Seasonal Oligopoly Power in the D'Anjou Pear Industry

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We estimate seasonal oligopoly power at a disaggregated variety level in the D'Anjou pear market. Our data spans 1993 to 2000, during which time imported pears became more prevalent in the U.S. market. The range of monthly industry-conduct-parameter magnitudes is 0.034 to 0.195 and is most pronounced when the fresh D'Anjou pear crop first becomes available in the earliest months of the marketing year. Possible reasons for timing of oligopoly power relate to the growth of imported pears during the latter portion of marketing year. In addition, oligopoly power may diminish during the marketing year as pears in storage decline in quality.

Although agents in the agricultural marketing chain are often assumed to be price takers, there are some sectors that exhibit high levels of concentration. Supply and competition are more likely to vary during the course of a year in agricultural industries than in other industries because of biological and weather constraints. This seasonality may be mitigated by new developments in chemicals, transportation, and shipping that allow imports to compete more than in the past--for example, fruit from Latin America can supply off-season fruit to the United States. In this paper, we study seasonal oligopoly power in the D'Anjou pear market.

Although the market for growing D'Anjou pears appears to be competitive, opportunities may exist for cooperative behavior by pear packers. Oligopoly power in the D'Anjou pear market would create consumer-welfare losses, possibly prompting market regulators to step in. The existence of oligopoly power may also alert pear growers that it may be profitable to vertically integrate into the packing market if feasible. Price mark-ups may also affect the quantity of imported fruits or other fruits such as apples or oranges.

The seasonality of supply makes the pear market interesting from an industrial-organization perspective. Even so, few researchers have studied oligopoly power in the pear industry, and to our knowledge no researchers have studied this issue at the disaggregated variety level. In their study of seasonal oligopoly power, Arnade and Pick (2000) found modest levels of oligopoly power in the aggregate U.S. pear market. Estimates from Wann and Sexton's (1992) multiple-product framework suggested limited oligopoly power in pear processing ($\theta = 0.08$) but greater power in the fruit cocktail market ($\theta = 0.48$). Hypotheses of perfect competition and pure monopsony in pear procurement were both rejected. Our study of the pear market focuses on a particular variety of pear--D'Anjous--and thus mitigates the potential problem of concluding that little or no oligopoly power exists because of the confounding of market forces across various pear types with differing marketing seasons and market advantages. D'Anjous have different coloration, shape, and taste from other types of pears; they are not only seasonally differentiated, but are also differentiated with respect to usage. Moreover, our study is based on recent data that spans the latter part of the 1990s to the year 2000, during which time imported pears became much more prevalent in the U.S. market, and therefore has the potential for demonstrably effecting oligopoly power in pear markets.

Beyond Arnade and Pick (2000), only a few researchers have studied seasonal market industry conduct. MacDonald (2000) studied seasonal demand and competition for different seasonal food products using electronic scanner data. He found that prices fell during demand peaks, which may have been due to advertising effects. DeVoretz and Salvanes (1993) found the possibility of seasonal oligopoly power in the salmon industry. Using data from 1983 to 1988 they concluded that this was due to more inelastic demand during certain times of the year.

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More generally, empirical industrial-organization economists have long been concerned with measuring the degree of competition in markets. The measurement of departures from marginal-cost pricing lies at the core of these studies, with important ramifications for consumer welfare, firm profits, and efficiency of the market. While product prices are readily observable, marginal cost is difficult to observe directly, necessitating the inference of firm conduct through "conjectures" of firms. This approach has become known as the "New Empirical Industrial Organization" (Bresnahan 1989). Early examples of this approach include Appelbaum (1979, 1982), Gollop and Roberts (1979), and Roberts (1984).

Two dominant modeling approaches exist for estimating oligopoly power. Studies estimating oligopoly power using single-demand equations, or systems of demand or inverse-demand equations, include Beutel and McBride (1992) and Hall (1988). These models frequently draw criticism because they can generate inconsistent or biased parameter estimates insofar as specification may include right-hand-side quantity or price variables that are also functions of unspecified endogenous-supply behavior. The second principal modeling approach employs a system of supply and demand equations to estimate the Lerner index (1934). Studies using this methodology include Schroeter (1988) and Porter (1983), and as with any system of equations the parameter estimates are sensitive to model specification. In short, neither the single equation nor the systems-of-equations method is without difficulties in terms of empirical implementation.

