Transport Costs Impacts on the Fresh Market for Peaches—With Special Emphasis on the Northeast

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An interregional transportation model was constructed using ordinary least squares and reactive programming to evaluate the short-run economic impact of changing transportation rate on the U.S. interregional equilibrium and, in particular, the Northeast's competitive position for fresh peaches. Using fixed regional supplies, uniquely determined regional per capita consumption and existing transportation rates the reactive programming algorithm obtains solutions to the spatial equilibrium problem including: overall regional quantities supplied and demanded, prices, consumers[1] outlays, producers' revenues and opportunity, transfer and shipping costs. Transportation rates were varied 20 percent above and below the current rates to examine the short-run economic impact on the prevailing equilibrium. The East Coast was a relatively isolated market and therefore was not significantly affected by changes in transportation rates. The most significant changes in producers' revenues and trade flow patterns occurred in the remaining regions that traded mostly amongst themselves.

Introduction

The agricultural sector in the Northeast has undergone a number of significant changes in the past several decades. Although major declines have been noted in poultry, potato and the tomato industries, the fact remains that the agricultural sector is a major industry and influence in the region in terms of employment and value added (Beilock and Dunn, 1982; Dunn, 1981; Dunn and Beard, 1982; Law, 1981; Swackhamer, 1981).

It is the general consensus that a number of related factors have contributed to the decline of agriculture in the Northeast and yet, many experts feel a major factor has been the overall changing competitive environment brought about because of transportation related issues. In particular, changing transport costs as related to energy, equipment, labor and deregulation (both rail and motor) have had major cost impacts.

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In the fresh fruit industry in particular, transportation costs play a major role in determining price which, in turn, influences the interregional supply and demand of the product. For example, significant increases in the costs of transporting fresh fruits have occurred from 1976 to 1982. The overall cost of transporting fresh fruits in the U.S. rose 21 percent in constant dollar terms (95% in current dollars) over the six-year period 1976 to 1982 (USDA, 1976 and 1982). Although it is expected that transport costs will decline slightly in the mid and late 1980s, the overall long-run trend is expected to continue upward.

The purpose of this study is not to dwell on the factors that caused transport rates to increase or decrease, but rather to determine how their end result—increased or decreased transportation rates—would impact on the U.S. interregional equilibrium for fresh peaches and how this impact would alter the Northeast's competitive position.

Market Equilibrium Methodology

This study uses reactive programming (King and Gunn, 1981) to determine the equilibrium of the U.S. interregional market for fresh peaches. Using predetermined demand and supply functions for independently determined demand and supply regions, as well as transportation costs between demand and supply regions, the algorithm produces three output summaries: producing region, market regions, and trade flows with opportunity costs. These regional summaries include overall quantities supplied and demanded, prices, consumers' outlays, producers' revenues, and opportunity, transfer and shipping costs.

To use reactive programming to solve for the U.S. interregional equilibrium for fresh peaches requires three specific inputs. First, production and consumption regions must be defined to establish a framework in which to work. Second, demand and supply functions must be determined specific to each region. Finally, transportation rates must be established between every demand and supply region combination,

Specific Methodology

Production and consumption regions were determined by dividing the continental U.S. into separate demand and supply regions. The criteria for determining the demand regions was based on the primary centers of population throughout the U.S., as well as characteristic similarities of states comprising a region. The states forming a particular demand region were represented by a corresponding single demand point.

The criteria used in defining a supply region was to determine the primary centers of peach (freestone) production throughout the U.S. The states forming a specific region were grouped together because they had similar production characteristics such as varieties, production cost, and/or wholesale price. These states were also represented by a single center of production.

Demand and supply functions were determined for each marketing region to establish a framework in which consumption and production could interact. This involved the collection of relevant regional time-series data for the years 1960-1982, constructing a demand function for each demand region, via ordinary least squares, and establishing the quantity supplied for each supply region.

