THE ADEQUACY OF THE INDEPENDENCE OF MARKETS ASSUMPTION IN INTERREGIONAL COMPETITION MODELS

W. Lanny Bateman

INTRODUCTION

An important function of agricultural economics is to determine the competitive potential for beginning or expanding production of a commodity in a specified area. This problem is approached through budgeting techniques and/or more sophisticated models such as linear or reactive programming. Many examples using LP or reactive programming algorithms are available. In two recent studies, reactive models were used to examine the market for potatoes [3] and sweet cherries [4]. These studies provided an insight into the relative competitive position among producing areas and among consuming centers. To reach a solution, the competitive assumption of LP or reactive models requires independence of supply functions for producing regions and demand functions for consuming markets. Thus, frequently the demand price for a given commodity in a market is estimated as a function of volume in that market and perhaps time, income or other variables. The resulting equation is used by inserting the mean value of all explanatory variables except volume, resulting in an equation that has price as a function of volume, plus a constant, and is compatible reactive programming.

The solution algorithm to a reactive programming model requires that producers ship to consuming centers where net revenue is highest. For example, Arizona would ship lettuce to New York as long as the New York price, less transfer costs, exceeded the Chicago price less costs. If the New York price became low, shipments would then go to Chicago. Thus, the competitive model would indicate the expected positive relationship between prices in different markets.

If there is limited competition, or if industry structure is such that some markets or supplying regions influence the market, then competitive models will not correctly estimate competitive potential for entering or expanding in a market. The positive price relationship could exist, but at a different level than the competitive model would imply. The assumption of independence then becomes critical and may not be sufficient to use and interpret results. This paper examines factors affecting the Chicago wholesale — Arizona shipping point price spread for lettuce. Results provide useful information in determining the adequacy of the indepencence assumption for interregional competition models.

DATA AND CONCEPTUAL FRAMEWORK

Under competitive conditions, the price of a commodity among spatially separated markets should differ by no more than transportation cost differences. The extent that this is not true can be attributed to unequal costs and availability of transportation (including mode) and differing supply and demand conditions. In any case, an indication of a departure from a competitive market opens the possibility of interrelated prices among markets.

Lettuce was selected as an appropriate commodity for initial study, because it is the largest volume fresh vegetable produced. In addition, its value of production exceeded other fresh vegetables in 1973 and 1974. Production is concentrated in Arizona and California. In 1970-73 these two states accounted for over 85 percent of total unloads; however, shipments were rather evenly distributed over 41 cities [6].

Data upon which the analysis was based

Assistant Professor, Department of Agricultural Economics, University of Georgia College or Agriculture Experiment Station, Georgia Station, Experiment (Griffin), Georgia 30212.

included the period 1963 through 1973. Two receiving points, Chicago and New York City, were used to examine the wholesale-shipping point price spreads from two Arizona shipping centers [5]. Other basic data included monthly lettuce unloads in Chicago, by origin and mode of shipment, with estimates of rail and truck miles from the selected shipping points.[1]

Regression analysis was used to examine the Chicago-Arizona price spread per carton of lettuce.[2] Data were organized to estimate the impact of trend, seasonality, volume from competing areas, relative demand and mode and distance of shipment (Table 1).

Table 1. DATA AND VARIABLES USED IN EXAMINING THE CHICAGO WHOLESALE-ARIZONA SHIPPING POINT PRICE DIFFERENCES

Variable	Code or data used	
Y	Chicago-Arizona lettuce price spread. Wholesale Chicago price less Arizona shipping point.	
V_1	Year, coded as 63, 64, ..., 73	
V_2	Jan.	
V_3	Feb.	V_2 through V_8 are dummy variables
V_4	Mar.	for the seven months of significant
V_5	April	Arizona shipments.
V_6	May	
V_7	Nov.	
V_8	Dec.	
V_9	Rail unloads of lettuce in Chicago from Arizona[a]	
V_{10}	Truck unloads of lettuce in Chicago from Arizona[a]	
V_{11}	Rail unloads of lettuce in Chicago from California[a]	
V_{12}	Truck unloads of lettuce in Chicago from California[a]	
V_{13}	Rail unloads of lettuce in Chicago from all other[a]	
V_{14}	Truck unloads of lettuce in Chicago from all other[a]	
V_{15}	Percentage of total U. S. unloads in Chicago	
V_{16}	Road miles from Arizona to Chicago	
V_{17}	Rail miles from Arizona to Chicago	
V_{18}	Road miles from California to Chicago	
V_{19}	Rail miles from California to Chicago	
V_{20}	New York wholesale price less Arizona shipping point price for lettuce	

[a] Unload are in carlot equivalents.

