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Cartels That Vote: Agricultural Marketing Boards and Induced Voting Behavior

Jonathan Cave and Stephen W. Salant

The Agricultural Marketing Act of 1937 permits the establishment of committees that, among other activities, may legally regulate industry sales for the benefit of producers. Unlike other cartels operating in the United States, these committees are exempt from antitrust penalties. Indeed, the federal government itself polices each agreement, punishing those who violate committee edicts.

Since more than half of the fruits and tree nuts and 15 percent of the vegetables produced in the United States, measured in value terms, are regulated by such committees, it seems important to understand their behavior. Figure 8.1 indicates crops currently regulated by such federal orders. Since 1937 hundreds of orders have been initiated; most have terminated for one reason or another.[1] At the moment, forty-seven different federal orders exist. Of these, twenty-four provide for some form of direct regulation of quantity. The rest purportedly regulate quality. Of the twenty-four containing quantity regulations, only a handful are commonly regarded as serious sources of resource misallocation: the orders for hops, spearmint oil, walnuts, filberts, California-Arizona navel and valencia oranges, and lemons. The rest are typically regarded as ineffective.[2] Why some quantity-restricting cartels are more effective than others is a puzzle worthy of explanation.

Our goal in this research project is to understand the behavior of administrative committees authorized to restrict volume. Understanding this behavior is interesting in its own right and in addition may clarify how other cartels operate. Like every cartel, these administrative committees must grapple with difficult collective choice problems; however, they are not burdened with the enforcement problems that beset the typical cartel. Administrative committees afford students of cartel behavior three advantages: (1) their collective choice mechanism (majority-rule voting) is explicit, (2) their meetings are open to the public, and (3) their public records reveal how each committee member voted on each proposed volume restriction (no matter whether it passed or failed).

The participants in these markets are consumers, growers, and intermediaries referred to as handlers or packinghouses. To establish an order requires a vote of the growers only (at least two-thirds of the growers

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Figure 8.1 Fruit, vegetable, and nut marketing agreements and orders. Source: U.S. Department of Agriculture Marketing Service Program Aid No. 1095.

or a smaller number representing at least two-thirds of the volume). Orders generally state in detail the number of board members of each type (growers, handlers, or consumers) that growers and cooperatives can nominate. For example, the valencia committee is composed of eleven members—six growers, four handlers, and a consumer representative. Three of the growers and two of the handlers can be nominated by the cooperative that ships more than 50 percent of the crop (since time immemorial, Sunkist). The remaining cooperatives can nominate (using volume-weighted voting) one grower and one handler, whereas independent growers can nominate the two other growers and one handler. The eleventh member is selected by the other ten and must be neither a handler nor a grower. Each member serves for a term of two years.

Committees range in size from six members (Colorado potatoes) to forty-seven (raisins). Producers hold a majority on forty committees and have excluded handlers altogether on six committees.

Only the actions of the handlers are directly regulated by the committee's decisions. Under a time-honored principle known as "equitable marketing opportunity" (incorporated in sections 608 (c) (6) (C) and (D) of the Agricultural Marketing Agreement Act of 1937), all handlers are given the opportunity to ship the same percentage of the crop under their control to the regulated market, which we call the "primary" market. In practice, however, some handlers do not avail themselves of this opportunity. The divergence that typically exists between aggregate sales, on the one hand, and aggregate allotments (the amount authorized by the committee), on the other, is evidence that some handlers ship less than they are permitted. Table 8.1 reflects this stylized fact.[3] Why some handlers find it contrary to their self-interest to sell on the regulated market as much as the committee gives them the "opportunity" to sell also merits explanation. How handlers dispose of the rest of their crop depends on the specific order. Orders in which the handler can dump the rest of his crop on unregulated secondary markets are known as "market allocations" or "season-long prorates." Currently in this category are cranberries, raisins, almonds, walnuts, filberts, California dates, oranges, and lemons. Orders in which any production in excess of the allotment must be stored are known as "producer allotments." Currently in this category are hops, spearmint oil, and Florida celery.

In the next section of this chapter we review the standard model of marketing orders and discuss anecdotal evidence inconsistent with it. In subsequent sections, we develop an alternative model that, unlike the conventional model, accounts explicitly for the divergent interests of com-

Table 8.1 Illustration of divergence between aggregate allotments and sales, hops and celery from 1960 to 1980

Season beginning	Florida celery (1,000 crates)[a]		Hops (1,000 lb)	
	Allotment[b]	Sales	Allotment	Sales
1960	[c]	7,086	[d]	45,652
1961	[c]	7,122	[d]	35,454
1962	[c]	7,132	[d]	44,072
1963	[c]	7,372	[d]	51,336
1964	[c]	7,573	[d]	53,081
1965	8,055	7,770	[d]	56,060
1966	7,887	7,350	56,173	54,620
1967	7,887	6,867	55,753	49,498
1968	7,887	6,997	51,497	43,733
1969	7,887	6,128	46,063	41,592
1970	7,887	7,174	48,208	45,619
1971	7,887	7,069	49,601	48,057
1972	8,372	7,366	49,377	52,463
1973	8,797	6,071	55,528	55,152
1974	8,354	6,475	60,270	57,796
1975	8,326	5,686	60,270	55,593
1976	9,223	5,529	60,270	57,538
1977	8,082	5,979	60,270	54,767
1978	8,433	7,941	60,270	55,424
1979	9,644	7,900	63,234	55,254
1980	8,601	5,700[e]	76,424	75,816
1981			78,280	

Source: USDA Report No. 477, p. 40.
a. Sixty pounds per crate.
b. Quantity that may be sold in primary market outlets. Sales figures are for the primary market.
c. Order effective November 15, 1965.
d. Order effective July 22, 1966.
e. Preliminary.

mittee members and the fact that these conflicts are reconciled by voting. We clarify how the interest of each market participant depends on the restrictions adopted. Then we illustrate that these "induced preferences" need not be single-peaked even in the simplest of cases. Finally, we show that under majority rule the committee will nevertheless select the restriction most preferred by the board member with the median endowment. This chapter constitutes the theoretical underpinning of an ongoing research project.

The Standard Model of the Monolithic Marketing Board and Some Anecdotal Evidence against It

For decades agricultural marketing boards have been the subject of extensive study by economists, consumer groups, and government officials. The literature that has arisen concerning these cartels is vast.[4] In some cases it consists of comprehensive analyses of the weekly meetings of specific boards. For the most part, however, it consists of more formal, stylized models of board behavior.

These latter treatments tend to analyze the producer allotment and market allocation schemes by means of the same two models.[5] Producer allotments tend to be viewed as classic monopolies. Each committee is assumed to market whatever quantity maximizes industry profit. For example, if sale of the entire crop would cause losses at the margin, it is predicted that surplus will be discarded until the profit from an additional sale is zero. Market allocation is regarded as classic third-degree price discrimination coupled with free entry. Under this model the committee restricts sales in the inelastic primary market to the point where marginal revenues (net of any market-specific marginal handling costs) are equal in the primary and secondary markets. Since the entitlement to sell in the lucrative primary market is proportional to the size of one's crop, aggregate crop size is predicted to expand (in markets where expansion is permitted) until the losses in the secondary market offset the profits in the primary market, and total profits are dissipated.