The general hypothesized form of a price dependent demand function for fresh peaches was:

$$P_P = f(Qd, Sd, Cd, Y, t)$$

where:

P_p = regional wholesale price of fresl peaches
Qd = quantity demanded of fresh peaches
Sd = quantity demanded of substitutes
Cd = quantity demanded of complements
Y = consumer income, and
t = tastes and preferences

In terms of the supply equations, regional production of fresh peaches was treated as perfectly inelastic with respect to price changes in the short-run. This reflects the fact that fresh peaches are a short seasonal fruit and output cannot be significantly controlled in the short-run. The quantity of fresh peaches produced was calculated by averaging the five-year regional output figures from 1978 through 1982. This average figure represents the quantity of fresh peaches supplied from a particular region.

In order to ensure that the interregional demand and supply equilibrium is in accordance with U.S. fresh peach production and use, a national balance sheet was constructed. This balance sheet equated total U.S. fresh peach production with total U.S. demand for fresh peaches corresponding to five-year averages from 1978 to 1982. To obtain these totals, regional figures were summed.

Finally, truck transportation costs between each demand and supply region were obtained. The transportation cost represents the costs of shipping one pound of fresh peaches from a given production center to a given demand center. This was determined by multiplying distance between a given origin and destination by the deflated cost (1972 dollars) of shipping one pound of peaches one mile.

Results

Results are presented in two stages. First, results used as inputs to the reactive model and second, the output results from the actual equilibrium model.

Inputs

(1) The demand and supply regions were defined using definitions from a previous study

by Dunn and Beard (1982). Eight demand regions were denned using the 48 states in the continental United States and the District of Columbia. A major city representing these states was selected and used as a focal demand point. Four supply regions were also denned using a central supply city point (Edelberg, 1985).

(2) Time series data were collected on the hypothesized form of the demand function. No significant complements were found for fresh peaches, and overall tastes and preferences for different peach varieties were assumed homogeneous. In order to estimate regional demand functions, the national variables were transformed to regional levels, and all variables in monetary terms were expressed in constant 1972 dollars.

Three techniques were used to calculate the regional quantity demanded. However, due to severe problems inherent in using fresh fruit and vegetable unload data (USDA, 1969-83), i.e., underestimates, national per capita consumption data were used. National per capita consumption figures were regionalized by multiplying them by regional population. In actuality, this is a misrepresentation of the situation, as per capita consumption of fresh peaches does, in fact, vary widely according to geographic location.[1]

A unique regional consumption figure was developed in order to try to represent a more realistic regional per capita consumption value (Edelberg, 1985). This unique regional consumption value attempts to estimate regional consumption by taking into account actual production in a consumption region. The basic assumption is that per capita consumption will be larger in production areas. National consumption of fresh peaches was calculated for the time span 1960-1982 by multiplying the national per capita consumption data by the corresponding national population data. The national consumption data were then divided by national production resulting in national consumption as a percentage of national production in a time-series format. The quantity of fresh peaches produced in a demand region was then multiplied by this percentage consumption calculated for each time period arriving at the quantity of peaches consumed in a demand region before trade.

[1] Peaches and other fresh fruit consumption was found to vary by U.S. regions, money income and degree of urbanization (USDA-Food Consumption of Households), 1965.

Mathematically, the quantity of peaches consumed in a demand region (without trade) can be represented as follows:

$$\frac{\text{(Per Cap. Cons, x Natl. Pop.)}}{\text{National Production}} \times \text{Production in a Demand Region}$$

(3) In order to assure consistency in the collected data, a balance sheet was constructed to equate average fresh peach production with average fresh peach consumption for the years 1978 through 1982. Unexplained consumption of 16.37 percent was attributed to total losses (Edelberg, 1985).

(4) In the reactive transportation computer model, the wholesale price of fresh peaches was the dependent variable in the regional demand equation. The best relationship was found to be expressed as:

$$P_p = f(\text{PRICEC, NONCIT.N, YDPIC, NQUANT.D or QUANTITY.D})$$

where

PRICEC = real wholesale price of fresh peaches
NONCIT.N — regional consumption of noncitrus fruits
YDPIC = real regional disposable income
NQUANT.D = regional consumption of fresh peaches based on national per capita consumption data
QUANTITY.D = regional consumption of fresh peaches based on unique regional per capita consumption data

The regressions for the eight demand regions were constructed using the two variations of consumption. It was found that the unique per capita method was more realistic in that regional per capita does vary and that its test statistics were better (see Table 1).

