SPATIAL PRICE DIFFERENCES DURING MARKET TRADE TRANSITIONS

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APPLICABLE TRADE THEORY

Interregional trade and associated price differences between regions has been the subject of extensive economic analysis. Trade patterns reflect intraregional supply and demand conditions and transfer cost among regions. Once patterns of trade are established, price differences among regions simply reflect transfer cost from exporting to importing regions [1]. But, patterns of trade do not necessarily remain stable over time. Changes in areas of concentration of production and consumption causes price differences among areas to change. Examples of such market transitions include the movement of cattle feeding into the high plains area of Texas and Oklahoma and the development of the broiler industry in the South. Existing interregional trade theory provides all of the tools necessary to generalize regarding the behavior of price differences among regions during periods of transition from import to export positions and vice versa. However, little has been written regarding these import-export transitions. The purpose of this paper is to show that changes in price differences among regions during the transition period need not be abrupt, and that changes in price differentials, at least in some cases, follow a stable, explainable pattern of change.

The possible range of price differences between two regions may be defined as follows [3, 5].

Let: P_y = price in region y,
P_x = price in region x
T_{yx} = transfer cost from region y to region x, and
T_{xy} = transfer cost from region x to region y,

Then:

(1) $P_y - T_{xy} \leqslant P_x \leqslant P_y + T_{yx}$

If only two regions are included in a market transition analysis, price differences during the transition period may be defined as follows:

(2) Region x importing: $P_x = P_y + T_{yx}$

(3) Region x neither importing nor exporting: $P_y - T_{xy} < P_x < P_y + T_{yx}$

(4) Region x exporting: $P_x = P_y - T_{xy}$

In actual situations, there are typically many regions involved in patterns of trade and corresponding product price surfaces. If price in any given region "i" is denoted as P_i, and if region x is a net importer: $P_x = P_i + T_{ix}$ for at least one i. If region x is a net exporter, $P_x = P_i - T_{xi}$ for at least one i. If there exist some region i such that: $P_i + T_{ix} < P_y + T_{yx}$, and if region x is importing but not importing from region y:

(5) $P_x = P_i + T_{ix} < P_y + T_{yx}$

and when region x is exporting but not exporting to region y,

(6) $P_x = P_i - T_{xi} > P_y - T_{xy}$.

Thus, if region x makes the transition from an importing to an exporting region, there need not be an abrupt change in the price differential between region x and region y from $P_x = P_y + T_{yx}$ to $P_x = P_y - T_{xy}$. Instead, the price differential might go through a sequence of changes: from $P_x = P_y + T_{yx}$

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The author wishes to acknowledge the valuable consultations with R. A. King, R. A. Schrimper and L. A. Ihnen in developing the ideas contained in this paper. However, the author is solely responsible for any errors in its content.

to $P_x = P_i + T_{ix}$ (i = 1,q) to $P_x = P_i - T_{xi}$ (i = 1,ℓ) to $P_x = P_y - T_{xy}$, where q equals the number of regions where $P_i + T_{ix} < P_y + T_{xy}$ and ℓ equals the number of regions where $P_i - T_{xi} > P_y - T_{xy}$. Prices in region x will decline relative to price in region y in a sequential manner as the transition progress with the number of steps in the sequence dependent on the number of feasible alternative importing and exporting regions.

SIMULATED SPATIAL PRICE DIFFERENCES

To demonstrate changing price differentials during periods of market transition, reactive programming was used to simulate trade and price differences among five hypothetical regions as one region moves from a net import to a net export position and all other regions maintained their original position [4]. The assumed supply and demand curves for the five regions are shown in Table 1. The assumed transfer cost matrix is shown in Table 2. At a price of $20.00 regions B and D have excess demand, with the excess relatively larger in areas D, and areas C and E have excess supplies with the excess relatively larger in area E.

