Price Transmission for Agricultural Products in Brazil

Geraldo S.A.C. Barros and João G. Martines[1]

Abstract: This paper analyzes the farm, wholesale, and retail price series of nine agricultural products (rice, beans, maize, soyabeans, potatoes, onions, bananas, tomatoes, and oranges). Causality analysis is carried out to determine the possible existence of a market level that systematically tends to lead price changes. Immediate and total elasticities of price transmission are estimated to provide evidence regarding the relative size of price variations at different market levels. All results relate to the city of São Paulo, as a consumption centre, and the relevant supplying wholesale firms and production regions. For most of the products analyzed (those traded predominantly in the domestic market), wholesale was detected to be the market level at which price changes were initiated. For products traded internationally—like soyabeans and oranges—the farm level was apparently the point from which price changes are transmitted to the domestic market. Price transmission may also originate at the retail level for products with high income elasticity of demand or with a consumption pattern affected by weather conditions, like oranges and tomatoes. In general, a price change initiated at the wholesale level is reasonably reduced when it reaches the retail level. Almost all other price changes tend to be transmitted approximately proportionally between market levels. Price transmission is distributed over time, but most of the variation tends to be transmitted within three months of the initial shock.

Introduction

In Brazil, as in many other Latin America countries, people are concerned with the inflationary effects of agricultural price shocks as well as with their transmission along the marketing system. At the same time, people believe that marketing agents, at both wholesale and retail levels, are always able to increase their selling price more than proportionally to the increase in costs, resulting in ever increasing marketing spreads and profits. As a consequence, agricultural market intervention—such as price and marketing margin ceilings, import subsidies, and export taxes and quotas—have been common practices in Brazil.

In order to better understand the behaviour of prices along the marketing channels, this paper analyzes farm, wholesale, and retail price series of nine agricultural products (rice, beans, maize, soyabeans, potatoes, onions, bananas, tomatoes, and oranges). Special interest is directed towards both the direction and intensity of price transmission.

The analytical procedure to be used includes two phases. First, causality analysis is used to determine the direction of price transmission. Second, elasticities of price transmission are estimated to provide evidence regarding the relative size of price variations at different market levels.

Theoretical Aspects

Market structure has been considered the most important factor associated with the direction and intensity of price variations. Gardner (1975) provided a comparative-static model explaining farm-retail price spread formation and the price transmission process. Competitive equilibrium price variations may originate at any market level—farm, wholesale, or retail. With respect to price transmission, Gardner shows that its elasticity, as measured from the farm-to-retail level, will be less than or at most equal to unity if constant returns to scale prevail in the marketing process and if the elasticity of supply of marketing inputs is higher than both the elasticity of supply of the farm product and the elasticity of demand at the retail level.

Heien (1980) formulated a dynamic model in which competitive disequilibrium is allowed at the retail level. In this model, only farm-to-retail price transmission is possible, since markup pricing is assumed. Although markup pricing is compatible with market competition, as illustrated by Heien's model, this type of behaviour is usually associated with noncompetitive markets. Indeed, in many situations, the assumption of competition in the marketing sector may be seen as rather unrealistic.

Access to information as well as abilities to assimilate and respond to it are not uniformly distributed along the several levels of the marketing system. In addition, structural differences and the degree of specialization can affect how quickly prices change in response to available information regarding market conditions. These characteristics may favour wholesale agents both in terms of access to information and ability to lead price changes.

Ward (1982) presented evidence for fresh vegetables in the USA that wholesale prices tend to lead both retail and shipping-point prices. Results indicating that wholesale prices lead retail prices are also presented by Heien (1980) for several food products in the USA. Kinnucan and Forker (1987) decided to assume a unidirectional upward causal relationship between farm level and retail prices. In general, estimates of the elasticities of price transmission, as measured from farm or wholesale levels to retail, are less than one.

