Fresh Grapefruit Supply-Chain Adjustments: Consolidation in Produce Packing?

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This study evaluates long-term structural adjustments in fresh grapefruit packing under aggregate market pressures, including those from retail concentration. While individual firms enter and exit, Markov-model results are indicative of an industry near equilibrium with little expectation of change in the distribution of firm sizes given existing patterns of sector adjustment. Estimation of Lorenz curves and corresponding Gini coefficients fully support Markov-analysis findings. Lags in the packing sector adjustment process in the face of sweeping forces of change in fresh produce markets are likely to put this sector at a relative disadvantage within the supply chain.

As food-industry supply chains mature, the players change and power can shift from one vertical sector to another over time. As early as 1956, Galbraith noted that an increase (or perceived increase) in market power by one sector might act as an inducement for structural change among those firms either selling to or buying from that sector. Such adjustments have been observed in agriculture as more firms formalize food-supply-chain relationships (Cook 1999).

Much of the recent literature has focused on increasing consolidation in retail food markets (Kaufman 1999; Dimitri 1999; Patterson and Richards 2000; Reardon, Berdegué, and Timmer 2005). In 2000 the 20 largest U.S. food retailers controlled 52 percent of total grocery store sales, compared with less than 37 percent in 1987. Over the same period, share of sales by the four largest firms increased from 17 to 27 percent (Harris et al. 2002). A 2001 USDA study of trade practices in fresh fruit and vegetable markets was motivated, in part, by shipper concerns that increased retail concentration would result in an exercise of market power, with an associated growth in trade practices such as buyer requests for off-invoice fees and services (Calvin et al. 2001).

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Has there been a corresponding change among retail suppliers? We measured structural change between the 1970/71 and 1999/2000 seasons in fresh produce packing for Florida grapefruit, one commodity included in the 2001 USDA project. Factors influencing the distribution of firm size within an industry are many and complex, and this study makes no attempt to determine causality from individual forces of change. Rather, the focus is on long-term structural trends in one supply-chain sector under the aggregate influence of market pressures, including those from retail adjustments.

Specific objectives of the paper are to identify a model for evaluating long-term patterns of structural adjustment in a fresh fruit packing industry, to evaluate change in these patterns within one sector of a fresh fruit supply chain, and to draw implications for the overall supply chain.

Conceptual Model

Two techniques are used to evaluate structural adjustment trends in the packing sector. First, a Markov model is used to evaluate the long-term patterns of adjustment among fresh grapefruit packers over the last three decades. Next, Lorenz curves and Gini coefficients provide further empirical evidence and a visual illustration of adjustments in sector concentration. Results are used to evaluate movement of individual firms across specified size categories and to derive an equilibrium distribution.[1]

[1] Other techniques to measure structural adjustment are available, but the data (time-series of firm-level output) lends itself to Markov analysis. Econometric models that draw more heavily on the "new institutional economics" use data that would include cost and/or price observations which are

Markov Chain

As in many seminal market structure studies, the Florida fresh grapefruit packing sector is modeled as a first-order, homogeneous, stationary Markov process (Adelman 1958; Padberg 1962; Hallberg 1969). In the most general case, a Markov chain is a discrete-state, discrete-time model associated with a finite or countable state space S for a sequence of binary random variables; $y^f_j(t) = 1$ if packing firm f is in a defined market state j at time t, and zero otherwise. The model is characterized by an initial distribution, $\{\pi^f_j\}_{j \in S}$, representing the probability that firm f is in state j at time t = 0, and conditional probabilities that firm f is in state j at any time t given its history:

$$(1)\quad \{p(y^f_j(t) = 1) \mid y^f_k(r),\ k \in S \text{ and } r = (t-1),(t-2),...\}.$$

The simplest Markov model is a first-order homogeneous chain. A Markov chain of this type incorporates the simplifying assumptions that the probability of firm f being in state j at time t depends only on its state at time t–1 (i.e., the process is of order 1) and that the probability distribution is identical for every firm f in the model (i.e., the process is homogeneous).

In order to test for a change in long-term adjustment patterns within a sector, data are separated at a likely time of disruption. Independent Markov models are developed for the sub-periods within the data set and for the pooled observations. The underlying patterns of adjustment are then compared for evidence of a change about the point of separation. The market structure is assumed to be evolving under the influence of aggregate forces—the question is whether there is evidence of a *disturbance* in that evolutionary process. The null hypothesis is that the Markov process at work in each of the two sub-periods is identical. As the process is assumed to be first-order and only two samples are compared, the test statistic is

$$(2)\quad \chi^2 = \textstyle\sum_i \chi^2_i \ \text{ where } \chi^2_i = \Sigma_j C_i(p_{ij1} - p_{ij2})^2/p_{ijo},$$

where p_{ij1}, p_{ij2}, and p_{ijo} are the estimated i-to-j transition probabilities for period 1, period 2, and the pooled data, respectively. The test statistic χ^2 is distributed as chi-squared with m(m – 1) degrees of freedom, where m is the number of states in S. The null hypothesis is rejected if χ^2 exceeds the threshold for $\alpha = 0.05$. In such a case the conclusion is that there has been a change in the underlying Markov process describing structural adjustment in the sector between two periods; i.e., that the process of change itself has changed. [2]

Gini Coefficients

Structure in the packing sector and any propensity for change over time is further evaluated using Lorenz curves and corresponding Gini coefficients. The ratio of the area between a diagonal line and an estimated Lorenz curve to the total area below the diagonal is commonly known as the Gini coefficient. An empirical estimation of this coefficient provides an index for judging the level of competition and the direction of change in concentration within a sector.