At a price of $20.00 all supply curves have elasticities of approximately –0.05 and demand curves have elasticities of approximately –0.40. Region A was used as the transition region with a_i taking on values from –280 to –580 in increments of 100 for the four comparisons used. Values of b_i were adjusted simultaneously with value of a_i to maintain the elasticity of supply at about –0.05. (b_1 = 1.43, b_2 = 1.10, b_3 = 0.83, b_4 = 0.69).

Equilibrium conditions of trade among regions and prices for each region were computed using the four different supply equations from region A (A_1, ..., A_4) while all other supply and demand equations were held constant. Table 3 shows the price relationships and trade conditions between region A and all other regions for each region A supply equation.

Using supply equation A_1, region A imported from both region C and region E. As supply of region A was increased, region A stopped importing from region E and reduced imports from region C. As region A moved to an exporting position, region A first exported to region B and then to region D.

Table 4 shows the difference in prices between region A and all other regions for each stage in the import and export transition. As region A decreases imports, region A prices decline relative to all other regions except the region from which region A is still importing. As region A moves to an export position, prices in region A continue to decline relative to all other regions except region B to which region A first

Table 1. SUPPLY AND DEMAND FUNCTIONS FOR REACTIVE PROGRAMMING SIMULATION (PRICE IN DOLLARS PER HUNDREDWEIGHT)

Region	Supply	Demand
A	$P = a_i + b_iq$	$P = 70 - 0.14q$
B	$P = -380 + 3.67q$	$P = 70 - 0.14q$
C	$P = -380 + 1.48q$	$P = 70 - 0.33q$
D	$P = -380 + 21.05q$	$P = 70 - 0.03q$
E	$P = -380 + 0.05q$	$P = 70 - 0.008q$

Table 2. TRANSFER COST AMONG HYPOTHETICAL REGIONS USED IN THE SIMULATION (DOLLARS PER HUNDREDWEIGHT)

	A	B	C	D	E
A	0	.25	.35	.75	1.00
B	.25	0	.45	.55	.80
C	.35	.45	0	.95	.70
D	.75	.55	.95	0	.95
E	1.00	.80	.70	.95	0

Table 3. EQUILIBRIUM PRICE AND TRADE BETWEEN REGION A AND OTHER REGIONS (DOLLARS PER HUNDREDWEIGHT)

	A	B	C	D	E
A_1					
Prices	21.17	20.97	20.82	21.12	20.17
Trade	210.6^{o}		121.8^{I}		16.3^{I}
A_2					
Prices	20.57	20.67	20.22	20.82	19.87
Trade	273.2^{o}		79.85^{I}		
A_3					
Prices	19.96	20.21	19.76	20.36	19.41
Trade	357.4^{o}	6.16^{E}			
A_4					
Prices	18.42	18.67	18.22	19.17	18.22
Trade	368.4^{o}	161.5^{E}		70.6^{E}	

o denotes production and consumption within region A
I denotes imports to region A
E denotes exports from region A

Table 4. PRICE IN REGION A MINUS PRICE IN EACH OTHER REGION (DOLLARS PER HUNDREDWEIGHT)

	B	C	D	E
A_1	.20	.35	.05	1.00
A_2	−.10	.35	−.25	.70
A_3	−.25	.20	−.40	.55
A_4	−.25	.20	−.75	.20

began exporting and region C which exports to the same areas as region A.

This simulation of a market in transition shows the general concept of sequentially declining prices as the transition occurs. Imports are received from regions of least net delivered cost. Exports are made to regions of maximum net return. If several import and export possibilities exist, the most profitable alternatives are utilized first, the least profitable are utilized last.

AREA PRICE DIFFERENTIALS

The point to point trading models used in the previous sections demonstrate the general concepts of price changes during market transitions but are rather inexact in the treatment of price differences between two large areas. But, from the point to point models, the hypothesis can be formulated:

(7) $$P_X - P_y = f(C_X - PR_X)$$

where:

P_X = average price in area X,
P_y = average price in area Y, and
$C_X - PR_X$ = net imports to area X (consumption minus production).

