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Delineating the Nature and Extent of the Market for Agricultural Commodities*

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In this paper, an approach is suggested for defining the nature and extent of a geographic market and a product market for agricultural commodities relying on the concept of instantaneous causality. The market(s) for rice is (are) used for the empirical implementation of the approach. The results, based on both domestic and world prices, suggests that the extent of the geographic market changed between 1968 and 1986. This has obvious policy implications.

I. Introduction

Endeavoring to delineate the nature and extent of competition in the market for various agricultural commodities is important for a variety of reasons. For example, such information is significant in formulating marketing strategies and in developing pricing decisions. Alternatively, in antitrust considerations, both the product market and geographic market are relevant.[1] Thus, in the case of a geographic market, if prices of an agricultural commodity supplied by different economic agents tends to uniformity (given allowances for transportation cost) and if prices outside the market are independently determined (that is, if the demand and supply determiants in the market(s) outside are for the most part independent of the demand and supply determinants within the market of interest), then a geographic market is the area in which collusion can successfully take place resulting in higher prices for the commodity in ques-

* The views expressed are those of the author and do not necessarily represent the policies of the Department of Agriculture or the views of other Department of Agriculture Staff members.

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1 See Department of Justice (1984).

ferent products where the demand confronting them is neither completely sensitive nor completely insensitive to the prices charged by the producers. Consequently, the gaps that were postulated to bound a market need not be recognized equally by all producers within the market since all producers need not be equally sensitive to price changes of imperfect substitutes. Gaps can appear in different places for different brands during different phases of the business cycle, for different magnitudes of price changes of substitutes, and for different conditions in the markets of the different consumers.

Economic theory does not suggest that agricultural commodities making up a relevant market must exhibit identical prices. Rather, the factors posited by Jevons are more relevant. Jevons contends that, when attempting to delineate a market, the variation in the price of any good or service will tend to affect, in the same direction, the price of all like goods or services. Commodities, for example, need not be physically identical nor would one expect their prices to be always equal. But prices will move together over time.

It might be the case that prices between competing agricultural commodities are to be different but if the conditions of demand and exchange are interdependent, the ratio of their prices, all other things equal, will remain constant over time. This observation gives rise to the conclusion by Areeda and Turner (1978) that "close price relations among products over a substantial period of time are sufficient to establish a strong presumption that the products should be included in the same market" (p. 352).

It must be remembered that the degree of price uniformity and the extent to which different goods or services constitute a single market will be dependent on the relevant cross-price elasticities which, in turn, are a function of the direct (own) price elasticity for the good or service (Horowitz (1977)). This latter factor should be apparent in the price correlations.

There are a number of limitations, however, in using simple price correlations to infer anything about the extent of the product or geographic market. Foremost among the limitations is that simple price correlations do not imply causality (Granger and Newbold (1977)). For example, two price series that possess significant upward trends due to general inflationary pressure will exhibit a relatively high positive correlation. Such trends must be removed before performing analyses for inferential purposes.

Another shortcoming is that simple correlation analysis does not consider the dimension of time. Consequently, the fact that two com-

Followng Granger (1969), let (A_t, $t = 0, \pm 1, \pm 2, \cdots$) be the given information set, including at least (X_t, Y_t). That is, A consists of all data series that are available for all time periods. Let $\overline{A}_t = (A \mid s < t)$, $\overline{\overline{A}}_t = (A \mid s \geqslant t)$, and similarly define $\overline{X}_t$, $\overline{Y}_t$ $\overline{\overline{X}}_t$, $\overline{\overline{Y}}_t$. Thus, for example, $\overline{A}$ consists of all of the observations from the available data series existing prior to period t while $\overline{\overline{A}}$ consists of all of the observations from the available data series arising in period t and thereafter. Let $P_t\ (Y \mid B)$ denote the minimum mean square error single step predictor of Y_t given an information set B and $\sigma^2\ (Y \mid B)$ the resulting mean square error.