The eight regional demand equations along with their t-values and price elasticities are as follows:

Price Elasticities

Region 1:

$$P = 33.890 - \underset{(3.501)}{0.913}(\text{QUANTITY.D}) - \underset{(1.117)}{0.018}(\text{NONCIT.N}) + \underset{(0.435)}{0.048}(\text{YDPIC}) \qquad -3.990$$

Region 2:				
p = 32.742 -	0.063(QUANTITY.D) (5.555)	- 0.004(NONCIT.N) (1-132)	- 0.019(YDPIC) (1.177)	-1.710
Region 3:				
P - 19.132-	0.017(QUANTITY.D) (1.252)	- 0.006(NONCIT.N) (1.677)	-1- 0.032(YDPIC) (1.263	-10.621
Region 4:				
P = 23.325 -	0. 1 16(QUANTITY.D) (0.965)	- 0.022(NONCIT.N) (1.941)	+ 0.139(YDPIC) (2.272)	-8.799
Region 5:				
P - 25.306 -	O.OIS(QUANTITY.D) (5.779)	- 0.003(NONCIT.N) (1.254)	+ 0.008(YDPIC) (0.502)	-1.696
Region 6:				
P = 23.381 -	0.068CQUANTITY.D) (2.619)	- 0.009(NONCIT.N) (1.399)	+ 0.030(YDPIC) (0.705)	-3.492
Region 7:				
P = 13.991 -	0.004(QUANTITY.D) (0.749)	- 0.004(NONCIT.N) (0.997)	+ 0.006(YDPIC) (0.205)	-6.303
Region 8:				
P - 19.300 -	0.113(QUANTITY.D) (5.134)	+ 0.017CNONCIT.N) (1.127)	- 0.190(YDPIC) (1.674)	-2.429

In order for the regional linear demand equations to be used with reactive programming, it was necessary for each demand equation to be reduced to the form where only the constant term and one independent variable remain. This transformation was accomplished by incorporating the quantity of noncitrus fruits (NONCIT.N) and disposable income (YDPIC) variables into the constant term.

It was concluded that wholesalers' responsiveness was high in terms of changes in quantity demanded resulting from price changes. These high price elasticities can probably be attributed to the fact that wholesale prices rather than retail prices were used, and that the percentage price variation is much greater with wholesale prices. The large variations in price elasticities is probably due to regional availability of peaches and substitutability of other products.

(5) As reported in the Fruit and Vegetable Truck Cost Report (1982), a current transportation rate of $1.145 per mile per carlot was calculated by adding the components of total shipping costs together. Assuming that there are 34,200 pounds of peaches in a carlot, it, therefore, costs 0.003348 cents to transport one pound of fresh peaches one mile. To obtain the constant dollar transportation cost per pound between regions, the cost of shipping one pound of peaches one mile (0.003348 cents) was multiplied by the distance between each supply and demand regional point and then deflated to 1972 dollars using a transportation deflator (2.024) (New Jersey Crop Reporting Service, 1982).

Outputs

In an effort to evaluate the impact of changing transportation rates on the interregional equilibrium for fresh peaches the model was evaluated under three scenarios: (1) Prevailing rates (constant dollars); (2) A 20-percent increase in prevailing rates; and (3) A 20-percent decrease in prevailing rates. Results are presented in Appendix A—Tables A1-A4.

Scenario 1 showed that at existing transportation rates, producers' revenues totalled $326,534,590. In terms of trade flows, Si's production (East + Northeast) went to Demand Regions 1 (Northeast) and 2 (East). S2 (Midwest) shipped all of its fresh peaches to nearby D3 (Midwest). The vast majority of S3 * s production (Southeast) went to D5 (Southeast) with some peaches being shipped to D2 (East). The West Coast (S4) was a region which shipped the majority of its production to distant regions, D4 (North Central), D6 (Southwest), and D8 (Northwest). Much of S4's supplies also went to nearby D7 (West).