Specific examples of problems that arise with single-equation approaches include Hall's method that relies on the assumption of constant returns-to-scale (CRS) technology. A Monte Carlo study by Hyde and Perloff (1994) showed that deviations from the assumption of CRS result in a biased estimate of the degree of oligopoly power. In Beutel and McBride's single-equation demand-function estimation, where the mark-up over marginal cost was recovered, they showed that in regressing price on quantity the possible endogeneity of quantity was not addressed. With respect to econometric problems involving the systems-of-equations approach, Hyde and Perloff demonstrated that misspecifying the production function results in biased parameter estimates of the degree of monopsony power.

This paper estimates supply and demand equations, so results are consistent to the extent that the model specification is correct. The Lerner estimates are then calculated for a measure of oligopoly power. However, because a number of input prices were not included, we are unable to also jointly estimate a system of input demands, and because reduced-form parameters were used, we are also unable to utilize cross-equation restrictions. For both of these reasons, opportunities for obtaining more-efficient elasticity estimates were not available.

The D'Anjou Pear Market

For certain agricultural industries, sales desks/packers have the potential to exert oligopoly power. In the Northwest D'Anjou pear industry, there are approximately 1700 growers throughout Washington and Oregon, but over eighty percent of the sales and marketing of pears is handled by less than ten sales desks/packers.[1] Larger produce-supply firms have advantages in their vertical relationships with major food retailers. Some major food retailers are doing business with fewer but larger produce suppliers who can better meet their increasingly complex requirements, such as electronic data interchange (EDI) and special packaging requirements (Patterson and Richards 2000; McCluskey and O'Rourke 2000).

The United States is second to China in total pear production (O'Rourke 1998). There are two types of seasonal American pears: summer and winter pears. Most U.S. pear production occurs is just three Western states: California, Oregon, and Washington. Bartlett is the major summer variety and is primarily sold for processing. D'Anjou is the major winter variety; it is sold primarily in the fresh market. Almost all of the D'Anjous are grown in the Western states, primarily Washington and Oregon (Gao and O'Rourke, 1992). Pears are the second most important deciduous fruit (after apples) in terms of gross revenues in the Pacific Northwest.

D'Anjou pears are typically fully harvested by late September. These pears are then sorted by grade and size, boxed, and placed in either regular or controlled-atmosphere storage by the packers who receive them in bulk (Gutman, Mittelhammer, and Schotzko 2002). The pears are marketed

[1] The packers do not actually buy the pears from the growers. Rather, they provide marketing services, so oligopsony power is not an issue.

throughout the year, with the exception of August, due to storage limitations. Historically, D'Anjous enter the market in the early fall at the same time that Bartletts from California are nearing the end of their marketing season, and D'Anjous are thought to face significant competition from imported fresh pears from South America beginning in February or March. Bosc pears appear in the market with D'Anjous throughout the entire D'Anjou marketing year (Gutman, Mittelhammer, and Schotzko 2002).

The Northwest D'Anjou pear market is characterized by seasonality and supplied by different sources during different seasons, so it appears quite possible that seasonal trends in conduct exist in the industry. Industry behavior might also change over time due to new storage methods that affect the produce industry (Gutman, Mittelhammer, and Schotzko 2002). Estimating oligopoly power using annual data may therefore generate results that suggest a competitive market when, in fact, seasonally varying oligopoly power may exist (Arnade and Pick 2000). For example, additional oligopoly power may result when only a few producers have remaining D'Anjou pear stocks during the May-through-July marketing period, and oligopoly power may wane when fresh pears from Latin America become available in the spring and early summer months.

The pear market, like most other produce markets, has become increasingly global in recent years. Imports from Latin American producers have increased; in particular, shipments of imported pears were typically between 2.8 and 3.8 million boxes annually, but beginning in crop year 1997 (defined as September 1997 through July 1998) about 5.7 million boxes were imported to the United States. For crop years 1998 and 1999, shipments were 5.3 million boxes and 5 million boxes, respectively. This can be compared to the approximately 11 million boxes of D'Anjous shipped domestically each year. Major alternative pear varieties that have the potential to compete with D'Anjous are primarily imported pears from Latin America and Bartletts and Boscs from Washington and California. Possible alternative substitute fruit varieties include oranges, whose price Arnade and Pick (2000) included in their demand model for pears (despite its statistical insignificance in their analysis) and apples, which we investigate in our empirical analysis.