It can further be hypothesized that the relationship between $P_X - P_y$ and $C_X - PR_X$ will be positive.[1] That is, as net imports to area x decreased (or exports from x increase) during the transitional period, P_X will be expected to decline relative to P_y. The range of the

[1] Equation (7) is not meant to imply direction of causation because trade among regions and price differences are simultaneously determined by intraregional supply and demand.

relationship would be the same as in equation (1), but would be less precisely defined for the large area analysis. The import-price relationships become essentially continuous in the large area analysis because price changes among the many points within each area make only minute contributions to changes in average prices for an area as a whole.

THE NORTH CAROLINA EXAMPLE

North Carolina is an example of a market in transition with regard to the balance of pork production and pork consumption. During the past decade, North Carolina has moved from a net import position of over 100 million pounds per year to a net export position of about 90 million pounds per year. The Midwest has remained a major pork exporting region throughout the North Carolina transition period. From the above area model, pork prices in North Carolina would have been expected to decline relative to midwest prices as the production to consumption balance changed. Assuming no change in relative cost of marketing and processing between the two areas, live hog prices would have been expected to reflect a relationship similar to pork prices.

In Figure 1, North Carolina hog prices were compared to Interior Iowa and Southern Minnesota hog prices during the years of transition[2] [2]. The vertical axis represents differences between live hog prices in the Midwest market and live hog prices in North Carolina ($P_{nc} - P_{mw}$). The horizontal axis represents the difference between pork consumption and pork production in the State of North Carolina ($C_{nc} - PR_{nc}$). During the early 60's North Carolina imported substantial quantities of pork. A large portion of this pork came out of the Midwest. Thus price differences during the early 60's, as expected, reflected a price premium for North Carolina roughly equivalent to transfer cost between the two areas.

During the second half of the decade, North Carolina began the move toward a net export