Although this conventional view has a great deal of support among economists modeling volume-restricting marketing orders, we believe it is erroneous. The standard view fails to consider that each allotment percentage is chosen not by a benevolent dictator but by a committee operating under majority rule. If committee participants vote according to their divergent economic interests, the outcome of the voting process may differ radically from the predictions of the conventional model. In an industry of handlers of varying size, a committee dominated by small handlers, for example, can be expected to make a different collective decision than a committee composed of large handlers. The large handlers will favor tight restrictions on all fellow handlers to limit free riding. In contrast, the small handlers will prefer lax restrictions on every handler since they can depend on the larger handlers to hold up the "price umbrella" by restricting their own output even if not required by the committee to do so.

The more institution-oriented students of marketing orders have frequently emphasized that committee decisions are compromises that reconcile deep-seated divisions within a given industry. To illustrate, consider the citrus industry. The divisions within that industry were apparent even before the inception of any order. The largest cooperative (now Sunkist) had restricted sales in the inelastic market in an attempt to price discriminate, but it had failed repeatedly to get the needed cooperation of the smaller handlers and the smaller cooperative (now Pure Gold). Sunkist's problem with free riders was conveniently resolved after 1933 by federal regulations making noncompliance illegal, but, as can be imagined, the imposition of the government order was bitterly opposed by the independent handlers and Pure Gold. A half century later this conflict still smolders. Within the last year, a group of independents succeeded in pressuring the secretary of agriculture to suspend the navel order—to the great dismay of Sunkist.[6]

Size differences among market participants account for much of the conflict within the citrus industry.[7] In his comprehensive review of twenty years of weekly minutes of meetings of the orange board, Clodius (1950, p. 327) commented on a dispute that was to become chronic:

> [Pure Gold] also criticized the level at which their weekly allotments were placed by the committee, holding that they always had customers who were willing to buy more of their oranges, if only the level of volume proration had not been set so low. From the viewpoint of any shipper who controls such a small part of the total supply, the amount he ships does not have any effect on the price he receives. This was the position of [Pure Gold] and the independents. Thus their criticisms of the committee in this matter were understandable. Had all the small shippers been permitted to ship what they wanted each week, these incremental supplies would probably have had a substantial price reducing effect ... The program would fail if for no other reason than that which caused the voluntary programs to fail—those whose shipments were not being restricted gained disproportionately.

These conflicts within the industry played themselves out in the decisions of the orange committee. Compromises were reached only after protracted deliberations. Clodius (1950, p. 308) reports that the independents, Pure Gold, and Sunkist would begin each meeting with widely divergent recommendations for the allotment percentage. "Rarely do the three coincide. Thereupon the groups bargain until some kind of compromise is found ..." In fact, according to Clodius (1950, p. 158), on one occasion compromise proved utterly impossible. In December 1941 the orange order had to be terminated because the board—then composed of an even number of members and lacking a tie-breaking rule—became hopelessly deadlocked.

Based on his careful examination of twenty years of such meetings, Clodius (1951, p. 1046) ultimately concluded:

> Short-run maximization is also not possible because of lack of homogeneity of interests within the composition of the Committee reflecting industry attitudes. Every decision of the Committee is a result of compromise among the dominant shipper, which is a cooperative, a much smaller cooperative shipper, and the private shippers. Committee representatives tend to be prejudiced toward their own organizations. Because of the great diversity among organizations, their interests rarely tend to coincide; *thus joint maximization is impossible* [our emphasis].

What Clodius concluded about the orange committees,[8] the National Commission on Food Marketing concluded about most other administrative committees. After discussing deep conflicts in most industries—in large part related to size differences—the commission (1966, p. 348) remarked: "It is doubtful that the interests of those administering most orders coincide to the extent that an order could be operated consistently in a highly monopolistic manner."

Given the abundant evidence of widespread conflict within many administrative committees, we are skeptical of claims that they invariably act "as if" to maximize industry profits. Indeed, in our view proponents of such theories often tacitly admit that the conventional model does not apply to all orders containing volume restrictions since they never apply it to orders that they regard as somewhat competitive. Instead, at the outset they disregard such cases an uninteresting and of no "policy relevance."[9] We illustrate here an approach that we hope is applicable to the entire class of volume-restricting orders, not just to an arbitrary subset. We find that changes in the composition of the administrative committees and the rules governing them will have predictable economic consequences that policymakers may wish to consider when deciding how to reform the current system. In contrast, the conventional model suggests that such political changes will have no economic effects whatsoever.

Industry Equilibrium and Induced Preferences about the Allotment Percentage

The formal model contains n firms—the packinghouses. Firm i has at its disposal a total quantity q_i—referred to here as an "endowment" and in the trade as the "base." Handlers divide sale of their crop (regarded here as homogeneous) between a primary and a secondary market. In the primary market the demand curve is assumed to be relatively inelastic and to depend on sales in that market only.[10] Demand in the secondary market is assumed to be infinitely elastic at a price c. We have adopted these demand assumptions because they (1) simplify our problem, (2) correspond to the assumptions most often used in the literature on the alternative model of marketing orders, and (3) seem to reflect reality for certain orders.[11] Since production decisions are assumed to have taken place previously, we treat production as an endowment and therefore have no need to consider its costs. Of course c can be regarded as the opportunity cost of sales in the primary market. In the case of producer allotments, $c = 0$.[12] For concreteness, we assume that the firms are numbered in increasing order of size: $q_1 < q_2 < \cdots < q_n$. We denote by Q_i the aggregate endowment of the smallest i firms: $Q_i \equiv q_1 + \cdots + q_i$.

The marketing board sets the maximum proportion F of each firm's endowment that may be sold on the primary market. The strategy of firm i is a quantity $y_i \leq Fq_i$ to be sold on the primary market; the rest of i's endowment $(q_i - y_i)$ is sold on the secondary market. The profit of the ith firm will generally depend on its arrangement with its growers. If the packinghouse is a cooperative, it retains a percentage of the revenues and remits the remainder to the growers in proportion to the size of their crops. For simplicity, we assume this form of contractual relationship below.[13] Hence the ith handler will want to maximize revenues from the primary and secondary markets:

$$\max_{y_i \in [0, q_i F]} \; y_i P(y_i + Y_{-i}) + c(q_i - y_i),$$

where

$$Y_{-i} = \sum_{j \neq i} y_j.$$

Denote aggregate sales in the primary market by $Y\,(\equiv y_i + Y_{-i})$. If y_i is a best reply to Y_{-i}, one of the following Kuhn-Tucker conditions must hold:

$$y_i = 0 \quad \text{and} \quad P(Y) - c < 0, \tag{1}$$

$$_i \in [0, q_i F] \quad \text{and} \quad P(Y) + y_i P'(Y) - c = 0, \quad \text{or} \tag{2}$$

$$_i = q_i F \quad \text{and} \quad P(Y) + q_i F P'(Y) - c > 0. \tag{3}$$

\ pure-strategy Nash equilibrium point is an n-tuple of strategies $y_1, \ldots, y_n$), each of which is a best reply to the others.

Under relatively mild assumptions it is possible to demonstrate the xistence of a unique equilibrium point in pure strategies.[14] Denote the ector of equilibrium strategies by $\mathbf{y}^*(F)$ and aggregate equilibrium prinary market sales by $Y^*(F)$.

We now turn to the properties of this Nash equilibrium. Since demand s strictly monotone decreasing, each handler's profit function is strictly oncave in its own decision variable (y_i),[15] and only one of the Kuhnucker conditions (1) through (3) can hold for each i. To ensure that the andlers will wish to sell anything at all on the primary market, we assume hat $P(0) > c$, which means that (1) does not hold for any i, provided $F > 0$. ince $Y^*(F)$ is unique, we can classify handlers as constrained or unconstrained at a given F. Firm i is constrained at F iff condition (3) holds for irm i in the equilibrium associated with F; in that case we write $i \in C(F)$. f not, (2) must hold, and we say that firm i is unconstrained at F; the set f unconstrained firms is denoted $U(F)$.