Testing the Degree of Oligopoly Power

The principal hypothesis examined in this paper is that Northwest packers and sales desks exercise seasonal oligopoly power in the D'Anjou pear industry, allowing the Northwest D'Anjou pear industry to achieve positive incremental economic profits. In order to study the seasonal oligopoly power in this industry, an industry conduct parameter, θ, is allowed to vary on a monthly basis. For a given time period this parameter is defined as

$$(1) \qquad MC = P(1 + \theta/\xi)$$

where MC is marginal cost, p is price, ξ is price elasticity of demand, $\theta \in [0, 1]$ represents an index of oligopoly power, and $-\theta/\xi$ is the Lerner index. Perfectly competitive behavior is denoted by $\theta = 0$, and $\theta = 1$ denotes monopoly or perfect collusion. Various types of oligopoly behavior are represented by values of θ between these polar cases, with higher values of θ implying more significant divergences from competitive behavior. By allowing θ to vary monthly, we can test for varying levels of market behavior throughout the marketing year. For the purposes of estimating oligopoly power in the Northwest pear industry, an equilibrium model of supply and demand over crop years is estimated and analyzed.

Model Specification

The model is designed to estimate the index of oligopoly power, θ, derived from equation (1), as suggested by Porter. In specifying the model it is assumed that firms seek to maximize profits. It follows that the first-order condition characterizing the optimal supply of size i pears in month t is given by

$$(2) \qquad P_{it} = (1 + \theta_{it}/\xi_{it}) = MC_{it}$$

where P_{it} is the sales desk/packer price for D'Anjous of size i and month t, ξ_{it} is the price elasticity of demand, and MC_{it} is marginal cost.

Supply

Generalizing the specification of Porter to allow for the effects of a vector of cost-function shifters, Z_{it}, the cost function is specified in the form

(3) $C(q_{it}) = c_s q_{it}^{\tau_s} f(Z^s_{it}) + F,$

where $C(\bullet)$ is the industry cost function, q_{it} is quantity, $f(\bullet)$ denotes a function of cost shifters, F denotes fixed cost, and c_s and τ_s are parameters of the cost function with the former denoting the cost-function intercept and the latter denoting the elasticity of variable cost with respect to output. The marginal cost function can be defined via differentiation to be

(4) $MC(q_{it}) = c_s \tau_s q_{it}^{\tau_s - 1} f(Z^s_{it}).$

We note that in specifying the cost and marginal cost functions for the D'Anjou pear industry, it is assumed that costs are being modeled for the entire wholesaling operation, which is considered to be a combination of grower and packer operations. This assumption is justified because packinghouses are often owned by consortiums of growers. Appelbaum (1982) demonstrated that if producers use the same technology and face similar input prices, an aggregate marginal cost function exists. These conditions can be reasonably assumed to hold in the D'Anjou pear industry. The industry cost function then represents the amalgamated costs for both the producers and packers, and both production and marketing costs are being modeled.

Upon combining equations (2) and (4), and taking logarithms of both sides of equation (2), the inverse industry-supply function can be expressed as

(5) $\ln(p_{it}) = \delta_s + (\tau_s - 1)\ln(q_{it}) + \ln(f(Z^s_{it})) - \ln(1 + \theta_{it}/\xi_{it}),$

where $\delta_s = \ln(c_s \tau_s)$. We note that when $\theta_{it} \neq 0$, equation (5) might be better referred to as a supply relationship than a supply equation per se, given that when oligopoly power exists, in effect price is higher than marginal cost, and it is this effect that is being represented by the trailing term in equation (5).

Demand

Regarding the specification of D'Anjou pear demand, we follow Porter and specify demand in terms of a loglinear function of price, as

(6) $q_{it} = D_i(p_{it}) = c_d p_{it}^{\tau_d} g(Z^d_{it}),$

where $D_i(\bullet)$ is the market-demand function for pears of size I; $g(\bullet)$ denotes a function of the vector of demand shifters, Z^d_{it}; and c_d and τ_d are parameters of the demand function with the former denoting the demand function intercept and the latter denoting the elasticity of demand with respect to price. Taking logarithms, the specification of the demand function becomes

(7) $\ln(q_{it}) = \delta_d + \tau_d \ln(p_{it}) + \ln(g(Z^d_{it})),$

where $\delta_d = \ln(c_d)$.

