: logarithm of soybean price in Parana;

Dj: binary variables to control the effects of seasonality;

T: trend variable;

$\alpha 0$, $\alpha 1$, $\alpha 2i$, $\alpha 3k$, $\alpha 4j$: Estimated parameters in equation 01;

$\beta 0$, $\beta 1$, $\beta 2i$, $\beta 3k$, $\beta 4j$: Estimated parameters in equation 02;

$\varepsilon 1t$, $\varepsilon 2t$: Random errors.

The Granger causality test used in this study will employ 12 past values of the explaining variable and 12 past values of the dependent variable. Binary variables are used to control seasonality, variation occurring in a time series over the same months of the year with more less with the same intensity, which is applied to explain farm product price changes of products whose harvest and non-harvest periods correspond to periods determined within a year.

Next, equations (01) and (02) were used in the null hypotheses test:

$\alpha 11 = \alpha 12 = ... = \alpha 112 = 0$ (equation 01),

$\beta 11 = \beta 12 = ... = \beta 112 = 0$ (equation 02).

If the two hypotheses were rejected, there would be a bi-causal relationship; if the two were not rejected, there would not be any causal relationship; if 01 was rejected and 02 was not, causality would be from Pspr to Psch; and if 01 was accepted and 02 was not, causality would be from Psch to Pspr.

The F statistic will be used to test these hypotheses with the F value estimated by the following formula for equations (01) and (02):

$$F = \frac{(SQRr - SQRu) / m}{SQRu / (n - k)}$$

Being that SQRr is the sum of squares of the remains from the constrained equation; SQRu the sum of squares of the remains from the equation without constraints; m the number of dephased terms; and n the number of observations. All prices are expressed as Neperian logarithms, and Dj and T are the previously defined variables.

2.1.1. Price transmission elasticities in one-way causality models

Price transmission equations are estimated by following the direction verified by the causality test. In the case of causality from the CBOT soy price to the soybean price found in Parana, the basic equation would be:

$$Pspr_t = \sigma_0 + \sigma_1 Psch_t + \sum_{i=1}^{12} \sigma_{2i} Psch_{t-i} + \sum_{j=1}^{11} \sigma_{3j} D_j + \sigma_4 T + \varepsilon_t \quad (03)$$

From that equation, the number of significant dephasings to define a price transmission equation is tested. The procedure consists of evaluating the significance of the variable exclusion F-test at a 5% level, as dephasings are being excluded (1 to 12), (2 to 12), ..., (11 to 12). After defining the final form, the values for σ_1 and σ_2 will be the monthly price transmission elasticities.

2.1.1. Price transmission elasticities in two-ways causality models

In the case of a bi-causal relationship, a model of simultaneous equations corresponding to the relationship between the CBOT and Parana soybean prices must be estimated. The number of dephasings was defined *ad hoc* as 12 monthly values.

Structural form of our model of simultaneous equations:

$$P_t^{ch} = \sigma_0 + \sigma_1 P_t^{pr} + \sum_{i=1}^{12} \sigma_{i+1} P^{pr}_{t-i} + \mu_{1,t} \qquad (04)$$

$$P_t^{pr} = \phi_0 + \phi_1 P_t^{ch} + \sum_{i=1}^{12} \phi_{i+1} P^{ch}_{t-i} + \mu_{2,t} \qquad (05)$$

Being:
Pch: logarithm of soybean price;
Ppr logarithm of Parana soybean price;
$\sigma 1$ to $\sigma 13$ and $\phi 1$ to $\phi 13$ are partial price transmission elasticities.

The equations used in this model are over-identified, demanding the use of the least square method in two stages for estimation. The description of this method is as follows:

1st stage: estimation of regressions for pre-determined variables (exogenous variables + dephased endogenous variables). For equation (04), the first stage would be:

$$\hat{P}_t^{pch} = \pi_0 + \sum_{i=1}^{12} \gamma_i P^{ch}_{t-i} + \sum_{k=1}^{12} \rho_k P^{pr}_{t-k} + \mu_{3,t} \qquad (06)$$

2nd stage: estimation of equation (04) in the case of price transmission in Chicago using the Parana price estimated at the first stage $(\hat{P}_{tpr})$. The procedure is the same to estimate equation (05), estimating the soybean price in Chicago $(\hat{P}_t^{ch})$ at the 1st stage, which will be related to the price in Parana at the 2nd stage.