To test Lorenz curves for structural change, define PF as the cumulative percentage of firms, starting with the largest firm, and SM as market share held by each cumulative share of firms, and let YR represent the year value (e.g., YR = 1980 … 2000) to reflect shifts in the Lorenz curve through time such that

$$(3)\quad SM_t = \frac{1}{(1 + \exp^{\delta_0 + \delta_1 \ln(PF_t) + \delta_2 \ln(PF_t))^2 + \delta_3 YR_t + \varepsilon_t})}\ .$$

unavailable in this case. The Markov analysis allows comparison of long-term patterns of adjustment among fresh grapefruit packers over time. The Gini coefficients then provide additional evidence through an econometric estimate of adjustment.

[2] A critical assumption is stationarity. If the Markov process itself is non-stationary in either sub-period, it will be impossible to detect a change associated with market forces including retail and wholesale consolidation. Thus each independent matrix is tested for time-invariance prior to testing for differences between matrices. The null hypothesis is that $p_{ij}(t) = p_{ij}$ for all i, j, t—that is, that the Markov process does not change with time within a specified period. The likelihood ratio test statistic

$$(6)\quad -2 \log \Pi_t\, \Pi_i\, \Pi_j\, [(\, p_{ij} / p_{ij}(t)\,)]^{\,nij(t)}$$

has a chi-square distribution with m(m–1)(T–1) degrees of freedom, where T is defined as appropriate for the period and m is the number of states in the model. If the test statistic is not significant there is insufficient evidence to reject the assumption of time-invariance. Statistical tests for stationarity were conducted for each of the transition matrices estimated for this paper. In each case, there was insufficient evidence to reject the null hypothesis of time-invariance, so the assumption of a stationary chain is supported.

Because the shares must lie between zero and one, a logistic function can be readily estimated so that Equation 3 can be rewritten as

$$(4)\quad \ln\left(\frac{1}{SM_t}-1\right)=\delta_0+\delta_1\ln(PF_t)+\delta_2\ln(PF_t))^2+\delta_3 YR_t+\varepsilon_t$$

and the corresponding Gini coefficient is then the integral over PF where

$$(5)\quad Gini_t=\int_{PF=n_0}^{1}\frac{1}{(1+\exp^{\delta_0+\delta_1\ln(PF_t)+\delta_2\ln(PF_t))^2+\delta_3 YR_t+\varepsilon_t})}dPF_t - 0.5.$$

Characteristics of the Data

Firms that pack fresh Florida citrus are licensed by the Florida Department of Agriculture and Consumer Services (FDACS) and report total volume shipped under each license in each citrus season. Total U.S. fresh grapefruit utilization is reported by the Florida Agricultural Statistics Service (FASS), a division of the National Agricultural Statistics Service (NASS) of the USDA. Data were collected from FDACS and FASS for the 1970/71 through 1999/00 production seasons and used to measure changing patterns of adjustment in fresh Florida grapefruit packing.

The states of the Markov model are defined by a firm's share of U.S. fresh grapefruit utilization. Defining the states of the model as a percentage of national utilization implicitly incorporates information about aggregate forces of change in broader grapefruit markets including competition from other production regions. Total U.S. utilization ranged from a low of 22.6 million boxes in 1989/90 to a high of 34.6 million boxes in 1988/89. Florida's total share of the U.S. fresh grapefruit utilization ranged from a low of 57 percent in 1982/83 to a high of 78 percent in 1990/91.

Since the model states are defined as market share, firm size is a relative measure. A firm can move between states without altering its absolute level of output. Similarly, sizable adjustments in output may not result in a state change if proportional changes occur throughout the industry. A firm's state at any time is a function not only of its own output but also of the output of all other fresh grapefruit packing and shipping firms. Thus, consistent with evolution of a supply chain, the probability of a firm changing states represents general trends in the market rather than only the behavior of individual firms.

In order to calculate states, it is necessary to define the pool of firms that could enter fresh grapefruit packing in Florida. The number of participants in the model is defined to be the total number of shippers active at any level in any season during the years of interest. The number of active shippers ranged from 167 in 1970/71 to 94 in 1999/2000. A total of 410 distinct shippers were active during the period 1970/71 through 1999/2000; this is considered the size of the pool available for market entry.

The initial distribution of firms among seven defined states is shown in Table 1. Note that state zero consists of the pool of participants who were not active in the market in 1970/71 but who entered the market at some point between 1970/71 and 1999/2000. Over one-half (59.3 percent) of the firms in the pool were in the inactive category during 1970/71. Only two firms packed shares greater than two percent of U.S. utilization during the first year; these two firms accounted for 9.01 percent of the shipments from Florida and 4.96 percent of national utilization. Of the 167 active firms, the majority (127 firms, or 76 percent) were small, with less than one-half percent of U.S. utilization each. Table 1 also depicts a similar distribution for those firms active in the 1999/2000 season.