Given the preceding definition of the demand function, it follows that the trailing term in equation (5) relating to the oligopoly-power index is representable as $(1 + \theta_{it}/\tau_d)$, so that in effect the demand and supply models share the parameter τ_d. In the next section we discuss the data available to estimate the demand and supply functions, and we specify the empirical counterparts of equations (5) and (7) that are used to generate empirical estimates of the seasonally varying oligopoly-power index.

Data and Empirical Model

Most industry oligopoly-power studies use annual data. In order to obtain sufficient observations, these applications may include thirty or more years of industry data, during which time significant technical and/or structural changes may have occurred. This study uses monthly data covering the crop years (September through July) 1993–1994 through 1999–2000. The use of monthly data allows an investigation of seasonality in oligopoly power. The Pacific Northwest Pear Bureau provided most of the data used in this statistical analysis. These data consisted of observations on D'Anjou pear transactions at the shipper's point of sale (F.O.B); information on size, grade, quantity sold, destination (whether domestic or export); and month sold. Data on the Producer Price Index (PPI) for inputs used in pear production were obtained from the Bureau of Labor Statistics. Data on monthly disposable income were obtained from the United States Department of Commerce's Bureau of Economic Analysis. Additional details relating to variable descriptions and summary statistics are presented in Table 1.

The dependent variables for the demand and supply system are warehouse level free-on-board (FOB) prices by size and month for US#1 D'Anjou pears, and quantity of boxes per size and month for

US#1 D'Anjous. The US#1 pear data used comprise over 80 percent of the total D'Anjou market. Extra Fancy and U.S. #2 pears were not used because of their small market share. Up to twelve sizes of pears are marketed in any given month, though not all sizes are observed each month. There were a total of 836 data observations spanning 77 months (September 1993 through July 2000, excluding the month of August each year in which no commercial market of D'Anjou pears exists). On average, there were just under eleven sizes observed each month.

Regarding the empirical specification of the inverse-supply function (5), we used the following specification, based on consideration of statistical significance, economic interpretability, and data availability:

$$(8)\quad \ln(p_{it}) = \delta_s + (\tau_s - 1)\ln(q_{it}) + \alpha_1 SIZE_{it} + \alpha_2 PPI_t^{Pear} + \alpha_3 STOR_t + \sum_{k\in S_S} \alpha_{k+3} D_k + \varepsilon^s_{it},$$

where p_{it} denotes the price of U.S. #1 D'Anjous by size and month in dollars per carton, q_{it} represents the quantity of U.S. #1 D'Anjous by size and month in cartons, $SIZE_{it}$ is the number of pears per 42 lb. carton, PPI_t^{Pear} is the producer-prices-paid index for pear production, $STOR_t$ is the monthly future value of one dollar given the federal funds rate, S_s denotes the collection of statistically significant monthly indicator variables, which in fact spanned the 9 months inclusive from September through May, D_k is a month-indicator variable, and ε^s_{it} is a residual term (additional details relating to the statistical results, including their interpretation and statistical significance, are provided in the next section). Note that in the empirical specification of supply (8) relative to the conceptual model (5), the value of $-\ln(1 + \theta_{it}/\tau_d)$ is being represented seasonally by the values of α_{k+3}, $\forall k \in S_s$, and the industry

Table 1. Variable Descriptions and Summary Statistics.

Variable	Description	Obs	Mean	St.dev.	Min	Max
p_{it}	Price of US#1 D'Anjous by size and month, in $/carton	836	14	4	4	24
q_{it}	Quantity of US#1 D'Anjous by size and month, in cartons	836	34586	38369	1	186151
$SIZE_{it}$	Number of pears per 42 lb. carton	12	125	36	50	180
PPI_t^{Pear}	Producer-prices-paid index for pear production	77	93	16	67	127
$STOR_t$ (Storage Opportunity Cost)	Monthly future value of \$1 = $\prod_{j\in S_s}(1 + r_j)$, where r is the federal funds rate in month *j* and S_t is the set of months in the marketing year from September to month *t*	77	1.03	0.014	1.003	1.054
$QIMP_t$	Imports in 1000-metric-ton units	77	7.7	9.4	0	41.7
P_t^{orange}	Orange prices per carton	77	6.74	2.07	1.81	13.7
P_t^{apple}	Apple price per pound	77	0.20	0.04	0.12	0.30
INC_t	Disposable income in month t, billions of $	77	492	51	413	593
YEAR	Crop-year index, where 1993=1, 1994=2, …, 1999 =7.	7	4	2.16	1	7
D_k	Month indicator = 1 in month k	11	.09	.30	0	1
$SINE_t$	Sine((j/6)π), where *j* is the number of the month, cyclically repeating by marketing year	11	0	.77	-1	1
$COSINE_t$	Cosine((j/6)π), where *j* is the number of the month, cyclically repeating by marketing year	11	0	.77	-1	1