Now X causes Y instantaneously if

$$(1) \quad \sigma^2\ (Y \mid \overrightarrow{\overline{A}}, X) < \sigma^2\ (Y \mid \overline{A}).$$

Note that this definition is in terms of single period predictions. That is, X causes Y instantaneously if the inclusion of current period and future values of X improve the prediction of Y over the case when X is excluded. Pierce (1975), however, has shown that if this holds for any multiperiod prediction then it also hold for a single period prediction.

While this definition is technically accurate, it is not directly implementable. To this end, consider the following discussion.

Assume that the information set consists of two variables X and Y and that there exist transformations

$$(2) \quad x_t = T_x\ X_t$$

$$(3) \quad y_t = T_y\ Y_t$$

such that (x_t, y_t) is a nonsingular linear covariance stationary, purely nondeterministic time series where X and Y are related causally in the same manner as x and y. Frequently, T_x and T_y will consist of first differences or seasonal differences since it is often the case that this type of transformation is both necessary and sufficient to render the observed series stationary. Since such transformations are linear and since the optimal predictors in terms of the definition of causality used here are also linear, any causality event is true of (X, Y) if and only if it is true of (x, y). Under these restrictions on x and y, it has been shown (Hannan (1970)) that the bivariate process $\begin{pmatrix} x_t \\ y_t \end{pmatrix}$ has the representation

$$(4) \quad \begin{pmatrix} x_t \\ y_t \end{pmatrix} = \sum_{j=0}^{\infty} \phi_j \begin{pmatrix} a_{t-j} \\ b_{t-j} \end{pmatrix} = \phi(B) \begin{pmatrix} a_t \\ b_t \end{pmatrix},$$

tion of u_t. This forms the basis of the statistical test to be employed. That is, it must be determined, for the market(s) under consideration, whether γ_0 is statistically significantly different than zero. In particular, to empirically implement the test, the data series must be suitably transformed (i.e., as in relationship (6)) and the residual white noise series used in a regression analogous to relationship (8). The peresence of statistical significance on the coefficient γ_0 will lead one to conclude that instantaneous causality exists.

This test is to be applied in what follows to a specific agricultural commodity, namely rice, to determine (1) whether there are different geographic markets or whether there is in fact a single world market for the commodity and (2) to determine whether there are different product markets. It is important to keep in mind that two seemingly different products will be considered as part of the same market (either geographic or product) only if instantaneous causality holds, which, in turn, will be the case only if the criterion discussed previously is satisfied.

Prior to turning to the implementation of the test, the rice market will be discussed along with the data used in the analysis.

III. The Product

Rice is the primary food for over one-half of the world's population. Currently, rice produced in the United States accounts for 19 percent of all rice shipped in international trade while accounting for only 1.3 percent of world production. Other major exporters of rice include Thailand (accounting for about 34 percent of the total in 1987) and Pakistan (accounting for about 8.9 percent of the total in 1987).

There are three general varieties of rice grown in the world including short again, medium grain, and long grain. Various regions of exporting countries tend to concentrate on one, or at most two, types. In the United States, for example, Arkansas, Texas, and Mississippi producers grow mostly long grain rice while California and Louisiana lead in medium grain production. Thailand, on the other hand, grows mostly long grain rice. The decision on which grain size to plant is a function of soil conditions, weather, crop yield, and world market conditions. (This latter consideration is argued by Unnevehr (1986), among others, as being important.)