Data and Methods

The city of São Paulo was selected as the consumption centre, and relevant marketing channels and production regions were defined for each food product analyzed—rice, beans, maize, soyabeans, potatoes, onions, bananas, tomatoes, and oranges. In the cases of maize and soyabeans, prices at wholesale and retail levels refer to the most relevant form for human consumption; maize flour and soyabean oil, respectively. For rice, beans, maize flour, and soyabean oil, the supermarket was chosen as the relevant retail unit. The "feira livre"—a popular street market where many small traders operate—was selected as the retail unit for fruits and vegetables. For these products, the wholesale level considered was the Central de Abastecimento de São Paulo, a state promoted and controlled wholesale market. Products sold at the supermarket were supplied at wholesale by the industries (in the case of maize and soyabean products) and by traditional wholesale units (in the case of rice and beans). Monthly price data from 1972 to 1985 were obtained from the Instituto de Economia Agricola (State of São Paulo) and Fundação Getúlio Vargas.

The method for testing the direction of causality among prices at the three market levels was devised by SIMS (1972). Jacobs, Leamer, and Ward (1979) discuss the several meanings of causality tests. The procedure suggested by SIMS detects causality in Granger's sense.

The test proceeds by first filtering the series. Absence of autoregressive residuals was confirmed by the Box-Pierce test Q (Box and Pierce, 1970). Two basic regressions are run:

$$(1) \ Y_t = a_0 + a_1 X_t + \sum_{i=1}^{4} a_{2i} X_{t+i} + \sum_{k=1}^{8} a_{3k} X_{t-k} + \sum_{j=1}^{11} a_{4j} D_j + a_5 t = e_{1t}, \text{ and}$$

$$(2) \ X_t = b_0 + b_1 Y_t + \sum_{i=1}^{4} b_{2i} Y_{t+i} + \sum_{k=1}^{8} b_{3k} Y_{t-k} + \sum_{j=1}^{11} b_{4j} D_j + b_5 t + e_{2t},$$

where X and Y are two price series, say wholesale and retail prices, D represents monthly seasonal dummy variables. Two hypotheses regarding coefficients of future variables are tested by means of an F-statistic (Bishop, 1979).

Elasticities of price transmission are estimated according to the direction of causality previously determined. For example, if causality runs from X and Y, then, following Ward (1982), the following regression is run:

$$(3) \ ln \ Y_t = B_0 + \sum_{i=0}^{h} B_i \ ln \ X_{t-i} + \mu_t,$$

where the B_i are the elasticities of price transmission. The total response of Y (say retail prices) to changes in X (say wholesale prices) is assumed to be distributed over time (Kinnucan and Forker, 1987). The number of lags to be considered is determined by a F-test of exclusion of variables form an "unrestricted" model with $h = 12$.

When causality is bidirectional, a simultaneous model is run. Another equation analogous to *(3)* is included, with X being the dependent variable and Y the explanatory variable. In this case, the restriction $h \leq 2$ was imposed. Two-stage least squares was the estimation method used.

Table 1—Effects of a 10-Percent Variation in the Wholesale Price on the Retail Price, São Paulo, 1972-85

Product	Immediate Effect	Total Effect	Lags
	- - Percent - -		Months
Bananas	1.06	5.02	4
Potatoes	3.96	6.30	1
Onions	5.39	8.18	1
Beans	5.39	8.89	1
Maize flour	5.55	5.55	0
Soyabean oil	4.68	10.65	6
Tomatoes	0.00	6.02	2

Results

The results from the analysis of causality may be summarized as follows: (a) causality is from wholesale to both farm and retail levels for rice, bananas, potatoes, onions, and beans; (b) causality is from farm level to wholesale and from retail to wholesale for oranges; (c) unidirectional causality is from wholesale to farm level and bidirectional causality is between wholesale and retail for tomatoes; and (d) bidirectional causality is between farm and wholesale and unidirectional is from wholesale to retail for soyabeans and maize.

Estimates of the elasticities of price transmission are presented in Tables 1 to 4 only for those marketing linkages in which causality was detected. Three characteristics of the price transmission mechanism are reported: immediate (current month) and total (given by summation of significant coefficients) effects of a 10-percent price change at one level on the other level and the number of lags associated with the total effects. A substantial part of the total effect takes place within three months of the initial price shock.