conduct parameter for month k is then defined by $\theta_{ik} = \arg_{\theta_{ik}}\{\alpha_{k+3} = -\ln(1 + \theta_{it}/\tau_d)\}$. The supply-function shifter component of equation (5) is represented in equation (8) by all of the regressors other than the indicator variables and q_{it}. Recall that August is excluded *a priori* since there is no commercial market for D'Anjou pears during that month.

The final empirical specification of the demand function is

$$(9)\ \ln(q_{it}) = \delta_d + \tau_d \ln(p_{it}) + \sum_{j=1}^{4} \beta_j SIZE_i^j + \beta_5 YEAR_i + \beta_6 QIMP_t + \beta_7 P_t^{orange} + \beta_8 P_t^{apple} + \beta_9 INC_t + \beta_{10} SINE_t + \beta_{10} COSINE_t + \varepsilon^s_{it},$$

where $YEAR_i$ represents the crop year where a value of 1 is given in 1993, 2 in 1994, etc.; $QIMP_t$ is the total quantity of all imported pears given in 1000 metric ton units; P^{orange} is the price of oranges for that month; P^{apple} is the price of apples for that month; INC_t is the U.S. disposable income for that month in billions of dollars; $SINE_t$ is the trigonometric function that equals $SINE(j\pi/6)$ where j is the number of the month; $COSINE_t$ is analogous to $SINE_t$; and ε^s_{it} is a residual term. We note that the trigonometric terms in the specification represent a seasonal cycle effect that was also found to be important in Arnade and Pick's (2000) analysis of aggregate pear demand. We also assume that consumers have a different demand for different sizes of pears. From these two equations we can now estimate oligopoly power by $\theta_k = \tau_d(e^{-\alpha_{k+3}} - 1)$, Because equation (8)–(9) represents a system of over-identified simultaneous equations, a three-stage least-squares estimation was used to obtain estimates of the parameters of the model.

Results

Three-stage least-squares estimates of the supply and demand system equation (8)–(9) are presented in Table 2. All of the signs of the estimated coefficients are consistent with economic theory, and the large majority of the estimated parameters were statistically significant at the 0.05 level of type I error or better, based on asymptotically valid Z-statistics and a standard normal asymptotic distribution. The R^2 statistics indicate that both the supply and demand equations fit the historical monthly data reasonably well. The estimated monthly price flexibility of supply, $(\tau_s - 1)$, is positive and inflexible at a value of .044, while the monthly price elasticity of demand, τ_d, is inelastic at a value of –0.72. The magnitudes and signs of these parameters ensure that a supply-demand equilibrium solution exists.

Significant shifters of the supply price include downward shifts due to economies in handling larger fruit and positive shifts due to increasing costs of production inputs and increasing storage costs as the marketing year progresses. Quantity demanded is effected by a significant seasonal component (.992 × SINE + .622 × COSINE) that exhibits a monotonically increasing demand effect from September until February, followed by a monotonically declining demand effect thereafter though July, which is the end of the marketing year. Demand is also affected by the pear size category, where the estimated size effect (a quartic function of SIZE) is such that price is a concave function of size (the number of pears per 42 pound carton) that exhibits a peak in the midsize 90-to-100 size category and troughs for the smallest size (180) and largest size (50) pears.