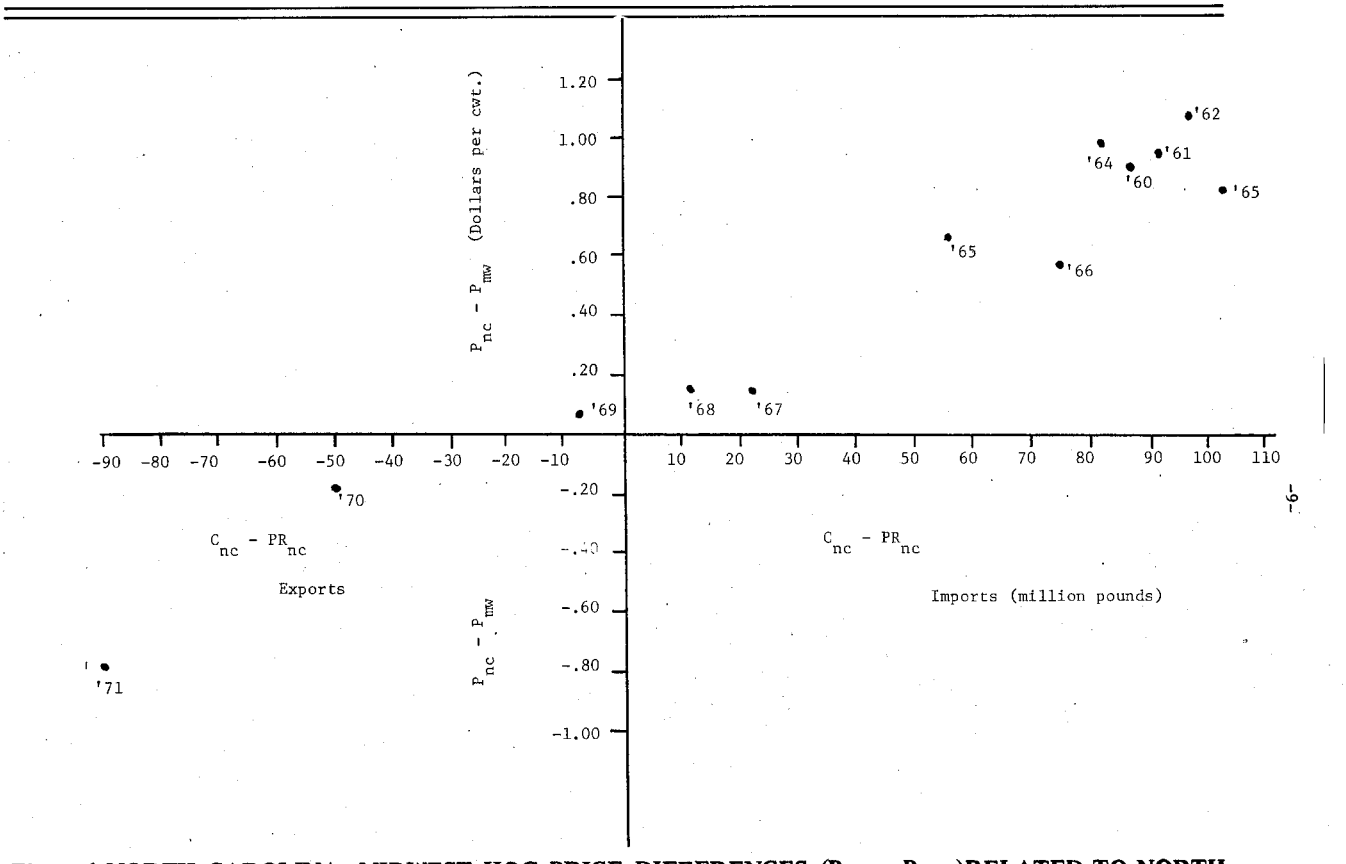

Figure 1. NORTH CAROLINA–MIDWEST HOG PRICE DIFFERENCES ($P_{nc} - P_{mw}$) RELATED TO NORTH CAROLINA CONSUMPTION-PRODUCTION BALANCE FOR PORK ($C_{nc} - PR_{nc}$). UNITS: DOLLARS PER HUNDREDWEIGHT AND MILLIONS OF POUNDS.

[2] Methods of marketing and price reporting are basically the same in North Carolina as for the Interior Iowa-Southern Minnesota market. Adjustments were made for differences in hog quality represented by the two price series.

position. As net imports declined, so did the premium of North Carolina hog prices over Midwest prices. North Carolina was able to achieve a net export position before prices fell below Midwest prices, but as exports continued to increase, North Carolina prices continued to decline relative to prices in the Midwest.

A simple linear least-squares fit of the data presented in Figure 1 yielded the following model and coefficient estimates.

$$P_{nc} - P_{mw} = 0.0942 + \underset{(14.14)}{0.0089}\,(C_{nc} - P_{nc})$$

The sign of the $C_{nc} - P_{nc}$ variable was positive as hypothesized and was highly significant with a t value of 14.14. The coefficient of regression, R^2, was .95 indicating that only about 5 percent of the variation in yearly price differentials was left unexplained after accounting for variation associated with the consumption-production balance. The standard error of the estimate was $0.13. (It should be noted that the above relationship is bounded by the range of prices denoted in equation 1).

The data sample was admittedly small and there are undoubtedly imperfections in the marketing systems which cause observed price relations to differ from those derived from theoretical bases. But nonetheless, hog price differences between North Carolina and the Midwest during the transition period of the 60's and early 70's seem to conform with the hypothesized behavior of price differences during market transition.

The magnitude of differences in prices and changes in prices between any two markets will depend on the nature of alternative markets. Price differences between any two regions depend on transfer costs not only between the two regions in question but also on transfer costs among alternative sources of supply and demand. Changes in price differences may be either abrupt or gradual in nature depending on the conditions of supply and demand in the alternative markets.

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