Structure Measured with Markov Transition Matrices

For the purposes of this study, the Markov process initiated with the 1970/71 production season, and outcomes are observed through 1999/2000. In order to test for changes in underlying patterns of industry adjustment, two sub-periods are defined: 1970/71 to 1994/95 and 1995/96 to 1999/2000. The shorter second period includes the years of rapidly accelerating food retail consolidation (Kaufman et al. 2000; Schaffner 2002). [3]

Transition matrices were estimated from equation 1 for each sub-period, 1970/71–1994/95 and

[3] Sub-periods divided at each year between 1987/88 and 1995/96 were also compared. There was no evidence of a change in the underlying patterns of adjustment detected in any of the sub-periods tested. We report results for the 1994/95 period since this is consistent with observed adjustments in other segments of the supply chain.

Table 1. Seven-State Model Distribution.

State	Market share: Firm percentage of U.S. utilization	Number of Florida packers	Share of Florida packers	Share of Florida utilization	Share of U.S. shipments
			-------------- percent	--------------	
		Initial distribution (1970/71 Season)			
0	0 (inactive)	243	59.3	0.00	0.00
1	0.0–0.4	127	31.0	21.86	12.04
2	0.5–0.9	23	5.6	27.99	15.41
3	1.0–1.4	7	1.7	15.28	8.42
4	1.5–1.9	8	2.0	25.85	14.24
5	2.0–2.4	1	0.2	3.99	2.20
6	2.5–	1	0.2	5.02	2.76
Total		410	100.0	100.00	55.07
		Final distribution (1999/2000 Season)			
0	0 (inactive)	316	77.1	0.00	0.00
1	0.0–0.4	55	13.4	7.02	4.20
2	0.5–0.9	14	3.4	16.97	10.16
3	1.0–1.4	9	2.2	18.99	11.37
4	1.5–1.9	9	2.2	26.73	16.01
5	2.0–2.4	5	1.2	18.24	10.93
6	2.5–	2	0.5	12.06	7.22
Total		410	100.0	100.00	59.90

Table 2. Matrices of Transition Probabilities for Sub-Periods within Model.

			Matrix of transition probabilities for 1970/71 through 1994/95				
0	**0.9498**	0.0446	0.0026	0.0014	0.0010	0.0002	0.0003
1	0.1825	**0.7859**	0.0280	0.0024	0.0006	0.0000	0.0006
2	0.0478	0.1612	**0.6269**	0.1284	0.0299	0.0030	0.0030
3	0.0327	0.0000	0.2383	**0.5374**	0.1449	0.0374	0.0093
4	0.0139	0.0069	0.0625	0.2222	**0.4792**	0.1806	0.0347
5	0.0000	0.0000	0.0270	0.0811	0.3649	**0.3378**	0.1892
6	0.0370	0.0000	0.0185	0.0741	0.0185	0.2778	**0.5741**
			Matrix of transition probabilities for 1995/96 through 1999/2000				
0	**0.9725**	0.0258	0.0000	0.0008	0.0008	0.0000	0.0000
1	0.1838	**0.7978**	0.0184	0.0000	0.0000	0.0000	0.0000
2	0.0377	0.1132	**0.7547**	0.0755	0.0000	0.0000	0.0189
3	0.0652	0.0217	0.1522	**0.6087**	0.1522	0.0000	0.0000
4	0.0000	0.0000	0.0256	0.1282	**0.6154**	0.2308	0.0000
5	0.0526	0.0000	0.0000	0.0526	0.3158	**0.5263**	0.0526
6	0.0000	0.0000	0.0000	0.0000	0.1111	0.3333	**0.5556**

Table 3. Matrix of Transition Probabilities for Pooled Data, 1970/1971 through 1999/2000.

State	0	1	2	3	4	5	6
0	**0.9530**	0.0420	0.0023	0.0012	0.0010	0.0001	0.0003
1	0.1817	**0.7880**	0.0273	0.0020	0.0005	0.0000	0.0005
2	0.0446	0.1559	**0.6386**	0.1287	0.0248	0.0025	0.0050
3	0.0369	0.0037	0.2177	**0.5572**	0.1476	0.0295	0.0074
4	0.0104	0.0052	0.0521	0.2083	**0.5104**	0.1875	0.0260
5	0.0103	0.0000	0.0206	0.0722	0.3608	**0.3711**	0.1649
6	0.0303	0.0000	0.0152	0.0606	0.0303	0.2727	**0.5909**

1995/96–1999/2000 (Table 2), as well as for the pooled data (Table 3). The (i,j) element of the transition matrix is the probability that a firm would move from state i at time t–1 to state j at time t. Therefore values to the left of the main diagonal represent firms that are decreasing market share (including those that exit the market) while those to the right of the main diagonal represent firms entering the market or increasing market share. Examination of the values along the main diagonals in the three matrices indicates that in 18 of 21 cases the most likely position for a grapefruit packer is to remain in the same state, reflecting inertia in the market. The very low probabilities in the first row of the matrix in each table indicate minimal chance of a new packing firm entering the market in any given year. New firms almost always enter with less than a 0.5 percent share, as shown by transition probabilities of 0.0446, 0.0258, and 0.0420 for the two sub-periods and the pooled data, respectively. Similarly, the first column shows the likelihood of market exit. Not surprisingly, packers with less than 0.5 percent market share (state 1) are the most likely to exit the market completely (all three transitional probabilities are greater than 0.18).