If handler i is constrained, (3) holds and any smaller handler j $(j < i)$ nust also be constrained. If handler i is unconstrained, (2) holds, and any arger handler $j(j > i)$ must also be unconstrained. Thus $C(F)$ and $U(F)$ re intervals; there is a largest constrained handler $i(F)$ such that $C(F) = 1, \ldots, i(F)\}$ and $U(F) = \{i(F) + 1, \ldots, n\}$.

The first-order condition characterizing the best reply of an unconstrained firm is symmetric. Hence all unconstrained firms i will sell the ame quantity (denoted $y^u(F)$) on the primary market, while each contrained firm will sell the maximum feasible amount $(y_i^*(F) = q_i F)$.

The profits of firm i in the unique equilibrium corresponding to a articular F are

$$\pi^i(F) = \begin{cases} \pi_u^i(F) = P(Y^*(F))y^u(F) + c(q_i - y^u(F)) & \text{if } i \in U(F), \\ \pi_c^i(F) = P(Y^*(F))q_i F + c(1 - F)q_i & \text{if } i \in C(F), \end{cases} \tag{4}$$

vhere

$$Y^*(F) = \sum_{i=1}^{n} y_i^*(F) = \sum_{i \in U(F)} y^u(F) + \sum_{i \in C(F)} q_i F.$$

These profits induce preferences of each firm over the choice of F. In turn the committee chooses F by simple majority rule, so we wish to relate the chosen F to the structure of these preferences.

The induced preferences are not single peaked even in the simplest case, where $P(\cdot)$ is linear. However, the collection of induced preferences has enough structure to ensure the existence of a unique majority-rule equilibrium to the voting game over F. We now clarify the elements of this structure on which our results will depend.

The first element of this structure we refer to as nesting. Suppose that we start with $F = 1$, in which case all firms are unconstrained. As F tightens (falls), more and more firms become constrained. In fact, associated with each firm i is a characteristic cutoff value F_i at which it just becomes constrained ($y^u(F_i) = q_i F_i$). Our previous results imply that these cutoffs are ranked in decreasing order of size: since $q_1 < \cdots < q_n$, it must be that $F_1 > \cdots > F_n$. If not, for $i > j$ there would exist F between F_i and F_j that would constrain the larger firm (i) but not the smaller (j), and $C(F)$ would not be an interval. Therefore the nesting property implies that as F falls, the smallest firms become constrained first, and firm i is constrained at F if and only if $F < F_i$. This reflects our intuition that smaller firms, having smaller inframarginal losses from additional sales in the primary market, would like to "free ride" on the voluntary (unconstrained) restraint of large firms.

The second element of this structure we refer to as scaling: by inspection of (4) it is clear that the profits of any two constrained handlers are monotonically increasing linear transformations of each other. Therefore, if F and F' are two candidate choices and if in equilibrium firms i and j are constrained at both F and F', the two firms will rank the candidates in the same way. In brief, the ordinal preferences of all constrained handlers are the same.

The third property we refer to as consistency. It requires that $\pi_c^i(F_i) = \pi_u^i(F_i)$, and it follows immediately from (4) and the definition of F_i.

Finally, the induced preferences have the property that each unconstrained handler prefers tighter restraints on its constrained rivals. We refer to this property as "unconstrained monotonicity"; it says that $\pi^i(F)$ is monotone decreasing in F throughout the range $[F_i, 1]$. Indeed, each firm's profit is continuous in F, and decreasing in F, when the firm is unconstrained.

These properties follow from the observation that the unconstrained firms are playing a symmetric Cournot quantity game. As Spence (1976), Loury (1986), and Bergstrom and Varian (1985) have remarked, Nash equilibria of symmetric games can sometimes be represented as extreme points of "potential functions." In this case, if there are k unconstrained firms, the unique Cournot equilibrium total primary market sales by the unconstrained firms can be characterized as the unique maximizer of $(k - 1)CS(Q \cdot F) + k\pi(Q : F)$, where $CS(Q : F)$ is consumer surplus and $\pi(Q : F)$ is the total revenue earned by the unconstrained firms on their primary market sales. Both of these are computed using the "residual demand curve" $P(Q : F) = P(Q + FQ_{n-k})$. This formulation shows clearly that the Cournot equilibrium associated with a smaller F's is less competitive and also that increases in the number of unconstrained firms result in more competitive outcomes for a given F.

Since the range of F is compact and the profit functions are continuous in F, it follows that each firm i has an ideal or most-preferred value of F, which we denote by I_i. It is straightforward to show that handlers in the industry with larger endowments prefer smaller allotment percentages. More precisely, if $q_1 < q_2 < \cdots < q_n$, $I_1 \geq I_2 \cdots \geq I_n$. For if $q_i < q_j$, then $F_i \geq F_j$, and (by monotonicity) either $I_i < F_j \leq F_i$ or $F_j \leq I_i < F_i$. In the former case $I_i = I_j$ (by scaling), and in the latter $I_j \leq I_i$.

The behavior of firms as F tightens is illustrated in figure 8.2 for the duopoly case. The first panel shows the two firms' unconstrained reaction functions. The unconstrained Nash equilibrium sales vector is located at their unique point of intersection, which is labeled a. In addition we have shown the endowment point, labeled q. As F tightens, the rectangle of length Fq_1 and height Fq_2, within which y must lie, shrinks. Note that since $q_2 > q_1$, the ray to the endowment point is steeper than the 45° line. As F falls, the maximum amounts that can be sold on the primary market move down this ray. From this, we can see that firm 1 (the smaller firm) is the first to become constrained, illustrating the nesting property described earlier. The allotment percentage at which firm 1 is just constrained is labeled F_1 in the figure.

The second panel shows the reaction curves for values of F where firm 1 is constrained. As F tightens, it is clear that the equilibrium sales vector moves up the unconstrained reaction curve of firm 2 until it meets the ray to the endowment point at F_2q. This segment is labeled b. As F falls further, both handlers are constrained, and the vector of equilibrium sales in the primary market moves down the ray. The second panel also indicates the isoprofit curve for each packinghouse, through the equilibrium point. As figure 8.2 illustrates, locally movement along b (as F falls) benefits the unconstrained firm. This illustrates the property of "unconstrained monotonicity." The final two panels illustrate the possibilities when both firms are constrained: it is possible that both firms will benefit (or be harmed)