In general, a price change initiated at the wholesale level is reasonably reduced when it reach-

Table 2—Effects of a 10-Percent Variation in the Farm Price on the Wholesale Price, São Paulo, 1972-85

Product	Region	Immediate Effect	Total Effect	Lags
		- - Percent - -		Months
Potatoes	Minas Gerais	24.38	9.71	2
Onions	Campinas	14.48	9.99	2
Beans	Sorocaba	8.09	8.09	0
Oranges	São Paulo	4.88	4.88	0
Maize flour	São Paulo	64.89	18.31	2
Maize flour	Paraná	15.80	10.01	2
Soyabean oil	São Paulo	5.73	5.73	0
Soyabean oil	Mato Grosso	4.60	4.91	1

Table 3—Effects of a 10-Percent Variation in the Wholesale Price on the Farm Price, São Paulo, 1972-85

Product	Region	Immediate Effect	Total Effect	Lags
		- - Percent - -		Months
Bananas	São Paulo	4.31	8.51	1
Potatoes	Campinas	5.99	9.26	4
Potatoes	Sorocaba	5.51	9.04	4
Potatoes	Paraná	2.82	9.83	2
Potatoes	Minas Gerais	0.00	7.70	2
Onions	Santa Catarina	2.30	9.95	3
Onions	Sorocaba	6.55	9.92	9
Onions	Campinas	1.98	14.74	2
Beans	Paraná	3.65	7.42	3
Beans	Campinas	6.79	9.49	3
Maize flour	Minas Gerais	2.14	7.20	1
Maize flour	São Paulo	8.92	9.12	2
Maize flour	Paraná	10.83	9.94	2
Tomatoes	Minas Gerais	23.56	11.50	2
Tomatoes	Sorocaba	6.93	9.11	8
Tomatoes	Campinas	7.70	9.41	8

es retail level. Almost all price transmissions involving wholesale and farm levels as well as those originating at the retail level tend to be approximately proportional to the initial shock; i.e., given enough time, a 10 percent change at one level of the market tends to result in a change of about 10 percent at the other level.

Table 4—Effects of a 10-Percent Variation on the Retail Price on the Wholesale Price, São Paulo, 1972-85			
Product	Immediate Effect	Total Effect	Lags
	– – Percent – –		Months
Oranges	6.51	10.37	12
Tomatoes	12.28	8.01	2

Conclusions

For many products—bananas, potatoes, onions, maize flour, and beans—wholesale was detected to be the market level at which price changes tended to initiate. All those products are traded predominantly in the domestic market.

Products traded internationally, like soyabeans and oranges, present price changes originating at the farm level. Apparently what happens is that, when the orange juice price changes in the external market, the national juice industry transmits the variation to orange growers. In the sequence, the domestic price would change at the wholesale level. An analogous linkage could be established between soyabeans or meal and soyabean oil.

Price variations may also begin at the retail level. Apparently this is the case for products presenting high income elasticity of demand or a consumption pattern significantly affected by weather conditions, like oranges and tomatoes. In other cases, like those of rice, maize flour, beans, and soyabean oil, retail agents play a passive role in the price transmission mechanism.

An important conclusion of the paper is that no evidence exists that the marketing sector tends to widen the initial price shocks. Since, in most cases, price transmission is at most proportional, the current opinion of unstabilizing behaviour in the marketing system is not justified. Therefore, price controls are not needed for this purpose and may indeed be a source of great distortions in the market.

Note

[1]Escola Superior de Agricultura "Luiz de Queiroz," Universidade de São Paulo.

References

Box, G.E.P., and Pierce, D.A. (1970) "Distribution of Residual Autocorrelations in Autoregressive Integrated Moving Average Time Series Models," *Journal of American Statistical Association*, Vol. 65, No. 332, pp. 1509-1526.

Bishop, R.V. (1979) "The Construction and Use of Causality Tests," *Agricultural Economics Research*, Vol. 31, No. 4, pp. 1-6.

Gardner, B.C. (1975) "The Farm-Retail Price Spread in a Competitive Food Industry," *American Journal of Agricultural Economics*, Vol. 57, No. 3, pp. 399-409.