A test of whether two samples are from the same Markov chain was then applied to compare the sub-periods using Equation 1. The test statistic is calculated at 48.4, with 42 degrees of freedom and a significance of 0.230, providing insufficient evidence to reject the null hypothesis that the two samples are in fact from the same process. Thus there is no evidence of a change in the underlying patterns of adjustment in the packing sector associated with consolidation of retail and wholesale outlets or of other aggregate forces of change about 1995.

Structure Measured with Gini Coefficients

A Lorenz curve based on the share of market held by the share of firms (starting with the largest firms) indicates that the largest 10 percent of the grapefruit packers had approximately 35 to 40 percent of the market in 1985 and 2000 (Figure 1). In both years, the largest half of all packers had more than 90 percent of the market. The slight shift of the Lorenz curve to the left from 1985 to 2000 indicates a marginal decrease in sector concentration.

Results of estimating coefficients in Equation 4 for fresh Florida grapefruit packers are d_0 = –28.8421 (t = –3.8232), d_1 = –2.8250 (t = –126.950), d_2 = –0.2845 (t = –49.620), and d_3 = 0.01222 (t =11.6148), with R^2 = .99 and F(270,4) = 11023. From Equation 5, the Gini coefficients decrease slightly, from 0.32 in 1980 to 0.30 in 2000 (Figure 1b). Gini coefficients can range from 0 (i.e., Lorenz curve is a 45 degree line, indicative of a perfectly competitive market) to 1 (i.e., Lorenz curve is a right angle, indicative of a monopoly).

While the time trend in the Gini values is statistically significant (t = 11.6), there is very little numerical difference among the values (Figure 2). Clearly, the Gini coefficients point to an industry that is not highly concentrated and is not becoming more concentrated over time. In fact, the slight Gini shift is toward less concentration, as seen with the slightly lower values in the more recent years (e.g., Gini(1980) = 0.319 and Gini(2000) = 0.298). Confirming results from the Markov evaluation, the relative stability of the Gini coefficient at the packer level points to a sector whose market position (and power) is not being influenced by horizontal structural changes but rather by shifts in power at other levels in the marketing chain.