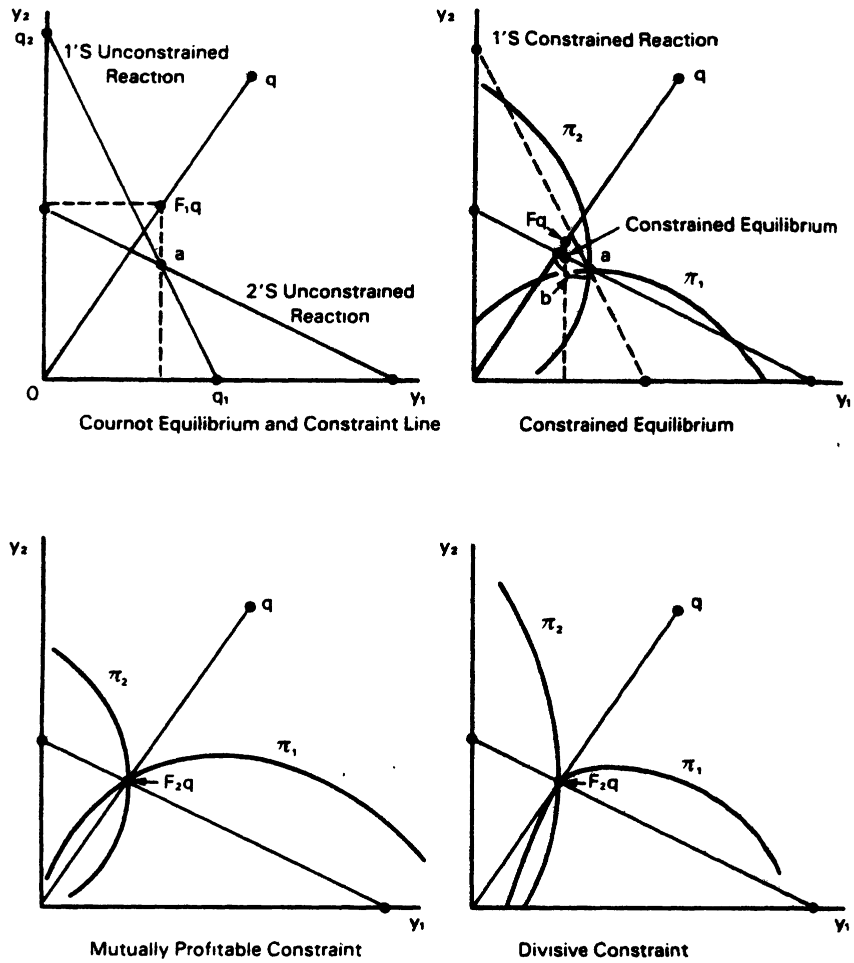

Figure 8.2 Industry equilibrium under marketing orders in the two-handler case

from tightening F, but it is also possible that only the larger firm will find this profitable.

Preferences Derived for an Example

The following example illustrates that the induced preferences derived in the previous section need not be single peaked even when inverse demand is linear:

$$P(Y) = a - bY. \tag{5}$$

Substituting this inverse demand curve into the Kuhn-Tucker conditions (1) through (3), we obtain for each i:

$$y_i = 0 \quad \text{and} \quad a - bY - c < 0, \tag{1'}$$

$$y_i \in [0, q_i F] \quad \text{and} \quad a - bY - by_i - c = 0, \quad \text{or} \tag{2'}$$

$$y_i = q_i F \quad \text{and} \quad a - bY - c > 0. \tag{3'}$$

We have already argued that (1′) never holds in equilibrium. Conditions (2′) and (3′) characterize the unconstrained and constrained firms, respectively. From (2′), the primary sales of each unconstrained handler will be

$$y_i = y^u = \frac{(a - bY - c)}{b} \quad \text{for all } i \in U(F). \tag{6}$$

Consider the unique equilibrium associated with F. If there are k constrained firms and $n - k$ unconstrained firms, aggregate sales in the primary market will be

$$Y^*(F) = (n-k)y^u + Q_k F = \frac{(n-k)(a-c) + bFQ_k}{b(n-k+1)}. \tag{7}$$

Hence the primary market sales of each unconstrained firm will be

$$y^u(F) = \frac{a - c - bFQ_k}{b(n-k+1)}. \tag{8}$$

We can use this expression to find the allotment percentage F_k that is just binding on firm k. Since $y^u(F_k) = F_k q_k$,

$$F_k = \frac{a - c}{b[(n-k+1)q_k + Q_k]}. \tag{9}$$

It is clear from this expression that the cutoffs have the nesting property derived previously:[16]

$$F_1 \geq F_2 \geq \cdots \geq F_n.$$

We now turn to the properties of the equilibrium quantities and the induced preferences. First, it will be noticed that even in the general case the preferences of the constrained and unconstrained firms can be written:

$$\pi_c^i(F) = [P(Y^*(F)) - c]q_iF + cq_i, \tag{10a}$$

$$\pi_{iu}(F) = [P(Y^*(F)) - c]y^u(F) + cq_i. \tag{10b}$$

Combining (5) and (2′), we have

$$P(F) - c = by^u(F). \tag{11}$$

From (8) it is clear that $y^u(F)$ and hence $P(F)$ are decreasing and piecewise linear in F. Moreover the limit (from either above or below) of $y^u(F)$ as $F \to F_k$ is

$$y^u(F_k) = \frac{(a-c)q_k}{[(n-k+1)q_k + Q_k]b}. \tag{12}$$

As F falls below F_k and the number of constrained firms rises from $k-1$ to k, (8) implies that the slope of $y^u(F)$, and therefore of $P(F)$, becomes more negative. To summarize, we have established that both the price and the unconstrained sales functions are continuous, piecewise linear, monotone decreasing, and convex in F. In fact they strictly decrease for $F < F_1$. These properties are illustrated in figure 8.3.

With these preliminaries established, we can consider the properties of the induced preferences. If the ith packinghouse is unconstrained ($F \geq F_i$), we can write its profits using (10b) and (11) as

$$\pi_u^i(F) = b(y^u(F))^2 + cq_i. \tag{13}$$

From the properties of $y^u(F)$, it is evident that $\pi_u^i(F)$ is continuous, decreasing and (since it is the sum of a constant and the composition of convex functions) convex in F.

On the other hand, if the ith packinghouse is constrained ($F < F_i$), we can write its profits as

$$\pi_c^i(F) = by^u(F)Fq_i + cq_i. \tag{14}$$

This is the sum of a constant and a negative definite (concave) quadratic in F. It is therefore continuous and, on each open interval (F_{k+1}, F_k),

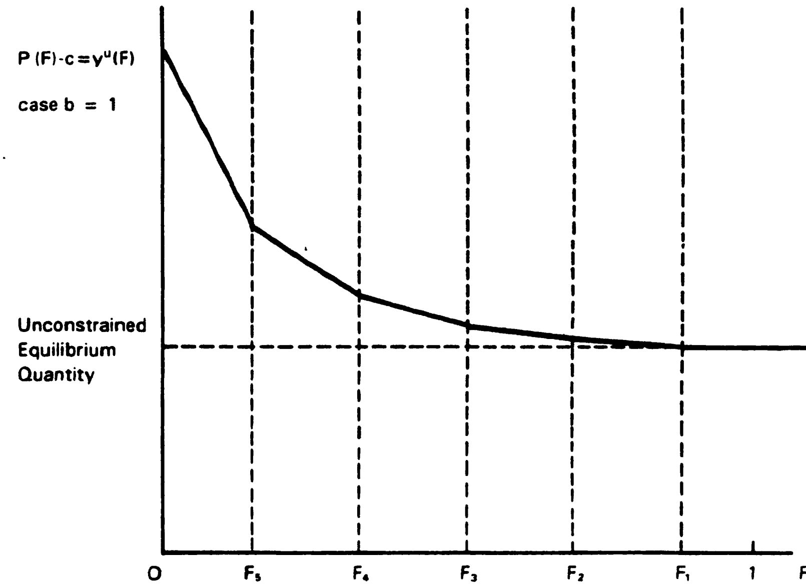

Figure 8.3 Price and unconstrained sales in the primary market as functions of F

continuously differentiable and strictly concave. On such intervals, its derivative can have either sign:

$$\frac{d\pi_c^i}{dF} = q_i b\left[F\frac{dy^u}{dF} + y^u\right]. \tag{15}$$

Since y^u is convex it follows that the slope of $\pi_c^i(F)$ increases as F increases through any boundary (F_k). As a result $\pi^i(F)$ need not be single peaked. However, since both $P(Y(F))$ and $y^u(F)$ are continuous, $\pi^i(F)$ is continuous in F.