[1]Air miles were estimated using a program developed previously [2] and mileage was estimated from equations developed in [1, p. 74].

[2]Each carton contains 24 heads.

The Chicago price spread for Arizona shipping points is the dependent variable (Y). Two shipping points were used[3]; however, only one was appropriate for each month. The shipping point would be based on the relative volume or district for which a price was reported. V_1 was included to account for trend, and V_2 through V_8 were months coded as dummy variables. The months excluded either had no prices available or insignificant volumes shipped to Chicago. Variables V_9 through V_{14} are the volume data by mode of shipment. Only Arizona and California were considered separately with all other sources aggregated. V_{15} relates the Chicago unload volume for lettuce relative to the rest of the U.S. Estimates of mileage from the appropriate shipping point and shipping mode are contained in V_{16} through V_{19}. These variables were used in lieu of transportation costs for the various shipment modes. To the extent that these variables explained the price spread, the independence assumption would be upheld. The comparable price spread for New York City is V_{20} and was used to estimate its influence on the Chicago market.

RESULTS

Monthly receipts of lettuce in Chicago averaged 6.5 percent of total U.S. unloads (Table 2), but exhibited considerable variation. Origin of unloads in Chicago was comparable to the national pattern, with most coming from California and Arizona. Although monthly average receipts from these two states were comparable, there was greater fluctuation in monthly receipts from Arizona. Rail was the primary shipping method for lettuce. As expected, the Chicago-Arizona price spread was smaller than for New York-Arizona by virtue of the shorter distance from shipping points, but relative variation was greater for the Chicago market. Little can be concluded from Table 2 except that the assumption of independent markets cannot be discounted. A more detailed regression analysis was needed to identify those factors with the most influence on the price spread for Chicago.

Table 2. MEAN VALUES AND STANDARD DEVIATIONS: CHICAGO WHOLESALE AND NEW YORK CITY WHOLESALE-ARIZONA SHIPPING POINT PRICE SPREAD, MONTHLY UNLOADS IN CHICAGO FROM SELECTED SHIPPING POINTS AND PROPORTION OF TOTAL U.S. UNLOADS IN CHICAGO FOR LETTUCE, 1963-73

Item	Unit	Mean Value	Standard Deviation
Wholesale-shipping point price spread[a]			
Chicago-Arizona	dol.	1.49	0.604
New York-Arizona	dol.	2.15	0.775
Unloads by origin and shipping mode			
Rail-Arizona	carlot	151.7	85.3
Truck-Arizona	carlot	16.9	17.5
Rail-California	carlot	153.2	78.5
Truck-California	carlot	28.0	19.1
Rail-Other	carlot	9.0	13.9
Truck-Other	carlot	33.7	10.6
Proportion of U. S. in Chicago	percent	6.5	1.5

[a]Per 24 head carton.

[3]Two Arizona shipping points: Yuma and Central district. In addition, two producing regions in California were the Salinas district and the Imperial Valley.

The initial step was to estimate the extent to which variables in Table 1 explain the whole-sale-shipping point price spread for Arizona lettuce in Chicago. Generally, volume alone, whether a sum of all unloads or separated by origin and mode of shipment, was a poor indicator of the Arizona-Chicago price spread. The best-fitting equation in terms of R^2 and number of significant variables (run A, Table 3) used a volume to distance ratio by mode of shipment.