In general the world rice industry has a relatively simple market structure. The production of rice geographically is much more restricted than most other field crops and rice exchanges hands fewer times between farmer and ultimate consumer. The normal movement from farmer to

Before proceeding to address the problem of defining the extent of the rice market empirically, a short digression on the importance of looking at the specific agricultural commodity (i.e., rice) is warranted. Interest in the issue of the rice market definition is prompted by recent instances in which this concern arose in antitrust matters involving California rice millers (Note that data on California rice prices are not included in the analysis because they do not go back to 1968). In 1982 the proposed acquisition of Pacific International Rice Mills, Inc. (PIRMI) by Early California Industries, the owner of Comet Rice, was abandoned after the U.S. Department of Justice's (DOJ) Antitrust Division announced its intention to file an antitrust suit. When Rice Growers Association of California (RGA) (the largest California miller) acquired PIRMI (the third largest) in 1984, the Antitrust Division initiated litigation which was successful in forcing a diverstiture. From the publically available record of these cases, it is possible to discern the market definition used by the DOJ in determining that these acquisitions would be anticompetitive. The product market was argued to be medium grain rice (the predominant type of rice grown in California) and the geographic market was argued to be the states of the Pacific region of the United States. The market so defined would show high concentration at the milling level. The combined market share of the four largest rice millers-RGA, PIRMI, Comet, and Farmers' Rice Cooperative — was given at 95 percent. The combined market share of RGA and PIRMI was given at 51 percent. In accepting the DOJ's market definition, the acquisitions would seem to pose a genuine competitive concern. If the long and medium grain rice produced and milled in the southern rice-producing states (accounting for about 90 percent of all rice produced in the United States) and also if the rice exported from countries in the rest of the world were included in the relevant market, it would be less plausible to argue that the acquisitions would create or enhance market power. If the broader market definition had been adopted by the court, the outcome of the RGA case might have been different.

IV. Empirical Results

If there is only a single geographic market and product market for rice, then one would expect to see the prices of all types of rice in the various geographic locations demonstrating a close relationship (in the fashion discussed in the section on instantaneous causality) to one another.

In order to implement the test for instantaneous causality, the filters F(B) and G(B) of relationship (6) must be estimated. The filter estimates, in turn, can be used to estimate the vector (u_t, v_t). Subsequently, v_t is regressed on lagged values of v and current period and lagged values of u.

The estimation results for all combinations of the residual price series (i.e., 40 different combinations) for relationship (8) where j is even of moderate size are quite voluminous. Consequently, only a selected number of price residual series combinations for various locations are reported. Results for other combinations will be briefly mentioned. Moreover, only those results where j is permitted to range from 0 to 12 are presented. Since the choice of j is arbitrary, it is interesting to note that the outcome of the analysis did not change when j was allowed to range up to a value equal to 24. The residuals from each price series are paired separately to the remaining series (e.g., the Arkansas medium grain rice price residual series (AM) is paired to the Houston long grain rice price residual series (HL), the Louisiana medium grain rice price residual series (LM), the Louisiana long grain rice price residual series (LL), and the Thailand rice price residual series (TH)). The estimates of the coefficients are obtained via classical least squares (Classical least squares estimation was the preferred technique because there was no suggestion in preliminary analyses that the common problems in time series data (e.g., heteroscedasticity) were present here.) The results for a limited number of series combinations for the 1968-1972 period are given in Table 2a and for the 1973-1986 period, they are given in Table 2b (The other regression results are available from the author). Additionally, the δ_j are not given since they are never statistically significant (as one would expect if the filters are properly identified and estimated).

The results are quite interesting. Instantaneous causality cannot be statistically rejected at even the 95 percent level for any of the paired combinations reported for the 1968-1972 period (see Table 2a) for milling centers in the United States (nor could it be rejected for any of the unreported estimates involving U.S. milling centers). That is, estimates of γ_0 are uniformly highly statistically significant when various types of rice at different U.S. milling centers are considered. Thus, there is just a single product market for all types of rice milled in the United States. Moreover, none of the other coefficients on the estimated relationship proved to be statistically significant which has implications in testing for unidirectional and bidirectional causality (which is not the subject of the present concern). (See Geweke, et al. (1983)). (It should be noted that this result is not consistent with the results reported in Brorsen, et al (1985). They find, for example, Arkansas prices impacting Houston prices but not the other way around (i.e., Houston prices do not affect Arkansas prices). That is, they only find unidirectional causality in some instances. Their analysis, however, is incorrect in a number of places. Consequently, their results are simply discounted is passing.)