2.1. Data sources

The data used are soybean producer prices in Brazil's main producer states: Parana, Mato Grosso, Rio Grande do Sul, Goiás, and Mato Grosso do Sul, which represent 85% of national production. Sao Paulo and Parana prices will be used for soybean meal, as these are the country's main consuming and producing states respectively. For wholesale and retail soy oil, Sao Paulo prices will be used, as this is the country's biggest soy oil refining and consumption center. CBOT prices will supply international market price quotes for soybean, soy meal and soy oil. The sources for these data are as follows: United States Department of Agriculture (USDA), Brazilian Stocking Company (Companhia Brasileira de Abastecimento – CONAB), Harvest & Market, State Secretary of Agriculture and Stocking of the State of Parana (SEAB/PR) and the Applied Economics Advanced Research Center (CEPEA- [Brazil]).

3. Results and Discussion

The following results come from the econometric tests shown in item 02. Prices are expressed in "Reais" [Brazil's currency] deflated by the IGP/Di of the Getúlio Vargas Foundation (October 1999). Price series are for the period from January 1982 to December 1999.

Our tests for the decade of the 1980s are distinct from our tests for the 1990s. The test results from the 1980s are compared with the test results from the 1990s and both are also compared to the study of soybean complex price formation and transmission made by Aguiar in the 1980s for the state of Sao Paulo.

Tests were also made among the external market (CBOT) price series, that is to say, soybean with meal, soybean with oil, and meal with oil for the periods mentioned above: 1982—1989; 1990—1999. Soybean and soy derivative prices in the external market were also related to the same forms in the internal market, i.e. soybean-soybean, meal-meal and oil-oil. It was confirmed that there was no level leading price variation in the international market.

Causality test analysis (Granger)

The results of the causality tests are shown in Tables 1 and 2. In these tables, a dependent variable and an excluded independent variable are specified, as well as the F-test significance (variable exclusion) and the degrees of freedom of the test.

The basic variables are the following:

P^{spr}_t – Neperian logarithm of the soybean price in Parana;

P^{srs}_t – Neperian logarithm of the soybean price in Rio Grande do Sul;

P^{smt}_t – Neperian logarithm of the soybean price in Mato Grosso;

P^{sms}_t – Neperian logarithm of the soybean price in Mato Grosso do Sul;
P^{sgo}_t – Neperian logarithm of the soybean price in Goiás;
P^{sch}_t – Neperian logarithm of the soybean price in Chicago;
P^{fpr}_t – Neperian logarithm of the soybean meal price in Parana;
P^{fsp}_t – Neperian logarithm of the soybean meal price in Sao Paulo;
P^{fch}_t – Neperian logarithm of the soybean meal price in Chicago;
P^{ospat}_t – Neperian logarithm of the soybean oil wholesale price in Sao Paulo;
P^{ospvj}_t – Neperian logarithm of the soybean oil retail price in Sao Paulo;
P^{och}_t – Neperian logarithm of the soybean oil wholesale price in Chicago.

Table 1 – Causality test between soybean and soy derivatives prices in different trade regions in the internal and external market in the decade of the 1980s.