Table 3. ESTIMATED COEFFICIENTS FOR SELECTED FACTORS AFFECTING THE CHICAGO WHOLESALE PRICE SPREAD FOR ARIZONA LETTUCE[a]

		Run A		Run B		Run C[c]	
Item	Mean values	Coefficient[b]	Standard deviation	Coefficient[b]	Standard deviation	Coefficient	Standard deviation
R^2		.542		.601		.556	
Intercept		.20313		.55929		.29386	
Variable							
X_1		.019	(.038)	.006	(.036)	.011	(.038)
X_2		-1.114**	(.422)	-1.024**	(.400)	-.538	(.330)
X_3		-.553	(.403)	-.534	(.381)	.04	(.425)
X_4		-.321	(.549)	-.133	(.525)	.213	(.343)
X_5		-.689	(.452)	-.786*	(.429)	-.187	(.268)
X_6		.016	(.424)	-.016	(.401)	.555*	(.299)
X_7		-.241	(.447)	-.231	(.422)	.260	(.292)
X_8	.072	1.013	(9.473)	3.999	(9.041)	-.252	(9.58)
X_9	.008	7.831	(43.617)	34.923	(42.768)	2.29	(44.89)
X_{10}	.062	29.899*	(15.369)	33.735**	(14.615)	40.818**	(19.16)
X_{11}	.012	113.922***	(36.075)	97.346***	(34.8)	110.554***	(35.89)
X_{12}	8.983	-0.001	(.007)	-.0004	(.007)	-.003	(.007)
X_{13}	33.707	-.007	(.012)	-.005	(.011)	-.010	(.012)
X_{14}	.065	-21.331	(14.142)	-30.13**	(13.869)	-22.641	(15.186)
$(X_8)^2$	.007	16.513	(30.095)	9.57	(28.593)	21.21	(29.76)
$(X_9)^2$	.0001	-782.349	(1358.238)	-1513.07	(1319.936)	-494.62	(1400.11)
$(X_{10})^2$	.005	-164.317*	(90.444)	-149.37*	(85.711)	-247.24**	(122.01)
$(X_{11})^2$	.0001	-2672.55***	(964.44)	-2526.055***	(913.607)	-2723.19**	(957.34)
X_{15}	2.151			.277**	(.116)	.237*	(.139)

[a]The independent variables are transformations of those described in Table 1: $V_1 = X_1$; $V_2 = X_2$, $V_4 = X_3$, $V_5 = X_4$, $V_6 = X_5$, $V_7 = X_6$, $V_8 = X_7$ are the dummy variables with Feb. influence included in the intercept. $X_8 = V_9/V_{17}$; $X_9 = X_{10}/V_{16}$; $X_{10} = V_{11}/V_{19}$; $X_{11} = V_{12}/V_{18}$; $X_{14} = V_{15}$, $X_{15} = V_{20}$.

[b]*"t" statistically significant at 10%, ** at 5% and *** 1%.

[c]For fun C: X_{15} is the residual from a regression of the New York-Arizona spread (footnote 4).

In this equation, the only significant monthly variable was January. The remaining significant variables were related to volume from California. The volume divided by miles variables (X_{10}, X_{11}) indicated that shipments from California would increase the spread for Arizona lettuce, an economically logical result because of the added transportation distance. However, these must be considered in conjunction with the squared terms(X_{10}^2, X_{11}^2)the negative coefficients here indicating that large volumes from California lower the spread. Again, this was a logical result and consistent with competitive assumptions.

Although statistically significant variables had logically correct signs, results did not fully explain the Chicago price spread variation. The question remained unresolved, then, as to the adequacy of the independence assumption between Chicago and other markets.

The previous equation was reestimated with all variables unchanged, but with the New York-Arizona price spread added as an explanatory variable. A considerable change in R^2 and significant coefficients occured in the estimating equation (run B, Table 3). Two additional variables as well as the new spread were statistically signigicant.

Two monthly variables exhibited an influence in Run B, though seasonality does not appear to be an important factor. Supplies from California were again the major influence on the Chicago-Arizona spread, with low volumes increasing it, but heavy volume would have a depressing effect.