The results looking at rice produced in Thailand versus domestically produced rice is also quite revealing. During the period for which the U.S. price of rice was above the Thailand price due to the price support program of the U.S. government, the results strongly indicate that rice produced in Thailand was not in the same market as rice produced in the United States. That is, because the price support program for U.S. produced rice maintained the price of rice in the U.S. at artificially high levels, the extent of the geographic market for U.S. produced rice was less than the entire world and less than it might otherwise have been.

Now turn to the results for the 1973-1986 period when as noted above, a variety of factors affected the quantity of rice produced in the world. Table 2b reports the results of the instantaneous causality test for this period. There is a quite different conclusion now. The extent of the geographic market has broadened to include the entire world. That is, there are not two separate geographic markets consisting of the U.S. and the rest of the world as was the case over the 1968-1972 period, rather there is now only one world market for rice.

The inference one can draw from the application of the test for instantaneous causality is straightforward. Clearly, over the period 1973-1986 all types of rice in the various geographic locations are part of the same market. That is, one cannot reject the null hypothesis that there is a single rice market in the world. Price movements by one type of rice in one location are coincidentally matched by price movements in the other types of rice and locations within the same month. Moreover, there is no distributed lag process involved. That is, there is no indication that several months (i.e., two or more) are needed to exhaust the effects.

One additional interesting consideration is the size of the coefficient γ_0 when the various rice types and locations are considered. The results for the 1973-1986 period suggest that the price interrelationships are strongest for the United States milling centers and weakest (but still statistically significant) for the U.S. and Thailand combinations. Thus, there is the suggestion that the rice prices are most strongly related when the rice is milled in the United States in deference to when it is processed in Thailand.

An alternative approach to examining the extent of a geographic and/or product market (which can serve as a point of reference for the results obtained here) has been touted by Stigler and Sherwin (1983). They propose using simple correlation analysis. It is suggested that "If we find parallel price movements (as indicated by high correlations), the loci of the prices are in the same market." With regard to the magnitude of the correlation coefficient necessary to conclude that two goods are in the same product market, no unique criterion is offered. It is simply suggested that markets can show every level of interdependence and hence if a correlation coefficient of 0.9 makes two markets one, then a correlation of 0.7 or 0.8 implies a lesser degree of interdependence.

The correlations of the price series (original series) for the five rice type/location combinations for the 1968-1972 period are presented in Table 3a while the correlations for the 1973-1986 period are presented in Table 3b. Based on the examples provided by Stigler and Sherwin in their exposition, the size of these correlation coefficients strongly suggests that there was two separate markets for rice consisting of the rest of the world and the United States during the first time period (1968-1972) and one market consisting of the world for the second time period (1973-1986).

These results are entirely consistent with those obtained via the test for instantaneous causality. As noted previously, however, simple correlation analysis of the type used by Stigler and Sherwin has been shown to pro-

Table 3a

RICE PRICE CORRELATIONS: 1968-1972[a]

	AM[b]	HL	LM	LL	TH
AM	1.00	0.71	0.73	0.68	0.01
HL		1.00	0.78	0.72	0.02
LM			1.00	0.84	–0.02
LL				1.00	–0.01
TH					1.00

[a] The correlation matrix is symmetric.
[b] AM denotes the price of Arkansas Medium Grain Price, etc.

Table 3b

RICE PRICE CORRELATIONS: 1973-1986[a]

	AM[b]	HL	LM	LL	TH
AM	1.00	0.88	0.96	0.96	0.80
HL		1.00	0.81	0.84	0.94
LM			1.00	0.99	0.81
LL				1.00	0.78
TH					1.00

[a] The correlation matrix is symmetric.
[b] AM denotes the price of Arkansas Medium Grain Price, etc.

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