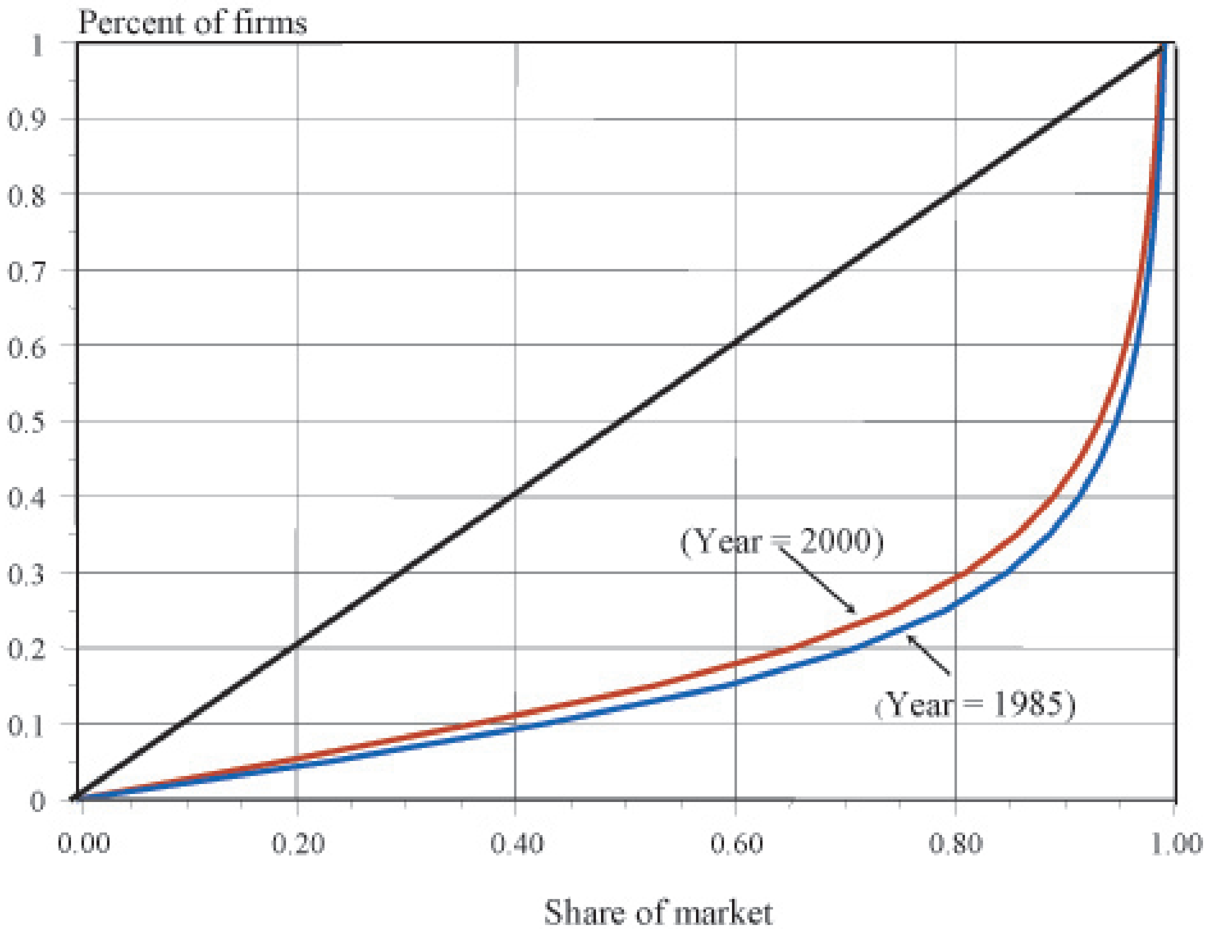

Figure 1. Lorenz Curves for Florida Fresh Grapefruit Packers, 1985 and 2000.

Individual Firm Adjustment

Stationarity in the Markov transition matrices (see footnote 1) and relatively flat Gini coefficients indicate stability in the patterns of aggregate market adjustments for this sector; however, these values do not imply that individual firms within the sector are static. Figures 3 and 4 track the movement of individual packing firms in specified size categories between 1970 and 2000. Small firms are defined to be active with less than 0.5 percent market share, medium firms have a market share between 0.5 percent and 2.0 percent, and large firms have a market share greater than 2 percent. There were 127 small, 38 medium, and two large firms active in the 1970/71 season. The vertical bars represent the movement of the individual small (Figure 3) and medium (Figure 4) firms over the 30-year period.

The difference in height between the bar in 1970/71 and any later period represents firms that exited the industry. So for example, of the 127 small firms in 1970/71, 93 remained small in the following year, four grew to midsize (medium), and 30 exited the industry. Consistent with the results presented in the Markov transition matrices, attrition was greatest among the small firms. By 1999/2000, 111 of the original 127 small firms had exited the industry. Of the 38 medium firms that were active in 1970/71, by the following season four had become small, three had become large, and none had exited the industry. By 1999/2000, five of the original medium firms were in the small category, four were in the large category, and 17 had exited the industry. Of the two large firms in existence during the 1970/71 season, one had exited the industry by 1973/74 and the other by 1989/1990 (not shown).

Figure 2. Gini Coefficients for Florida Fresh Grapefruit Packers, 1980 to 2000.

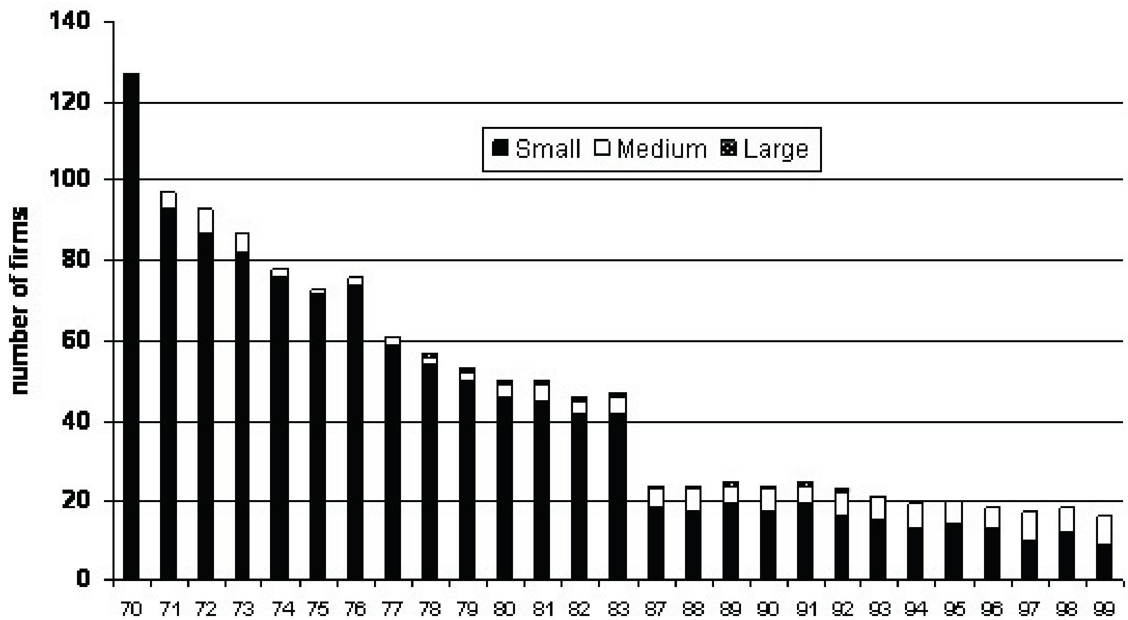

Figure 3. Transition Pattern of Fresh Florida Grapefruit Packers Classified as Small in 1970/71.[a]

[a]Small (0.0 to 0.5 % share); Medium (0.5 to 2.0% share); Large (greater than 2.0% share).