Tables 8.2 through 8.5 numerically evaluate the induced preferences in the linear demand case for illustrative markets with three handlers. As the table headings indicate, the simulations differ with respect to individual endowments, parameters of the linear demand curve, and the price in the secondary market. To confirm that induced preferences need not be single peaked, consider the fourth and fifth columns of table 8.3. When F first binds on the smallest firm ($F = F_1$), $\pi_1 = 25.781$. As F tightens, π_1 falls. When F just binds on the largest firm ($F = F_3$), $\pi_1 = 25.669$. Still tighter F's, however, cause π_1 to reverse direction and increase. It then begins to decrease again. The reader can verify that the preferences for the handler

Table 8.2 Monopoly outcome with identical endowments

Demand parameters: $A = 10$; $B = 2$; $C = 5$

Endowments: 6.6667; 6.6667; 6.6667

	F	y^u	P	π_1	π_2	π_3
Nash	1.00	0.625	6.25	34.115	34.115	34.115
	0.2750	0.625	6.25	34.115	34.115	34.115
$F_1 = F_2 = F_3$	0.0938	0.625	6.25	34.115	34.115	34.115
	0.0750	—	7.00	34.334	34.334	34.334
$MB = JM$	0.0625	—	7.50	34.375	34.375	34.375
	0.000	—	10	33.333	33.333	33.333

F = allotment; maximum fraction permitted on primary market
y^u = fresh market sales of each unconstrained handler (if any)
P = price in primary market ($P = A - BQ$)
π_i = profit of agent i
C = price in secondary market
F_i = allotment at which firm i becomes constrained
MB = marketing board equilibrium—ideal point of firm 2
JM = joint monopoly—industry profit-maximizing allotment.

Table 8.3 Moderate diversity in endowments

Demand parameters: $A = 10$; $B = 2$; $C = 5$

Endowments: 5.0; 6.0; 9.0

	F	y^u	P	π_1	π_2	π_3
Nash	1.00	0.625	6.25	25.781	30.781	45.781
F_1	0.125	0.625	6.25	25.781	30.781	45.781
	0.1217	0.630	6.26	25.768	30.795	45.795
	0.1185	0.636	6.27	25.753	30.809	45.809
	0.1152	0.641	6.28	25.739	30.823	45.823
	0.1120	0.649	6.29	25.724	30.830	45.830
F_2	0.1087	0.652	6.30	25.709	30.851	45.851
	0.1042	0.677	6.35	25.705	30.846	45.916
	0.0997	0.702	6.40	25.699	30.839	45.985
	0.0952	0.726	6.45	25.692	30.830	46.056
	0.0907	0.751	6.50	25.681	30.818	46.128
F_3	0.0862	0.776	6.55	25.669	30.803	46.204
	0.0690	—	7.24	25.773	30.928	46.391
$MB = JM$	0.0625	—	7.5	25.781	30.937	46.406
	0.000	—	10.0	25.0	30.0	45.0

F = allotment; maximum fraction permitted on primary market
y^u = fresh market sales of each unconstrained handler (if any)
P = price in primary market ($P = A - BQ$)
π_i = profit of agent i
C = price in secondary market
F_i = allotment at which firm i becomes constrained
MB = marketing board equilibrium—ideal point of firm 2
JM = joint monopoly—industry profit-maximizing allotment.

Table 8.4 A committee dominated by small independents

Demand parameters: $A = 10$; $B = 2$; $C = 5$

Endowments: 1.0; 2.0; 17.0

	F	y^u	P	π_1	π_2	π_3
Nash	1.0000	0.625	6.25	5.781	10.781	85.781
F_1	0.6250	0.625	6.25	5.781	10.781	85.781
	0.5714	0.643	6.29	5.735	10.826	85.826
	0.5179	0.661	6.32	5.684	10.873	85.873
	0.4643	0.679	6.36	5.630	10.921	85.921
	0.4107	0.696	6.39	5.572	10.970	85.970
$F_2 = MB$	0.3571	0.714	6.43	5.510	11.020	86.020
	0.2992	0.801	6.60	5.479	10.959	86.284
	0.2413	0.888	6.78	5.429	10.857	86.577
	0.1834	0.975	6.95	5.358	10.715	86.901
	0.1255	1.062	7.12	5.266	10.533	87.255
F_3	0.0676	1.148	7.30	5.155	10.310	87.639
JM	0.0625	—	7.50	5.156	10.312	87.656
	0.0000	—	10.0	5.000	10.000	85.000

F = allotment; maximum fraction permitted on primary market
y^u = fresh market sales of each unconstrained handler (if any)
P = price in primary market ($P = A - BQ$)
π_i = profit of agent i
C = price in secondary market
F_i = allotment at which firm i becomes constrained
MB = marketing board equilibrium—ideal point of firm 2
JM = joint monopoly—industry profit-maximizing allotment

with the intermediate endowment (π_2) are likewise not single peaked. Nevertheless, as we prove later, the preferences have sufficient structure to avoid Condorcet cycles and ensure the existence of a majority-rule equilibrium.

Voting Equilibrium and its Properties

From the induced preferences of each packinghouse over committee decisions, we turn now to the committee's determination of the allotment percentage. Recall that committees are typically composed of a small number of growers and handlers who serve for fixed terms of several years. At the time the committee votes each grower's crop has been assigned to the packinghouse of his choice,[17] and his costs are sunk. Alternative proposals for the allotment percentage are voted on until one meets with the approval of a majority of the committee.

To proceed, we make two strategic simplifications: each voter is assumed

Table 8.5 Consequences of reduced price in secondary market

Demand parameters: $A = 10$; $B = 2$; $C = 3$

Endowments: 1.0; 2.0; 17.0

	F	y^u	P	π_1	π_2	π_3
Nash	1.0000	0.875	4.75	4.531	7.531	52.531
F_1	0.8750	0.875	4.75	4.531	7.531	52.531
	0.8000	0.900	4.80	4.440	7.620	52.620
	0.7250	0.925	4.85	4.341	7.711	52.711
	0.6500	0.950	4.90	4.235	7.805	52.805
	0.5750	0.975	4.95	4.121	7.901	52.901
$F_2 = MB$	0.5000	1.000	5.00	4.000	8.000	53.000
	0.4189	1.122	5.24	3.940	7.879	53.516
	0.3378	1.243	5.49	3.840	7.680	54.091
	0.2568	1.365	5.73	3.701	7.402	54.726
	0.1757	1.486	5.97	3.522	7.045	55.419
F_3	0.0946	1.608	6.22	3.304	6.608	56.172
JM	0.0875	—	6.50	3.306	6.613	56.206
	0.0000	—	10.0	3.000	6.000	51.000

F = allotment; maximum fraction permitted on primary market
y^u = fresh market sales of each unconstrained handler (if any)
P = price in primary market ($P = A - BQ$)
π_i = profit of agent i
C = price in secondary market
F_i = allotment at which firm i becomes constrained
MB = marketing board equilibrium—ideal point of firm 2
JM = joint monopoly—industry profit-maximizing allotment

to disregard the future interactions he will have with other members of the committee, and contracts between a grower and his packinghouse give them coincident preferences over alternative allotment percentages. These are strong assumptions, and we make them at this preliminary stage to simplify a complex problem. If the evidence suggests they are inappropriate, we will modify them in subsequent work. In the orders with which we are most familiar (e.g., the citrus orders), the board lasts for a fixed duration and then is replaced in its entirety. In such cases, as long as there is no interseasonal interaction, voting behavior in each stage of the multistage game should coincide with behavior in the one-shot game. This (and its simplicity) motivate our first assumption.[18] As for the second, in the vast majority of fruit and vegetable markets, the contracts between growers and packinghouses involve "pools."[19] As we understand such pools, the packinghouse deducts a percentage of its gross revenues to cover its costs and divides the residual among the growers according to the size of the crop each grower has assigned to the packinghouse. For such contracts our second assumption would be appropriate; other contracts of course exist for which grower and packinghouse interests diverge.[20] The practical implication of the second assumption is that the preferences and endowments of each grower can be taken to be those of his packinghouse. If we find inexplicable differences between the voting behavior of growers and handlers on the committee, we will reconsider this assumption.