Table 1. Statistical Results of the Regional Regression Equations

Region	R2	Standard Error of Estimate	D-W Stat.	F-Stat.
		Regressions Based on National Per Capita Consumption		
Rl	.37	3.12	2.70	3.71
R2	.48	2.00	2.24	5.92
R3	.36	1.79	1.43	3.63
R4	.26	2.90	1.42	2.23
R5	.52	2.02	1.68	6.93
R6	.37	1.83	1.38	3.78
R7	-41	0.92	1.27	4.38
R8	.11	2.48	1.57	0.76
		Regressions Based on Unique		
	R2	Error of Estimate	D-W Stat.	F-Stat.
Rl	.55	2.64	1.60	7.70
R2	.73	1.46	1.67	16.78
R3	.41	1.72	1.22	4.40
R4	.27	2.87	1.27	2.40
R5	.76	1.42	1.95	20.30
R6	.45	1.72	1.16	5.12
R7	.43	0.90	1.28	4.69
R8	.60	1.65	1.96	9.58

Critical value for the F-statistjc at the 99% level of significance = 2.88 with 20 degrees of freedom.
Minimum significant coefficient of determination is -.397. Range of D-W statistic for no autocorrelation to exist is 1.14 < D-W < 3.04 based on the Van Neuman ratio.

This implies that D5 and D7 are self-sufficient demand regions.

When transportation costs were increased 20 percent, Scenario 2, producers' revenues decreased 0.8 percent of the prevailing revenues to $323,926,400. Supply Regions SI (East - f Northeast) and S2 (Midwest), smaller production regions, actually benefitted from increased transportation costs, while Supply Regions S3 (Southeast) and S4 (West Coast), larger production regions, incurred a loss in revenues. The large supply regions [S3 (Southeast) and S4 (West Coast)], which shipped peaches longer distances, lost revenue because their markets contracted in the face of increased shipping costs. These large production regions sold more quantities to demand regions closer in proximity where the wholesale price was lower than in distant markets. The major change of increased transportation costs was that, as these costs approached the price differential between a supply region's price and the price in a demand region, it became less profitable to ship to more distant demand regions.

The impact of decreased transportation costs in Scenario 3 was the opposite of Scenario 2. Total producers' revenues increased 0.82 percent of the prevailing revenues to $329,205,800. Supply Regions SI (East + Northeast) and S2 (Midwest) lost revenue (0.5% and 3.5% respectively) while Supply Regions S3 (Southeast) and S4 (West Coast) gained revenue (0.8% and 2.5%, respectively). Large production regions which shipped to distant markets were positively affected by lower transportation costs, while smaller production regions were negatively affected. The major impact of decreased transportation costs was that they increase the difference between transportation costs and the (demand and supply) price differential, thus making it more profitable to ship to distant demand regions.

Conclusions

The short-run economic impact of changing transportation rates on the interregional fresh peach market differed from region to region. The East Coast is a relatively isolated market which was not significantly affected when transportation rates changed plus or minus 20 percent. These rate changes left all trade flows from SI (East + Northeast) and S3 (Southeast) to Dl (Northeast), D2 (East), and D5 (Southeast) relatively unchanged. Furthermore, revenues received and expenditures paid in these regions changed little (less than 1 percent) (see Appendix A).

The other U.S. regions (Midwest, Southwest, North Central, and West Coast) acted as a second separate market which traded among themselves. In Supply Regions S2 (Midwest) and S4 (West Coast) net revenues changed by more than 2.5 percent, and the trade flow pattern of S4 shifted radically (in relative terms) as a result of changing transportation costs.

The two broad markets in the U.S. (East Coast and the rest of the U.S.) are isolated primarily because of the regional price differences. Peach production in smaller supply regions (Midwest and East-Northeast) was sold directly in these demand regions. The Southeast's supply price was relatively high for a large supply region (30.302 cents per pound), thus there was little profit motive in shipping to distant regions. On the other hand, the West Coast's supply price was quite low (23.433 cents per pound), which allowed for further net revenues by shipping to distant demand regions. Because of the above price situation, the vast majority of the Southeast's production stayed in that region and only a small percentage was shipped north to D2 (East). With the West Coast's relatively low supply price, they were able to increase their net returns by shipping to distant demand regions as well as nearby regions. Thus, West Coast shipped to all areas in the continental U.S. (West Coast, North Central, Midwest, and Southwest), except for the entire East Coast. This characteristic of isolated fresh peach markets in the U.S. was also apparent when transportation costs between regions were allowed to vary. The isolation effect caused the West and Midwest supply regions to experience the most noticeable changes in revenues and trade flow patterns, while the East Coast was not as significantly affected by changing transportation rates.