Dependent variable	Excluded independent variable	F (1)
P^{sms}	P^{spr}	3,09* (12,47)
P^{spr}	P^{sms}	0,40 (12,47)
P^{smt}	P^{spr}	3,76* (12,47)
P^{spr}	P^{smt}	0,86 (12,47)
P^{sms}	P^{sgo}	3,10* (12,47)
P^{sgo}	P^{sms}	1,51 (12,47)
P^{fsp}	P^{fch}	1,95* (12,47)
P^{fch}	P^{fsp}	0,89 (12,47)
P^{fpr}	P^{fch}	1,76* (12,47)
P^{fch}	P^{fpr}	0,73 (12,47)
P^{ospat}	P^{ospvj}	3,28* (12,47)
P^{ospvj}	P^{ospat}	2,06** (12,47)
P^{fch}	P^{sch}	1,63 (12,47)
P^{sch}	P^{fch}	0,77 (12,47)
P^{fch}	P^{och}	1,27 (12,47)
P^{och}	P^{fch}	0,53 (12,47)
P^{sch}	P^{och}	0,66 (12,47)
P^{och}	P^{sch}	0,46 (12,47)
P^{fsp}	P^{fpr}	1,08 (12,47)
P^{fpr}	P^{fsp}	0,85 (12,47)
P^{smt}	P^{sms}	0,74 (12,47)
P^{sms}	P^{smt}	1,48 (12,47)
P^{spr}	P^{sgo}	0,54 (12,47)
P^{sgo}	P^{spr}	1,07 (12,47)
P^{smt}	P^{sgo}	1,68 (12,47)
P^{sgo}	P^{smt}	0,74 (12,47)
P^{sch}	P^{spr}	0,67 (12,47)
P^{spr}	P^{sch}	0,75 (12,47)
P^{sch}	P^{srs}	1,00 (12,47)
P^{srs}	P^{sch}	1,04 (12,47)
P^{och}	P^{ospat}	0,88 (12,47)
P^{ospat}	P^{och}	1,64 (12,47)

(1) Degrees of freedom for the test are between parentheses
* Level of significance: 1%
** Level of significance: 5%

The data in Table 01 (the 1980s) show that there is a causal relationship from the soybean price in Parana to soybean prices in Mato Grosso and Mato Grosso do Sul and from the soybean price in Goiás to the soybean price Mato Grosso do Sul. Table 01 also shows that there is a causal relationship from soybean meal prices in Chicago to meal prices in Sao Paulo and Parana and that there is a bi-causal relationship in the soybean oil market between wholesale and retail prices in Sao Paulo.

Table 02 – Causality test between soybean and derivatives prices in different trade regions within the internal and external market, in the decade of the 1990s

Dependent variable	Excluded independent variable	F (1)
P^{spr}	P^{sch}	2,95* (12,71)
P^{sch}	P^{spr}	1,17 (12,71)
P^{srs}	P^{sch}	3,01* (12,71)
P^{sch}	P^{srs}	1,18 (12,71)
P^{sms}	P^{spr}	2,49* (12,71)
P^{spr}	P^{sms}	0,47 (12,71)
P^{smt}	P^{spr}	5,54* (12,71)
P^{spr}	P^{smt}	1,04* (12,71)
P^{sgo}	P^{spr}	3,66* (12,71)
P^{spr}	P^{sgo}	0,66 (12,71)
P^{sgo}	P^{sms}	2,95** (12,71)
P^{sms}	P^{sgo}	1,08 (12,71)
P^{sms}	P^{smt}	2,49* (12,71)
P^{smt}	P^{sms}	2,31* (12,71)
P^{smt}	P^{sgo}	0,32 (12,71)
P^{sgo}	P^{smt}	1,31 (12,71)
P^{fsp}	P^{fch}	2,64* (12,71)
P^{fch}	P^{fsp}	1,33 (12,71)
P^{fpr}	P^{fch}	2,53* (12,71)
P^{fch}	P^{fpr}	0,88 (12,71)
P^{fpr}	P^{fsp}	3,15* (12,71)
P^{fsp}	P^{fpr}	1,79 (12,71)
P^{ospat}	P^{och}	1,91** (12,71)
P^{och}	P^{ospat}	1,58 (12,71)
P^{ospat}	P^{ospvj}	1,28 (12,71)
P^{ospvj}	P^{ospat}	0,91 (12,71)
P^{fch}	P^{sch}	0,94 (12,71)
P^{sch}	P^{fch}	0,97 (12,71)
P^{fch}	P^{och}	0,98 (12,71)
P^{och}	P^{fch}	1,30 (12,71)
P^{sch}	P^{och}	1,21 (12,71)
P^{och}	P^{sch}	1,52 (12,71)