In what follows, we consider the determination of the allotment percentage by the administrative committee. At the time of voting, the composition of the committee is fixed as is the size of each grower's crop and his choice of packinghouse. We treat these variables as exogenous to the problem under investigation, recognizing that they could be incorporated in a more complex model.[21] We assume there are an odd number (L) of committee members chosen from the industry of n ($\geq L$) firms. To avoid confusion, we assign a "committee index" ($i = 1, 2, \ldots, L$) to each voter in addition to his "industry index." A larger committee index of a voter indicates a larger endowment. The index we will refer to will be the committee index unless otherwise indicated. The preferences of each of the L voters have the same general characteristics as the preferences of members of the industry from which they are selected.

Assume that there are an odd number of voters and that their endowments differ. Let the committee index m denote the voter with the median endowment. Let us recall the following properties of the induced preferences:

1. The firms are numbered in (strictly) increasing order of size.
2. The cutoff levels ($F_i, i = 1, 2, \ldots, L$) below which firm i is constrained in Nash equilibrium are ranked in decreasing order of size (nesting).
3. Profits of the unconstrained firms are monotone decreasing in F on the relevant range $[F_i, 1]$ (unconstrained montonicity).
4. Profits of the constrained firms are increasing linear transformations of each other (scaling).
5. The profits of each firm i are continuous in F (continuity).

Under these conditions it is easy to demonstrate the following result.

MEDIAN PACKINGHOUSE THEOREM There is a unique majority-rule equilibrium at I_m, the ideal point of the committee member with the median endowment.

Proof The formal content of this theorem is that, for any F, the number of voters preferring I_m to F is at least $(L + 1)/2$. The proof is in three steps.

By continuity, each voter i $(i = 1, 2, \ldots, L)$ has an ideal point I_i, and unconstrained monotonicity implies that $I_i \leq F_i$;[22] each voter's ideal point comes at a point where he is constrained. Combining this with the scaling property, we can see that if the ideal point of a small firm is smaller than the cutoff level of a larger firm, those two firms—and all firms of intermediate size—have the same ideal point. We refer to this property as "congruence given nesting."

Second, if $F < I_m$, the set of firms constrained at F includes the majority coalition $\{1, \ldots, m\}$. All the voters in this coalition are also constrained at I_m, so from the scaling property we know that they will agree as to the ranking of F and I_m. But I_m is preferred by m to F. This shows that such an F would lose to I_m in pairwise voting.

Finally, consider the only remaining possibility: that $F_{m+k} \leq I_m \leq \min\{F_{m+k-1}, F\}$ for some positive integer k. The set of firms unconstrained at F and at I_m includes the set $\{m + k, \ldots, L\}$, so every member of this set prefers I_m to F by unconstrained monotonicity. By the congruence property, I_m is also the ideal point of every voter in $\{m, \ldots, m + k - 1\}$, and thus each member of this set prefers I_m to F. Therefore every voter in the majority coalition $\{m, \ldots, L\}$ prefers I_m to F. Hence for any F, I_m wins in pairwise voting. ■

To illustrate, the preferences for a three-voter case are drawn in figure 8.4. Note that $F_1 > F_2 > F_3$, reflecting the assumption that $q_1 < q_2 < q_3$. Note also that voter i's preference is monotonically decreasing in F for $F \geq F_i$, and that the collection of preferences has the "scaling" property. The theorem therefore implies that the ideal point of the median voter (I_2) will be strictly preferred by a majority of the committee. Voter 3 would join voter 2 in defeating proposals for any larger F, while voter 1 would join voter 2 in defeating proposals for any smaller F. Hence even without single-peaked preferences, a majority-rule cycle is avoided.

The escape is a narrow one, however. If the "scaling" property did not hold a cycle could easily be produced. Suppose in figure 8.4 that π^2 and π^3 were as drawn but π^1 were modified so that $\pi^1(I_1) > \pi^1(I_3) > \pi^1(I_2)$. Then I_2 would no longer defeat I_3, and since I_1 defeats I_3 and I_2 defeats I_1, there would be no equilibrium.

Our theory does admit the possibility that the committee will vote for the restriction that maximizes industry profits. This would occur, for example, if handlers had identical endowments and hence had no conflicts of interest. But our theory also admits more competitive possibilities. These should arise when heterogeneity among the handlers creates conflicts of interest.

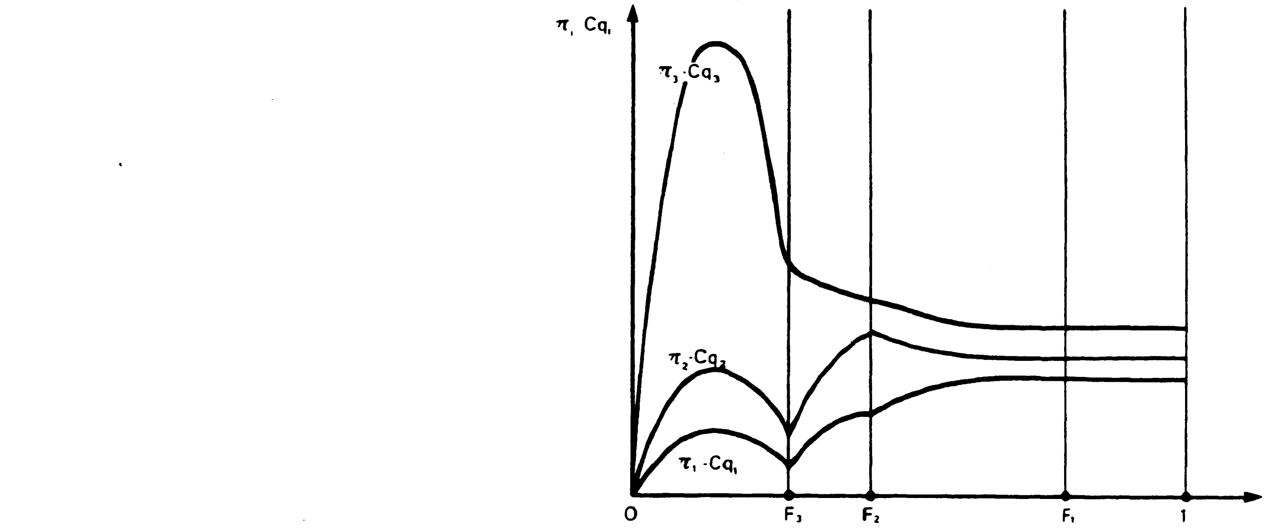

Figure 8.4 Induced preferences: not single peaked but sufficient for median voter result

The theory implies that whenever the committee does choose the monopoly restriction, each handler will sell as much as he is permitted on the primary market. Suppose in such circumstances some handler sold a smaller quantity on the primary market. Since monopoly price on the primary market would exceed the (fixed) price in the secondary market by the inframarginal loss, an additional primary sale would inflict on the profits of the entire industry, any unconstrained individual handler would have an incentive to increase his primary market sales. If the real-world conformed exactly to the assumptions of our model, then the mere evidence that some handlers sold less than they were permitted on the primary market would establish unambiguously that industry profits were not being maximized under the order and that the regulation was more competitive than is commonly supposed.[23]

Why would a committee composed of handlers and growers from the industry fail to maximize industry profits? Intuitively, the committee would select a restriction that does not maximize the profits of its members if a majority of them would lose—albeit a smaller amount than remaining members would gain—under the profit-maximizing restriction.