Implications

Large supply regions' revenues decrease and small supply regions' revenues increase due to growing transportation costs. In order for these larger supply regions (Southeast and West Coast) to minimize their revenue losses, they should concentrate on closer markets, and reduce shipments to more distant demand regions. Small supply regions (East + Northeast and Midwest), on the other hand, will benefit by this loss in competition from the Southeast and West Coast. The East + Northeast should only slightly shift some of its shipments from the Northeast to the East to maximize the gain in its revenues. The Midwest should not change its current trade pattern, as all its production would still stay in the Midwest.

Thus, in the short-run, the East + Northeast and Midwest gain revenues at the expense of Southeast and West Coast losses, *ceteris paribus*. The net effect of increasing transportation costs is a loss in total U.S. peach producers' revenues. Exact opposite implications would exist if transportation rates decreased.

In the above implications only a one-year short-run impact was examined. Over a longer period of time, supply would not be perfectly inelastic and production would vary both as a function of weather and market response. The *ceteris paribus* assumption would not necessarily hold and comparative and absolute advantages could change between regions causing various expansion and/or contraction of the supply regions. Demand responses could also change as taste, income, prices and complement and substitutes vary. In short, it would appear that little could be said about the market equilibrium or producers' response in the long-run due to uncertainty. On the other hand, in an intermediate-run (perhaps 1 to 5 years), probably very little total regional production change would take place due to resource fixity. Producers with a committed resource investment would likely wait several years before major responses in production are made due to the nature of the product.

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Appendix A

Table Al. Current Dollar Supply Price and Quantities Supplied in the Four Supply Regions (quantity in million pounds)

	Scenario One		Scenario Two		Scenario Three	
	Quantity	Price	Quantity	Price	Quantity	Price
S1	146.852	32.318	146.852	32.487	146.852	32.152
S2	67.695	31.870	67.695	32.969	67.695	30.770
S3	536.367	30.302	536.367	30.069	536.367	30.540
S4	405.287	23.433	405.287	22.845	405.287	24.021
Total	1,156.200		1,156.200		1,156.200	

Table A2. Current Dollar Producer Revenue in the Four Supply Regions

	Scenario One	Scenario Two	Scenario Three
SI	$ 47,459,500	$ 47,740,170	$ 47,215,730
S2	21,574,430	22,318,400	20,829,780
S3	162,529,870	161,280,130	63,806,420
S4	94,970,790	92,587,700	97,353,870
Total	$326,534,590	$323,926,400	$329,205,800

Table A3. Current Dollar Wholesale Market Price and Quantity Demanded in the Eight Demand Regions

	Scenario One		Scenario Two		Scenario Three	
	Quantity	Price	Quantity	Price	Quantity	Price
D1	15.893	33.865	15.680	34.345	16.103	33.391
D2	175.747	33.063	173.703	33.382	177.763	32.748
D3	124.154	32.235	96.314	33.406	152.017	31.062
D4	37.696	31.407	34. 192	32.414	41.203	30.400
D5	491.579	30.995	493.704	30.900	489.353	31.094
D6	89.582	30.813	84.311	31.701	94.860	29.925
D7	152.350	24.535	189.518	24.167	115.278	24.903
D8	69.199	26.964	68.779	27.081	69.623	26.845
Total	1,156.200		1,156.200		1,156.200	

Table A4. Trade Flow Patterns of Fresh Peaches from Supply Regions to Demand Regions (quantity in million pounds)

Origin/Destination	Scenario 1	Scenario 2	Scenario 3
S1-D1	15.893	15.680	16 103
S2-D2	130.959	131.171	130.749
S2-D3	67.695	67.695	67.695
S3-D2	44.788	42.531	47 014
S3-D3	0.0	0.132	0.0
S3-D5	491.579	493.704	489.353
S4-D3	56.459	28.487	84 322
S4-D4	37.696	34.192	41.203
S4-D6	89.582	84.311	94860
S4-D7	152.350	189.518	115.278
S4-D8	69. 199	68.779	69.623
Total Shipments	1 ,156.200	1 , 156.200	1 ,156.200