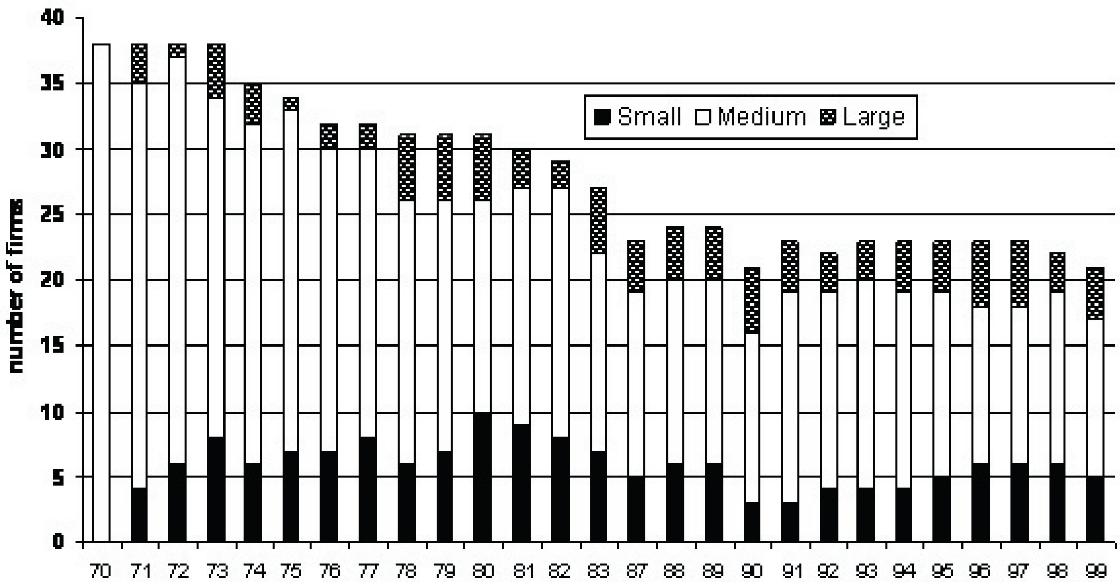

Figure 4. Transition Pattern of Fresh Florida Grapefruit Packers Classified as Medium in 1970/71.[a]

[a]Small (0.0 to 0.5 % share); Medium (0.5 to 2.0% share); Large (greater than 2.0% share).

Movement toward Equilibrium

Based on the patterns of adjustment identified in the Markov process for the pooled data, an equilibrium distribution can be calculated for the grapefruit packing sector (Table 4).[4] In the absence of a change in the underlying patterns of adjustment (as we found above), each process will converge to the distribution shown, although the rate of convergence is unknown. At equilibrium, individual firms continue to move between states as described by the transition matrix, but the overall distribution of firms among states is unchanging.

Figure 5 compares the actual number of active firms in 1970/71 (Table 1) and 1999/2000 with the projected number of active firms in the equilibrium distribution derived from this pooled data set. Between 1970/71 and 1999/2000 the number of active firms declined by nearly 44 percent, from 167 firms in 1970/71 to 94 firms in 1999/2000. Among these active firms, approximately 76 percent had less than 0.5-percent market share and 14 percent had a market share between 0.5 and 1.0 percent in 1970/71, as shown in Figure 6. At equilibrium, firms with less than a 1.0-percent share (states 1 and 2 in the transition matrix) account for 78 percent of the active firms, while there is a corresponding increase in the probability that firms will have a market share greater than 1.0 percent (states 3–6) if they are active. Figure 7 shows these relative changes across the states of active firms. Clearly, within the pool of active firms there is evidence of an increasing proportion of large firms in the industry between 1970/71 and 1999/2000. The estimated equilibrium indicates that by 1999/2000 the industry was very close to the total number of large firms projected.

[4] A Markov process which has a stationary distribution and which is aperiodic and irreducible converges to the equilibrium distribution (Rosenthal 2000). To derive a stationary distribution, let α be a row vector such that $(\alpha)P = (\alpha)$. This produces a system of m equations in m unknowns, but the equations are not independent because P is row stochastic. Since α is a probability distribution, $\Sigma_i \alpha_i = 1$. This constraint may be substituted for any of the original m equations to produce a linearly independent set that may be solved for $\{\alpha_i\}_{i\in S}$. The period of a state i is the greatest common divisor of the times at which it is possible to transition from state i back to i. By definition, a Markov chain is aperiodic if the period of every state is 1. The diagonal elements of each of the transition matrices estimated for this paper are all nonzero so it is immediately evident that the Markov processes are aperiodic. A Markov chain is irreducible if for any states i and j, there exists some number r with $p_{ij}^r > 0$—that is, if it is possible for an element to move from any state i to any state j in some finite number of steps. Again by examination of the transition matrices, each of the Markov processes is clearly irreducible.

Table 4. Equilibrium Distributions of Florida Fresh Grapefruit Packers.