Given the vector of industry endowments and the demand parameters, the economic equilibrium will depend on the composition of the committee. It is instructive to regard the industry's handlers as a fixed set of preferences indexed by their endowments and the committee as some selection from this set (subject to restrictions contained in the order). Any committee whose median voter has a given endowment will vote for the same restriction no matter what is the composition of the rest of the committee.

As was previously shown, handlers in the industry with larger endowments prefer smaller allotment percentages. This suggests that industries governed by marketing orders can be made more competitive by replacing a board member whose endowment exceeds the committee's median by a member whose endowment lies below it. Such changes will lower the endowment of the median voter and will cause the committee to relax its regulation. The analysis implies moreover that there is nothing to be gained by adding a voter with an exceptionally small endowment. The greatest relaxation that can be accomplished by a single replacement is a new equilibrium at the ideal point of the current committee member with committee index $m - 1$.

By selecting committees of alternative composition, a broad range of equilibria can be generated. The largest (smallest) such F would be selected by a committee composed of the smallest (largest) L firms in the industry; they would choose the ideal point of the firm with industry index $(L + 1)/2$ (alternatively, $n - (L - 1)/2$). Notice that the induced preferences over F are entirely independent of the makeup of the committee. They reflect the distribution of endowments across all the firms affected by the marketing order regulation.

One characteristic of all such voting equilibria is that a majority of the committee must be constrained. For if a majority were unconstrained, there would exist a tighter constraint, which it would vote for, and the initial situation could not have been an equilibrium.

In any event no matter how the committee members are selected, it is not possible for the "joint-monopoly" outcome to be selected unless it happens to be the ideal point of firm $n - (L - 1)/2$. This implies that substantial asymmetry in the distribution of endowments precludes fully collusive behavior, provided the voting procedure fits our description and side payments between the firms are prohibited.

Indeed, our model suggests that marketing boards will select more competitive outcomes in highly concentrated industries. By contrast, most theories of unregulated oligopoly in which structure matters suggest that concentration leads to greater departures from competitive equilibrium. This in turn suggests that marketing boards may have more attractive welfare properties in highly concentrated industries. If marketing boards create long-term pressures for reduced concentration, they may remove both the symptom (collusion) and the cause (high concentration) of market failures.

In our analysis we have explicitly excluded side payments from consideration. In addition we have implicitly assumed sincere voting: in other words, we assume that each voter's behavior is an accurate reflection of its induced preferences. Due to the fact that preferences of constrained voters fail to be single peaked, it may not be obvious that sincere voting is a dominant strategy. What is obvious is that misrepresentation that does not displace the median voter will have no effect on the outcome. Firms that are smaller (larger) than the median firm therefore may have the power to tighten (loosen) the constraint by voting as if they were larger (smaller) than the median firm. However, from the properties of unconstrained monotonicity and scaling, it is evident that a smaller (larger) firm will only profit if it can arrange to loosen (tighten) the constraint. Thus the only changes a firm can effect are those that do not improve the outcome. It follows that sincere voting is at least a Nash equilibrium in that a firm faced with sincere voting by other committee members cannot profit by misrepresentation.

Future Research

In the next phase of this project, the predictive power of our theory will be investigated using a combination of controlled experiments and an analysis of data on committee voting and handler sales drawn from the hops, navel orange, or filbert markets. Here we outline the planned research.

Experiments

Plott (1979) studied the voting behavior of a committee of five individuals required to make a succession of twelve decisions. To pass, a proposal required the approval of a majority. On each of the twelve rounds preferences were induced for each individual by offering him a payment dependent on the committee's decision in that round. In Plott's experiment the issue space was two dimensional. Each voter's indifference curves were concentric circles around a specified ideal point. Plott found that if there existed a Condorcet winner for a particular stage, the committee almost always chose it at that stage. He reported no evidence of sophisticated voting and no evidence of interdependence between votes on successive rounds.

We plan to conduct three types of experiments to test the predictive power of our model. First, we intend to examine the voting behavior of a committee whose preferences are induced directly by the experimenter as in Plott's case. Our experiment would differ from his in two principal respects: the issue space would be one dimensional and preferences would be asymmetric. Specifically, we plan to use the nonsingle-peaked preferences derived from our linear demand case. Like Plott, we will examine the behavior of a committee that votes on a succession of issues to see if it tends to select the Condorcet winner at each stage.

The second type of experiment will concern the behavior of handlers in a regulated market. Specifically, each subject will be given an endowment to allocate between two outlets (referred to as "markets") but will be allowed to designate no more than a common exogenous percentage of that endowment for the more lucrative primary market. Participants will be paid by the experimenter as follows: a fixed reward for each unit designated for the secondary market and a per unit reward that decreases linearly in the total amount that all subjects designate for the primary market. Our goal here will be to examine the validity of the theoretical prediction that subjects will behave like Cournot competitors.

The third type of experiment will involve two stages. Participants in the market experiment will be asked first to form a committee for the purpose of deciding collectively on a common allotment percentage. Before they vote, however, they will be told that this percentage will restrict behavior in the market experiments to follow and that the experimenter will pay subjects exactly as before (i.e., according to what they designate for the two markets). Unlike the previous type of voting experiment, in this last experiment the reward to each individual from the alternative committee decisions is indirect. The experimenter does not reward him directly for alternative decisions of the committee; instead, the experimenter's reward depends on the outcome in the subsequent stage. However, that outcome will be influenced (in ways that differ across subjects) by the common constraint. The premise of the theory is that each subject will take this influence into account when voting. The experiment will be designed to permit a clear distinction between the predictions of our theory and that of the alternative in which the allocation between the two markets maximizes the total payoff of the subjects.

Experiments such as these will permit us to determine if subjects behave as the theory predicts. If they do not, the claim that marketing boards behave this way in the "naturally-occurring" world would seem questionable. If, however, the experimental evidence is consistent with the theory, questions will of course persist about the applicability of the theory to naturally-occurring marketing orders. To resolve such questions, an analysis will be undertaken of data on the voting behavior of real-world marketing boards and the sales decisions of real-world handlers.

Analysis of Real-World Data

As table 8.1 reflects, the USDA collects data for each order on the allowed and actual sales of each handler. It is clear from the aggregate data that some handlers sell less than their allotments. Our theory predicts that it is the larger packinghouses (identifiable since their allotments are larger) which will sell less than their allowed amount.[24] We hope to secure disaggregated data from USDA for various orders so that we can examine this hypothesis.

We also plan to analyze the voting behavior of members of a marketing committee. The minutes indicate how each board member voted on each proposal (whether it passed or not). It is easy to ascertain the affiliation of each board member. In most cases the packinghouse that each voter represents publishes an annual report from which information on the "endowment" of the packinghouse can be obtained. As for the distribution of endowments in the rest of the industry, this information can be obtained from the USDA data referred to earlier. We hope to use this information to test our model.