More important changes in this equation were the indicated importance of relative volume in the market (X_{14}) and the New York-Arizona price spread (X_{15}). The importance of proportion of total volume (U.S.) moving to Chicago indirectly indicates that the Chicago market is influenced by others. The New York-Arizona spread had a positive coefficient, indicating that a $1 change in the New York-Arizona spread will change the Chicago-Arizona spread by $0.27

The positive influence of the New York-Arizona price spread is logically expected and alone would not prove that the independence of markets assumption is inadequate. The result must be viewed in terms of run A, and how the independence assumption is used. Run A contained variables that would be consistent with competitive price differentials due to costs or market volume. It would support the implied relationship, as reactive algorithms are commonly used. Addition of a price variable would likely result in autocorrelation if the market were competitive. Although R^2 might increase, little economic interpretation would be possible. In fact, its inclusion in a regression equation could indicate a decrease in the statistical significance of some variables. In run B this was not the case.[4] The equation's explanatory power was increased by the variable added and others became significant. Further, even though demand schedules are determined independently, a non-competitive price relationship would change the quantity at which shipments would be diverted from one market to the other.

An additional equation was estimated, using the New York-Arizona spread adjusted for competitive factors[5] (run C, Table 3). The resulting estimate was very similar to run A. The adjusted New York-Arizona spread was significant, indicating a possibility of other than competitive price influences in the market.

CONCLUSIONS

Studies of interregional competition commonly use deterministic model for estimating equilibrium conditions for demand, supply and price among producing and consuming regions. an assumption necessary for these models is that the demand (supply) functions among regions are independently determined. This analysis for Arizona lettuce indicates that this assumption must be used judiciously and may not adequately represent price influences in the market place.[6]

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[4]The highest correlation coefficient between the New York-Arizona price spread and an independent variable was .442 with X_9.

[5]A regression equation was estimated using the New York-Arizona lettuce price spread as a dependent variable. The equation was comparable to Run A, Table 3. The residuals were used as an independent variable in Run C.

[6]A similar analysis was performed with sweet potatoes using Louisiana and North Carolina shipping points and the Chicago and New York wholesale prices. Results indicated a completely different situation with trend being the most important influence. The New York-Louisiana spread showed no statistical influence on the Chicago-Louisiana spread. This further indicates that markets for commodities vary considerably and prices are subject to influences outside the competitive framework.

The wholesale-shipping point price spread on the Chicago market for lettuce from Arizona was analyzed. The competitive factors consistent with the independence assumption (volume related to distance to market from competing areas) was statistically related to the Chicago-Arizona spread. However, inclusion of the New York-Arizona spread indicated the significance of the total market proportion attributed to Chicago as well as the New York market's influence.

The limited scope of this analysis, and the real possibility that unload data do not correctly measure total volume and directional flows of a commodity, perhaps prohibit stating that the independence assumption is nullified or that competitive models are inappropriate. But there is sufficient evidence to assert that a broadly-based market with relatively even distribution and little seasonality in total shipments, such as lettuce, does not guarantee that independent demand functions correctly measure the magnitude of price and relationships between regional markets. Further, results of competitive regional models need to be examined in light of industry structure and of potentially related price levels between markets. Competitive results may not correctly estimate the potential for expanding or entering a market. Even though demand schedules are determined independently, a non-competitive price relationship would change the quantity at which shipments would be diverted from one market to the other.

It is the opinion of the author that few commodities, particularly fresh fruits and vegetables, are marketed in an independent environment. The rigidity of established shipment patterns limits the number of potential competing markets for products moving over long distances. Contractual agreements between producer groups and purchasers; or, concentration of buying or selling power can alter price relationships — magnitude if not direction. Results for sweet potatoes (footnote 6) illustrate the possibility of wide differences in markets for storable and non-storable commodities. This latter implies the importance of quality deterioration and the time period for which a product is marketable. Even if there is flexibility in the market place, fresh produce prices tend to be supply responsive allowing a major supplying region (or market center) to exert influence on other markets or producers.

The foregoing is not to say that reactive programming (or LP) is an unacceptable tool in marketing research. It does indicate that we may need to be more concerned with the price relationships assumed or implied and perhaps identify prices ranges over which certain relationships hold.

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