(1) Degrees of freedom for the test are between parentheses

* Level of significance: 1%

** Level of significance: 5%

The data in Table 02 (the 1990s) show there is a bi-causal relationship between soybean prices in Mato Grosso and Mato Grosso do Sul. Table 02 also shows the following results: (i) causality from the soybean price in Chicago to the soybean price in Parana; (ii) causality from soybean price in Chicago to price in Rio Grande do Sul; (iii) from Parana to Mato Grosso; (iv) from Parana to Mato Grosso do Sul; (v) from Parana to Goiás; vi) and from Mato Grosso do Sul to Goiás. There is a causality relationship in the meal market from the soybean meal price in Chicago to prices in Sao Paulo and Parana and from meal prices in Sao Paulo to prices in Parana. There is a causality relationship in the soybean oil market from prices in Chicago to wholesale prices in Sao Paulo.

These results were expected; prices were set by the CBOT, internalized via Rio Grande do Sul and Parana, and then transferred to the different trade regions in the heart of the Brazil. Internally, the price causality relationship is seen from the places nearest to a port to those furthest from the port, with the installed processing capacity in each state noticeably affecting the results.

2.1. Price transmission elasticities

The F-test results (variable exclusion) to verify the number of significant dephasings in the price transmission equations showed more than 90% of the cases that reached complete price adjustment included no more than one dephasing. Adjustment took longer than one month in just two cases, as shown in Tables 3 and 4. The short period needed for price adjustment at a determined market level after a given price variation in another market level is an indication of the market's efficiency and the rapidity of information transmission. Moreover, the sum of elasticities in price equations was verified to be equal to one.

Table 3 – Duration of the significant dephasings (in months) for price transmission equations, according to results of the causality analyses in the decade of the 1980s:

Dependent variable	Independent variable	Dephasing in months
P^{sms}	P^{spr}	2
P^{smt}	P^{spr}	1
P^{sms}	P^{sgo}	1
P^{fsp}	P^{fch}	1
P^{fpr}	P^{fch}	0

Table 4 – Duration of the significant dephasings (in months) for price transmission equations, according to results of the causality analyses in the decade of the 1990s:

Dependent variable	Independent variable	Dephasings in months
P^{spr}	P^{sch}	0
P^{srs}	P^{sch}	3
P^{sms}	P^{spr}	1
P^{sgo}	P^{spr}	1
P^{smt}	P^{spr}	1
P^{sgo}	P^{sms}	0
P^{fsp}	P^{fch}	0
P^{fpr}	P^{fch}	1
P^{fpr}	P^{fsp}	1
P^{ospat}	P^{och}	1

The price transmission equations shown in Tables 5 and 6 were selected using the definition of causal relationship and the number of significant dephasings,

Table 5 – Soybean and derivatives price transmission equations—decade of the 1980s

Dependent variable	Constant	Independent variables		
$Psms_t$		$Pspr_t$	$Pspr_{t-1}$	$Pspr_{t-2}$
Estimates	- 0.12*	**0.54***	**0.55***	**0.19****
(t)	(-3.23)	(6.29)	(5.97)	(2.08)
$R^2 = 0.81$ Q (20-0) = 16.88	DW = 2.05	$F^{(1)}$ (1.57) = 5.55**		
$Psmt_t$		$Pspr_t$	$Pspr_{t-1}$	
Estimates	- 0.04	**0.56***	**0.49***	
(t)	(- 1.74)	(9.74)	(8.24)	
$R^2 = 0.88$ Q (20-0) = 12.17	DW = 2.13	$F^{(1)}$ (1.57) = 0.64		
$Psms_t$		$Psgo_t$	$Psgo_{t-1}$	
Estimates	- 0.06	**0.56***	**0.49***	
(t)	(- 1.64)	(7.06)	(3.81)	
$R^2 = 0.92$ Q (20-0) = 30.26	DW = 1.80	$F^{(1)}$ (1.57) = 1.62		
$Pfpr_t$		$Pfch_t$		
Estimates	0.02	**0.55***		
(t)	(0.35)	(4.19)		
$R^2 = 0.63$ Q (20-0) = 22.48	DW = 1.62	$F^{(1)}$ (1.57) = 11.65*		
$Pfsp_t$		$Pfch_t$	$Pfch_{t-1}$	
Estimates	0.01	**0.52***	**0.46***	
(t)	(0.24)	(3.66)	(3.14)	
$R^2 = 0.65$ Q (20-0) = 21.70	DW = 1.66	$F^{(1)}$ (1.57) = 1.62		
$Pospat_t$		$Pospvj_t$		
Estimates	- 0.03	**1.02***		
(t)	(-1.27)	(41.95)		
$R^2 = 0.95$ Q (21-0) = 65.92*	DW = 0.81	$F^{(1)}$ (1.82) = 8.32*		
$Pospvj_t$		$Pospat_t$		
Estimates	- 0.07*	**0.94***		
(t)	(3.21)	(41.95)		
$R^2 = 0.95$ Q (21-0) = 63.69*	DW = 0.80	$F^{(1)}$ (1.82) = 8.32*		