The estimated industry conduct parameters in Table 3 are measures of the difference between price and marginal cost over the marketing year. These values can be interpreted as measures of oligopoly power, which are outcomes of some generally unknown game (Karp and Perloff 1993). A joint test of the hypothesis that each of the monthly oligopoly power values was equal was conducted and resulted in a Wald statistic of 55.06, which is significant at the .01 level. This suggests that the degree of oligopoly power changes during different seasons of the year. While the range of monthly conduct parameter magnitudes corresponding to the Northwest D'Anjou market (0.034 to 0.195) is roughly similar to that found by Arnade and Pick (0.001 to 0.245), in their 2000 study of seasonal oligopoly power in the aggregate U.S. pear industry (applicable to 1976-1993), the seasonal pattern of the estimated conduct parameters is notably different. In particular, we find that oligopoly power is most pronounced when the fresh D'Anjou pear crop first becomes available to the market in the earliest months of the marketing year (September and October); this power then wanes steadily, becoming low-to-none in the latter part of the marketing year (March to July). This is in contrast to Arnade and Pick's finding that oligopoly power for the pear industry as a whole was strongest in the late spring and summer months, but very small otherwise.

Table 2. 3SLS Estimation Results for Equation System.

Parameter	Parameter Estimate	t-statistics
δ_s	-4.734**	-3.72
τ_s	1.044**	13.76
α_1 (Size)	-0.398**	-25.78
α_2 (PPI)	1.001**	26.43
α_3 (STOR)	6.139**	5.00
September	0.314**	5.72
October	0.235**	4.76
November	0.156**	3.48
December	0.133**	3.29
January	0.104**	2.90
February	0.082**	2.61
March	0.066*	2.34
April	0.048	1.93
May	0.056*	2.46
δ_d	-48.769**	-15.07
τ_d	-0.724**	-2.91
β_1 (SIZE)	198.999**	19.71
β_2 ($SIZE^2$)	-247.057**	-17.00
β_3($SIZE^3$)	132.373**	14.94
β_4($SIZE^4$)	-26.530**	-13.67
β_5 (YEAR)	-0.182	-1.48
β_6 (IMP)	-0.007	-1.42
β_7()	0.106**	5.66
β_8()	1.129	1.07
β_9(INC)	0.007	1.44
β_{10}(SINE)	0.992**	11.40
β_{11}(COSINE)	0.622**	10.96
R^2 - Supply	.70	
R^2 - Demand	.78	

* significant at the .05 level.
** significant at the .01 level.
Note: the second t-value refers to a test of the hypothesis that τ_s=1.

Table 3. Oligopoly Power Values.

Month	Oligopoly power estimate	t-statistics
September	0.195**	2.629
October	0.151*	2.512
November	0.104*	2.244
December	0.090*	2.143
January	0.071*	2.066
February	0.057	1.922
March	0.046	1.796
April	0.034	1.597
May	0.039	1.890

* significant at the .05 level.
** significant at the .01 level.

Possible reasons for our finding that oligopoly power declines in the early spring and summer months relate to the fact that the 1990s exhibited substantial growth of imported pears in the U.S. domestic market during the latter portion of the marketing year, representing a new source of competition that had not been nearly as commercially significant in prior years. In addition, because the current analysis corresponds to a specific variety of pears, it might be expected that oligopoly power would diminish during the marketing year as these pears, in refrigerated or controlled-atmosphere storage for extended periods of time, decline in quality, and moreover need to be sold or else discarded as the marketing year comes to a close. This latter consideration need not be a factor in an aggregated-type of analysis such as Arnade and Pick's, where several varieties of pears with differing marketing years and storage cycles are being considered.

Powers (1992) utilized the price differential between fresh oranges and processing oranges to measure the extent to which the marketing order for California-Arizona navel oranges was successful in exercising oligopoly power in allocating oranges between fresh and processed use. He first obtained estimates of the demands in the fresh and processed markets and then expressed fresh versus processed market-price differential as the solution to a profit-maximization problem. His results for 1965-89 data indicated modest but significant monopoly power, with point estimates of θ ranging from 0.18 to 0.44. Oligopoly power was found to decrease after 1983, when the U.S. Department of Agriculture implemented rules that limited the number of weeks that allocation restrictions were in effect.

Perfect collusion, or monopoly power, was rejected for each month at any reasonable level. Our estimated price distortions (i.e., the industry price mark-up over marginal cost) during the period under study are represented by values of $|\theta_{it}/\tau_d| \times 100$, which were estimated to be as high as 27 percent during the marketing year. This can be compared with other industries in which price mark-ups over marginal cost were examined. For example, Schroeter (1988) found that estimated price distortions for the beef-packing industry from 1951 through 1983 were between 2.7 percent and 8 percent. He concluded from this that there was little price distortion in the beef-packing industry. As a point of comparison, the estimated levels of price distortion exercised by a cartel of railroads controlling shipments from Chicago to the Atlantic seaboard during the late nineteenth century was estimated to be 43 percent (Porter 1983), implying a great deal of price distortion and possibly even collusive behavior. Overall, the estimated level of price distortion for the pear industry seems relatively high and suggests some degree of oligopoly power in the industry, consistent with an oligopolistic market structure, at least during the early part of the marketing year.