No matter which order we choose to examine, however, we anticipate that some serious questions will arise concerning the applicability of our model. Take the citrus orders as an example. In each committee, several voters represent packinghouses belonging to Sunkist growers. Each such packinghouse is regulated individually. But does each packinghouse allocate its endowment autonomously in its own interest or is it directed from above? We have been told by a packinghouse representative we interviewed that such decisions are made at the local level, and the president of Sunkist independently confirmed this. But is this information accurate? Even if sales decisions are made at the local level, a representative from a local Sunkist packinghouse may cast his vote in a way that serves the interest of Sunkist as a whole rather than that of his particular packinghouse. Despite assurances from Sunkist that such voters represent their local packinghouses as we have assumed, it may still be reasonable to question this.[25] A second questionable assumption concerns the failure of the voters to anticipate that this year's allotment percentage may affect next year's production. A third concerns the fact that committee members may come from different geographical areas with different seasonal characteristics and possibly different qualities of produce. The list could easily be expanded indefinitely.

In any of these cases the theory could be modified to handle the real-world complication. But if inability to predict can always be attributed to failures to resolve such problems, the basic theory will never be tested. The great merit of controlled experiments is that they permit a test of the basic theory. If the theory fails to predict well in the controlled environment, we would not expect it to predict better in the uncontrolled one. If, however, it predicts well in the experiments, then a failure to predict well on naturally-occurring data would lead us to examine more closely questionable assumptions such as those we have mentioned here.

Notes

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1. The reasons for such terminations have been studied by Camm (1976) and Hallagan (1985).

2. For a ranking of various orders by their social cost, see Lenard and Mazur (1985).

3. The two crops listed in table 8.1 are regulated by producer allotments. Similar divergences occur, however, under market allocation schemes and under prorates. In the 1983–84 season, for example, filbert handlers shipped substantially less in the primary "in-shell" market than their allotments permitted under the market allocations, and handlers of navel oranges from District 2 typically sold less than their allotments under the prorate. The reasons for the observed divergences may partially depend on the particular order. We hypothesize, however, that among the reasons is the concern of relatively large handlers that additional sales would depress the price in the primary market and would result in more than offsetting inframarginal losses.

4. A particularly useful, annotated bibliography for the years 1940 to 1981 is contained in USDA (1981).

5. Camm (1976), Masson, Masson, and Harris (1978), and Lenard and Mazur (1985) may be viewed as representative of such treatments.

6. For a discussion of the controversy, see Samuelson (1985) or *New York Times* (1985). The leading opponent of the navel order, Carl Pescosolido, will benefit in the long run from elimination of the order because water costs in the San Joaquin Valley, where he operates, are dramatically lower than elsewhere (see Rausser 1971, p. 118, on these costs).

7. Conflicts among districts are also serious. For example, many handlers in Central California (District 1) feel that the existing regulations are inequitable because they ignore the differential advantage of handlers in Southern California (District 2) to sell fresh fruit in the unregulated export market.

8. There is evidence that the committee tries to appear united after it has worked out a compromise allotment. Clodius (1950, pp. 307–308) noted, for example, that "in the first

wenty-one months of the federal program, determination by the Distribution committee of he weekly shipments was based on unanimous agreement in more than 90 percent of the weeks. However, the determination was nearly always a compromise, despite the unanimous ote supporting the final recommendation." This observation suggests that the final vote of committee is less informative than prior votes and is intended to keep up appearances of olidarity for the secretary of agriculture, who must approve the final recommendations of ach committee.

). For an illustration of this common but unfortunate practice, see Lenard and Mazur (1985,). 20).

10. Actually, since price in the secondary market is fixed, nothing would change if we allowed demand in the primary market to depend as well on price in the secondary market.

11. For example, since more than 98 percent of orange-juice concentrate comes from Florida, t is reasonable that orange growers in California and Arizona regard the price in the secondary (concentrate) market as unaffected by their sales. In general, of course the demand in each market might be regarded as a function of both prices. Smith (1961) has emphasized the importance of such demand interdependence. However, we have not yet fully explored its consequences in our model.

12. The model may have other applications as well. For example, q_i could be interpreted as the productive capacity of firm i, and the constant c interpreted as a common marginal cost of production. Indeed, this constant c could be replaced with generalized and possibly non-symmetric opportunity cost functions $C_i(x_i)$ without necessarily vitiating the results. Certainly it is the case that if all firms share the same twice-differentiable convex cost function all the qualitative results go through.

13. An alternative contract—allegedly the "typical" arrangement between independent handlers and their growers—would instead award the packinghouse a commission that increases monotonically with the volume sold on the domestic fresh market. Such a contract would induce a handler to sell as much as possible on the domestic fresh market and—if he served on the administrative committee—to vote for the least restrictive regulation possible. Such contracts would create still another source of conflict within the committee and would constitute an additional reason to question the conventional belief that the committee chooses to maximize industry profits. Inclusion of this second form of contract would reinforce our basic point but would also complicate the analysis; it will be considered in a subsequent paper.

14. We assume that inverse demand $P(Y)$ is everywhere nonnegative, monotone decreasing and twice differentiable. Where price $P(Y)$ is positive, we require that $P'(Y)$ be negative. To ensure that positive quantities are sold on the primary market when $F > 0$, we assume that $P(0) > c$. These assumptions suffice for existence. To ensure uniqueness, we assume that for every feasible aggregate amount Y placed on the primary market and for every feasible individual amount $x < \min\{Y, q_n\}$,

$$\left[\frac{3P'(Y)}{2}\right] + xP''(Y) \leq 0.$$

15. This follows since marginal revenue in the secondary market is assumed to be constant and marginal revenue in the primary market will be strictly decreasing in own sales given the final inequality in note 14.

16. It will also be noted that it is possible for F_k to exceed 1 for some or all k. This means that the outputs of some or all firms are below the quantities they would wish to sell in the primary market even in the absence of the marketing order system.

17. We ignore the fact that a few growers use more than one packinghouse.

18. Moreover our assumption about how a committee behaves when making a finite set of decisions in sequence by majority-rule voting conforms with the experimental evidence reported in Plott (1979).

19. See the National Commission on Food Marketing (1966, p. 270) for a discussion of these "single-pool" systems.

20. See note 13.

21. How a self-interested, foresighted grower chooses a particular packinghouse for his crop deserves some comment. Assume provisionally that each packinghouse is equidistant from each grower and that each has the same convex cost of processing. In an equilibrium in which growers had foresight, no grower would assign his crop to a shipper anticipated to be unconstrained under the forthcoming allotment percentage. Such handlers would be so large that they would have lower per-unit revenues. The fact that some packinghouses are unconstrained and do have customers (see table 8.1 and note 3) suggests that the preceding assumption is inappropriate. In particular, a grower will tend to pick a packinghouse in his immediate area because of transport and transactions costs. In our analysis we do not attempt to explain why a particular packinghouse has a particular "endowment"; instead we take such data as given.

22. The property of consistency is used to ensure that each handler is actually constrained at his ideal point. If it were possible for π^i to jump up as handler i just becomes unconstrained, his ideal point could be exactly F_i, and yet he would not be constrained at that point.

23. In reality, of course, handlers sometimes sell less than their allotments for reasons not included in our model and in such cases valid inferences cannot be drawn merely from the evidence of undershipping. For example, navel handlers in District 2 have a differential advantage in the lucrative but limited export market and typically sell much of their endowment abroad. As a result their allotments often exceed what they ship to the regulated fresh market.

24. In examining this hypothesis, care should be taken to control for district and contract type, as discussed in notes 3 and 13.

25. Further assurance that Sunkist voters represent the disparate interests of their local packinghouse comes from the USDA representative who attends each navel meeting. According to Roland Harris, it is not uncommon for representatives of different Sunkist packinghouse to oppose each other in the voting. We plan to check this ourselves once we obtain the voting data.

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