(1) Test to verify the sum of elasticities to be equal to 1.
* Level of significance of the t-test, Q and F: 1%
** Level of significance of the t-test, Q and F: 5%

Table 6 – Soybean and derivatives price transmission equations—decade of the 1990s

Dependent variable		Constant	Independent variables	
	$Pspr_t$		$Psch_t$	
	Estimates	- 0.03	**0.62***	
	(t)	(-0.81)	(5.71)	
R^2 = 0.73	Q (26-0) = 38.89	DW = 1.65	$F^{(1)}$ (1.81) = 12.27*	
	$Psrs_t$		$Psch_t$	$Psch_{t-1}$
	Estimates	- 0.13*	**0.37***	**0.27****
	(t)	(-2.91)	(3.31)	(2.10)
R^2 = 0.65	Q (26-0) = 24.41	DW = 1.89	$F^{(1)}$ (1.81) = 8.05*	
	$Psms_t$		$Pspr_t$	$Pspr_{t-1}$
	Estimates	- 0.21*	**0.42***	**0.34***
	(t)	(-6.51)	(6.96)	(4.95)
R^2 = 0.89	Q (26-0) = 23.90	DW = 1.92	$F^{(1)}$ (1.81) = 14.90*	
	$Psms_t$		$Pspr_t$	$Pspr_{t-1}$
	Estimates	- 0.13**	**0.46***	**0.23***
	(t)	(-2.03)	(5.54)	(2.39)
R^2 = 0.92	Q (26-0) = 28.14	DW = 1.96	$F^{(1)}$ (1.81) = 21.70*	
	$Psgo_t$		$Pspr_t$	$Pspr_{t-1}$
	Estimates	- 0.16*	**0.61***	**0.29****
	(t)	(-2.99)	(5.94)	(2.44)
R^2 = 0.70	Q (26-0) = 34.29	DW = 1.87	$F^{(1)}$ (1.81) = 0.87	
	$Psgo_t$		$Psms_t$	
	Estimates	- 0.11*	**0.84***	
	(t)	(-1.81)	(7.91)	
R^2 = 0.79	Q (26-0) = 20.95	DW = 1.98	$F^{(1)}$ (1.81) = 2.42	
	$Psms_t$		$Psmt_t$	
	Estimates	- 0.06	**0.99***	
	(t)	(-1.85)	(34.1)	
R^2 = 0.92	Q (27-0) = 151.68*	DW = 1.09	$F^{(1)}$ (1.106) = 0.06	
	$Psmt_t$		$Psms_t$	
	Estimates	- 0.04	**0.92***	
	(t)	(-1.16)	(34.08)	
R^2 = 0.98	Q (26-0) = 131.96*	DW = 1.29	$F^{(1)}$ (1.106) = 8.14	
	$Pfpr_t$		$Pfch_t$	$Pfch_{t-1}$
	Estimates	0.02	**0.76***	**0.18**
	(t)	(0.62)	(7.58)	(1.65)
R^2 = 0.75	Q (26-0) = 23.14	DW = 1.99	$F^{(1)}$ (1.81) = 0.24	
	$Pfsp_t$		$Pfch_t$	
	Estimates	0.05	**0.79***	
	(t)	(1.38)	(7.86)	
R^2 = 0.77	Q (26-0) = 22.39	DW = 1.94	$F^{(1)}$ (1.81) = 4.54**	
	$Pfpr_t$		$Pfsp_t$	$Pfsp_{t-1}$
	Estimates	- 0.06**	**0.79***	**0.18***
	(t)	(- 2.53)	(15.71)	(2.86)
R^2 = 0.96	Q (26-0) = 20.03	DW = 1.83	$F^{(1)}$ (1.81) = 0.49	
	$Pospat_t$		$Poch_t$	$Poch_{t-1}$
	Estimates	0.20*	**0.29***	**0.20***
	(t)	(10.36)	(4.76)	(3.39)
R^2 = 0.68	Q (26-0) = 30.43	DW = 1.82	$F^{(1)}$ (1.81) = 43.40*	