State	Market share[a]	Sub-periods 1970/71 to 1994/95	Sub-periods 1995/96 to 1999/2000	Pooled data 1970/71 to 1999/00
		Percentage of firms (number of firms)		
0	0 (inactive)	72 (295)	84 (344)	73 (300)
1	0.0–0.4	18 (74)	12 (48)	17 (71)
2	0.5–0.9	4 (16)	2 (6)	4 (15)
3	1.0–1.4	3 (11)	1 (4)	2 (10)
4	1.5–1.9	2 (8)	1 (5)	2 (8)
5	2.0–2.4	1 (4)	1 (3)	1 (4)
6	2.5–	1 (3)	<1 (1)	1 (3)

[a] Firm percentage of U.S. utilization

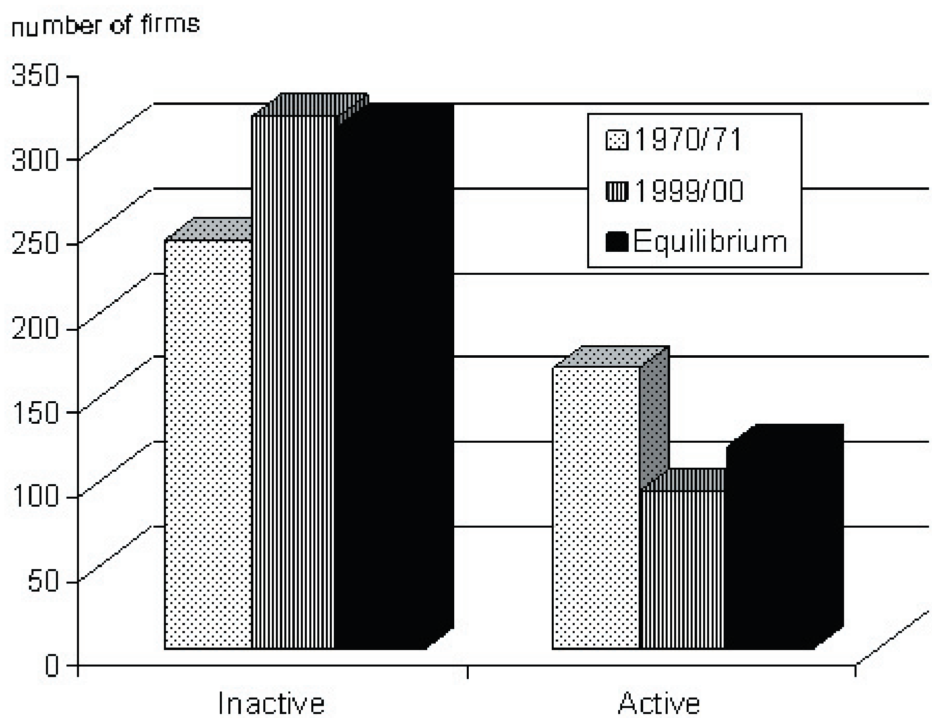

Figure 5. Distribution of Active and Inactive Firms in 1970/71 and 1999/2000, and Equilibrium Distribution.

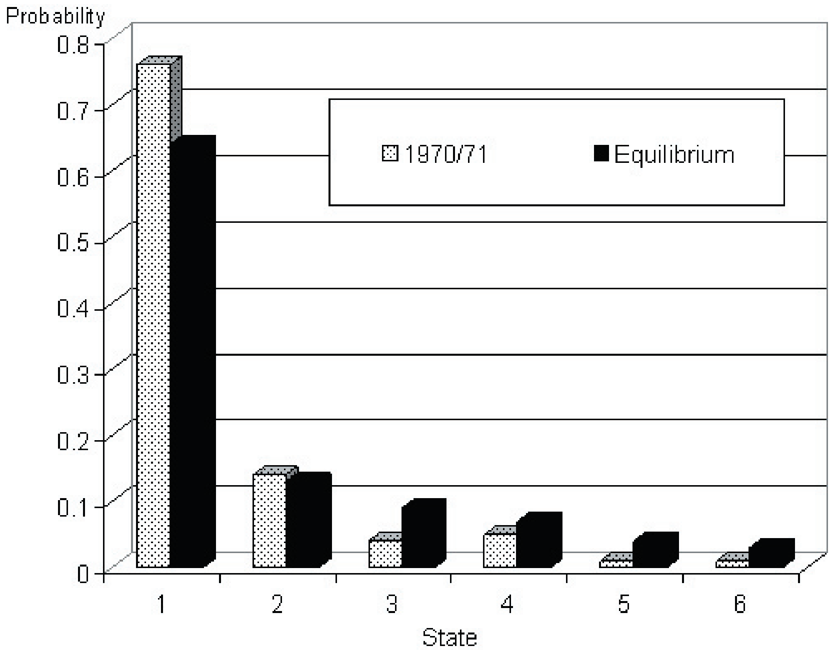

Figure 6. Probability of Active Firms being in Various States.[a]

[a] 1(0–0.5%); 2(0.5–1.0%); 3(1.0–1.5%); 4(1.5–2.0%); 5(2.0–2.5%); 6(>2.5%).