Heien, D.M. (1980) "Markup Pricing in a Dynamic Model of the Food Industry," *American Journal of Agricultural Economics*, Vol. 61, No. 1, pp. 10-18.

Jacobs, R.L., Leamer, E.E., and Ward, M.P. (1979) "Difficulties with Testing for Causation," *Economic Inquiry*, Vol. 17, No. 3, pp. 401-413.

Kinnucan, H.W., and Forker, O.D. (1987) "Asymmetry in Farm-Retail Price Transmission for Major Dairy Products," *American Journal of Agricultural Economics*, Vol. 69, No. 2, pp. 285-292.

Sims, C. (1972) "Money, Income and Causality," *American Economic Review*, Vol. 62, No. 4, pp. 540-552.

Ward, R.W. (1982) "Asymmetry in Retail, Wholesale and Shipping Point Pricing for Fresh Vegetable," *American Journal of Agricultural Economics*, Vol. 64, No. 2, pp. 205-212.

DISCUSSION OPENING—*Lilian Barros* (University of Exeter)

This paper covers an important subject and uses an appropriate approach for high-inflation countries. Critical policy intervention points (farm price supports, wholesale margin regulations, and consumer prices controls) and critical product groups are covered.

My questions pertain to the size of the coefficients and to "how to" issues; i.e., causality of price changes is difficult to determine in quantitative terms only and *a priori* assumptions for product groups might be useful, perhaps based on price elasticities of supply (ε_s^P) and income elasticities of demand (ε_D^Y).

I suggest grouping the products based on the reported results, as follows:

High ε_s^P → High Tech → Oligopoly (e.g., oranges)
    $+\Delta P$: *Farm* → Wholesale

Low ε_s^P → Low Tech → Price takers (e.g., rice and beans)
    $+\Delta P$: Farm ← *Wholesale*

High ε_D^Y → "Luxury" or expensive foods (e.g., tomatoes and oranges)
    $+\Delta P$: Wholesale ← *Retail* or Wholesale ↔ Retail

Low ε_D^Y → staple foods, steady demand for exports (e.g., soyabean oil)
    $+\Delta P$: *Wholesale* → Retail

Combining the assumptions yields:

ε_s^P	ε_D^Y	Source of $+\Delta P$	Product
High	High	*Farm* → Wholesale Wholesale ← *Retail*	Oranges
High	Low	*Farm* → Wholesale *Wholesale* → Retail	Soyabeans
Low	Low	Farm ← *Wholesale* *Wholesale* → Retail	Beans
Low	High	Farm ← *Wholesale* Wholesale ← *Retail*	Tomatoes

The reported coefficients on retail price changes seem more "dangerous" than those on the other price levels. The sizes of the coefficients reported for the 6-month lagged wholesale-to-retail price transmission for soyabean oil (11 percent) and the immediate farm-to-wholesale price transmissions for potatoes (24 percent), maize flour (65 percent), and onions (14 percent) seem large. Finally, why do the price effects vary by location (e.g., the wholesale-to-farm price transmission for onions, which varied from 9 to 15 percent)?

GENERAL   DISCUSSION—*Gopal   Naik*   (Indian   Institute   of Management)

Several questions were raised by the participants: whether the upper limit of the elasticity of price transmission be 1, even in the long run, and whether this will hold when one analyzes retail-to-farm level prices. Even if the causation is correct, errors of measurement will tend to depress the coefficients unless diagonal regression is used. The reasons for different results of causality for different commodities need to be explained.

In reply, Barros noted that price controls have undesirable effects on commodity supply. In the past, due to such price controls, many products disappeared from the market. He noted the suggestion by the discussion opener to classify commodities according to elasticities as an interesting one. Barros clarified that he did not mean the upper limit of the elasticity of price transmission should be 1. He said that he is aware of the problems of the causality method used, but he is comfortable with it in his study. He used the single-equation method to test unidirectional causality.

Participants in the discussion included G.T. Jones, W. Martin, and F. Rosa.