(1) Test to verify the sum of elasticities to be equal to 1.
* Level of significance of the t-test, Q and F: 1%
** Level of significance of the t-test, Q and F: 5%

The determination coefficients (R^2) proved to be satisfactory in all the equations as they indicated that alterations in the dependent variables are satisfactorily explained by the independent variables.

In the case of the test to verify the sum of price transmission elasticities to be equal to 1, we have the following: i) seven equations were estimated for the decade of the 1980s, and the sum of elasticities was not equal to 1 in three of them, as shown in Table 05; ii) twelve equations were estimated for the decade of the 1990s, and the sum of elasticities was not equal to 1, as shown in Table 06.

These results can be interpreted in the following way: Taking price transmission from Chicago to Parana in the 1990s (Table 06) as an example, it can be noted that an increase of 1% in the Chicago soybean price will cause an increase of 0.62% in the Parana soybean price instantly, i.e., in the same month. This less than proportional price transmission is a change from Aguiar's (1990) finding that there was a more than proportional price transmission from the external to the internal soybean market in the 1980s.

4. Conclusions

This research analyzed relationships among soybean, soy meal, and soy oil prices in both the internal and external markets at different market levels, i.e., producer, wholesaler, retailer, over two time periods, January 1982 to December 1989 and January 1990 to December 1999. The general results were as follows:

i) Some causal relationships between price series changed from one time period to the other.
ii) Generally, the soy sector price transmission period was verified to be very short, a month at maximum; though, this process was extended to two or three months a very few cases. The short transmission period indicates price transmission efficiency between market levels and between the regions studied.

Specifically, we conclude that there is a causal relationship between price series in the international market and price series in the internal market, mainly in the decade of the 1990s.

We also observed that producer level price variations tend to be preceded by variations in the international market and at the wholesale level (both for soy oil and meal). That can be explained by the rural Brazilian producers lack of information and marketing power relative to the other market levels.

Aguiar, in his study of the soybean complex in the decade of the 1980s, found that external price variations were transmitted to internal markets more than proportionally. This was not the case in the 1990s.

Our study did not verify a causal relationship between soybean prices in the internal market and soybean prices in the external markets. In the case of soybean meal, there were one-way relationships between external prices and internal prices. In the case of soybean oil, there were no causal relationships between external prices and internal prices, though there was found to be a bi-causal relationship between soy oil prices in the internal wholesale and retail markets.

The results allow us to conclude that interdependence between the Brazilian soybean and soybean derivatives markets and the international market intensified as a result of the economic opening process that began in the early 1990s. It is clear that this growing interdependence increased the significance of Brazil's commercial policies directed toward the soy sector.

Recent Brazilian currency devaluation and easing of the ICMS tax on soy exports greatly affected the country's soybean complex. Devaluation increased the profitability of soybean sector enterprises, especially in local currency terms. Export tax easing had a considerable, greatly differentiated impact on the various links in the complex's chain. While tax reduction increased soybean profitability, it also partially inhibited soy-complex industrial activity by increasing costs (even for raw material). As Brazilian soybean derivatives prices are determined outside Brazil, there is no way to transfer these increased costs to the external market. The result is a loss of competitiveness, thus, the loss of a portion of Brazil's share in the world soybean derivatives market.

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