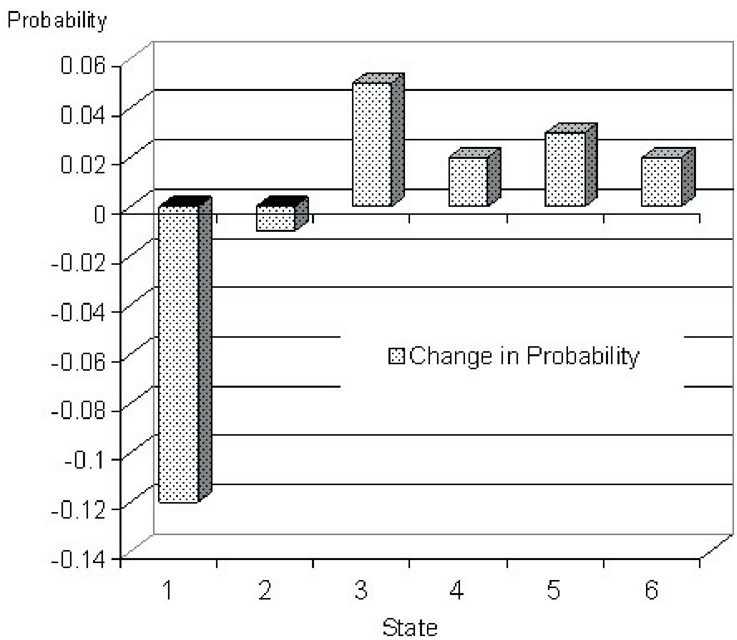

Figure 7. Change in Probability of Active Firms being in Various States between 1970/71 and Equilibrium.[a]

[a] 1(0–0.5%); 2(0.5–1.0%); 3(1.0–1.5%); 4(1.5–2.0%); 5(2.0–2.5%); 6(>2.5%).

Discussion

This study evaluates changes in the pattern of structural adjustments between the 1970/71 and 1999/2000 seasons among Florida fresh grapefruit packers in response to sweeping trends in produce markets, including consolidation of produce retailers and wholesalers, changes in consumer preferences, identification of new markets, and technological advances. Despite such numerous forces affecting fresh produce markets, there was insufficient evidence to identify significant alterations in the patterns of adjustment in the packing sector. Estimation of Lorenz curves and the corresponding Gini coefficients fully support findings from the Markov chain that the packing industry shows only marginal levels of concentration, with little evidence of change over time.

Initially, the stability in adjustment patterns among grapefruit packers is surprising given the magnitude of market changes in other sectors of the supply chain. Yet there are several plausible explanations. Annual supplies of fresh grapefruit from growers are highly variable. As with other tree-fruit industries, there are significant lags at the production level in a firms' ability to respond, so excess product is often available to packers (Kalaitzandonakes and Shonkwiler 1992). Conversely, limited geographic production areas have made supplies particularly susceptible to damaging frost or catastrophic freeze events in particular years (Elmer et al. 2001). Thus year-to-year uncertainty may increase both the inability of packers to identify trends and their reluctance to make long-run adjustments.

Large sunk costs at the packing/processing levels may also contribute to inertia within the sector (Sutton 1996). Fixed investment in specialized equipment provides an incentive for packinghouses to continue operation. With relatively small modifications, the equipment can be used to pack other citrus products, and many of the packing sheds do pack other citrus over the course of a season. Returns across alternative citrus categories might limit adjustment in the grapefruit sector as individual packinghouses seek to maximize total volume through the plant.

At the same time, sluggishness in packing-sector adjustment does not prohibit changes elsewhere in the supply chain, potentially leaving the packing sector lagging behind. An observable (although not easily measurable) phenomenon in the fresh grapefruit supply chain is the presence of sales organizations. Anecdotal evidence suggests that a small number of sales organizations were operating in the fresh grapefruit market throughout the 1990s. Sales organizations could serve as consolidators for the packinghouses and act to negotiate sales with the larger retail buyers. Then participating packers would essentially function as a single entity at that up-stage sector in the supply chain. These marketing agreements may be informal, are often confidential, and are not revealed in the packing reports unless a formal merger of firms has occurred. Data on such arrangements are only available through word-of-mouth or intermittent announcements in publications such as *The Packer* or *Citrus News*. It may be that retailers are facing a more concentrated grapefruit sales sector than is indicated by individual packinghouse data. While not currently available, it would be useful to compare the Gini values at other stages in the supply chain with those from the packer level. An index of such coefficients would give a picture of market power up and down the entire vertical-distribution system.

Stationarity in the estimated transition matrix for packers does not imply that the sector is in equilibrium or that individual firms do not enter and exit. Depending on actual transition probabilities, there may be substantial differences between current and projected distributions, indicating adjustments in firm numbers and size are still occurring. It is the process of adjustment itself that is stable. Empirical results from the fresh grapefruit packing sector are indicative of an industry near equilibrium with little expectation of change in the distribution of firm sizes unless there are changes in the underlying patterns of adjustment represented by the Markov process. While individual firms enter and exit the market and move between states, there are no profound structural changes suggesting acceleration in concentration in this downstream produce sector.

If faced with increasing buyer concentration, the stability of the Gini coefficients points to an industry facing potentially greater pressure and loss in market power due to changes at other points in the vertical supply chain. Lags in the packing-sector adjustment process in the face of sweeping forces of change in fresh produce markets are likely to have put this sector of the fresh grapefruit supply chain at a relative disadvantage in terms of market power.

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