Conclusions

A simultaneous system of supply and demand equations was estimated to recover industry conduct parameters monthly and over time for the Northwest D'Anjou pear industry. It was found that the Northwest D'Anjou pear industry has had some degree of oligopoly power when the new crop first enters the market and when flows of shipments from imports and/or other pear varieties are low. The empirical findings are consistent with the hypothesis stated at the outset of the paper. A notable degree of price distortion is found to prevail in the fall of each year, consistent with an oligopolistic market structure, but then wanes as the marketing year progresses and is small especially following the increase in imported pear quantities from Latin America.

The recent trend of consolidation in the food-supply chain has implications for the pear industry. Large packers in the pear industry should do well in a new food-supply chain with increased vertical coordination with retailers; however, smaller growers may suffer. The Northwest D'Anjou pear industry appears to possess some degree of oligopoly power at certain times of the year and thus may have been able to maintain positive economic profits by increasing prices above marginal cost at times. However, as global competition increases due to recent free-trade initiatives and production increases in Chile and Argentina, there is an indication that oligopoly power may diminish.

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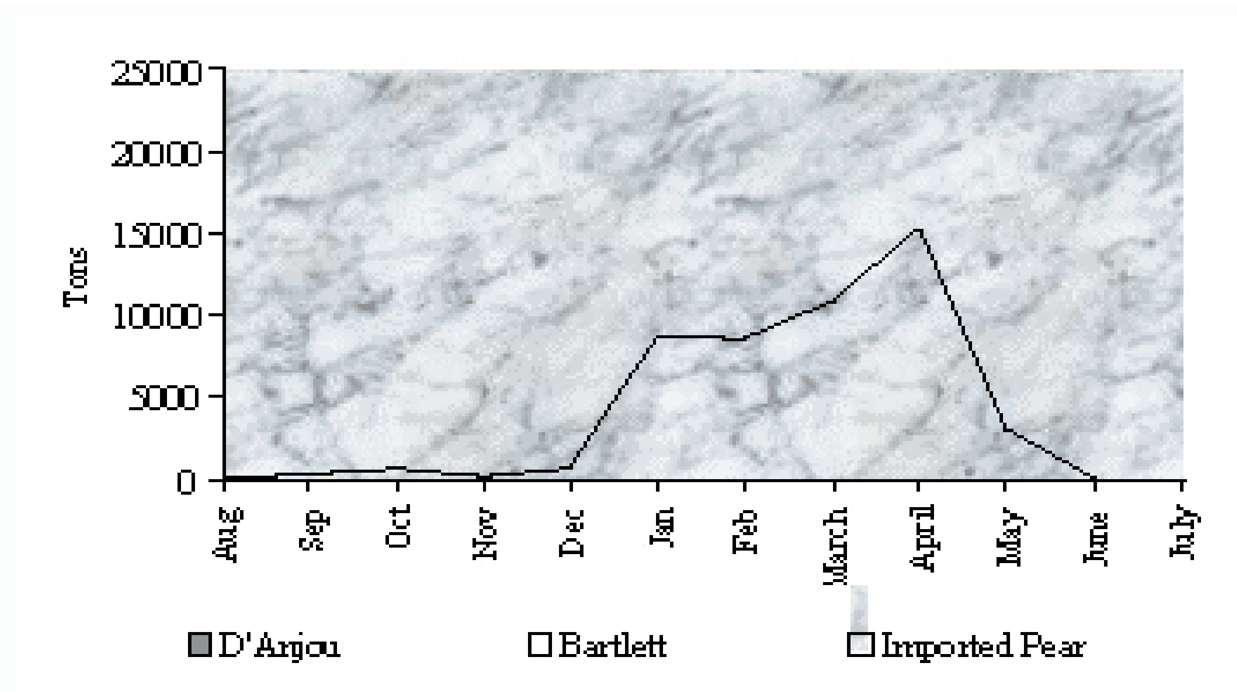

Figure 1. Average U.S. Pear Shipments by Month, in 1000 metric tons, 1993-1994.