Do U.S. Marketing Orders Have Much Market Power? An Examination of the Almond Board of California.

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Abstract: This paper tests the conventional wisdom that U.S. marketing orders act as profit-maximizing cartels. The paper analyzes the marketing order for U.S. almonds in both the domestic and export markets. Such a case study is relevant to all U.S. marketing orders because the size and scope of the U.S. almond industry on the world market, and the legal authority of the almond marketing order makes it a likely prospect for exhibiting true cartel behavior. The authors find that the market power exerted by the Almond Board of California's reserve setting is significantly less than would be expected from a profit-maximizing cartel.

Keywords: cartel, market power, marketing orders, price leadership, trade.

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Do U.S. Marketing Orders Have Much Market Power?
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As Stigler pointed out in an oft-cited paper there is little incentive for cartel members to remain loyal to the cartel's quantity strategy as long as there is a greater incentive for a member to free ride on the cartel's quantity restrictions. Unlike other industries that are bound by the Sherman Anti-Trust Act, however, many U.S. agricultural markets have legally enforceable cartels called marketing orders. Marketing orders are initiated through grower referenda and, once approved by the Secretary of Agriculture, are legally binding on all growers specified by the marketing order. Thus, unlike cooperatives, wherein membership is voluntary, and state-trading enterprises, which are governmental entities, marketing orders are true industry cartels as they mandate compliance on 100% of the producers in the affected industry and are headed by board members elected from that industry. Though some marketing orders are short-lived, in 1995, there were 36 federal marketing orders still operating and a variety of orders at the state level (Lee *et al.*, p. 5). While many of these marketing orders simply provide for grower funded advertising or research, some also include provisions for diverting portions of a crop from market, called a reserve, and it is these marketing orders that are the most cited as anti-competitive. According to research conducted by Lee *et al*. (p. 29), of the 42 federal marketing orders that had operated before January 1995, 38 percent could control volume to some degree (either in regulating the flow to market, affecting market allocation, or setting a reserve pool).

This paper focuses on one marketing order in particular, chosen for examination because its reserve policies and the industry it represents make it a prime candidate for an investigation of market power: the federal almond marketing order. Because U.S. almond production accounts

for approximately two-thirds of world almond production and four-fifths of world trade (Alston *et al.*), and because the entire U.S. almond industry operates under a marketing order that allows a board of almond-industry representatives, called the Almond Board of California (ABC), to set a reserve, the amount of market power accruing to U.S. almond producers is of great importance.

The goal of this paper is to determine whether the ABC uses its reserves in establishing market power in either the U.S. or the export market or both. Another way of looking at this question is to ask, "What if the marketing board does *not* have any market power?" In this case if a marketing order for an industry such as almonds, where a cartel should have significant power, in fact does not act like a profit-maximizing cartel, then allegations that other marketing orders are welfare distorting may carry less weight.

Background

Marketing orders that include reserve policies have always been controversial because they allow a board of industry representatives, acting on behalf of producers, to withhold portions of each year's crop from the market. French lays out the economic rationale for granting farmers such power as due to "the incompleteness of information, the uncertainty of prices and outputs, and the failure of the private sector to develop stabilizing institutions [resulting in] sub-optimal resource allocations, highly variable returns, average returns to growers of perennial crops that are depressed for extended periods, and occasional devastating losses" (p.918). French then goes on to raise the important issue that "The fact that they may also endow particular groups of farmers with unintended monopoly gains is a major consideration in evaluating net social benefits." Thus, the question to be asked, what "monopoly gains" do such legal cartels have?

In 1995 there were 36 federal marketing orders (Lee *et al.*), and although not all

marketing orders are allowed to divert product from markets, even orders that can enforce quality standards may be *de facto* quantity setters if grades and standards are set so as to limit supplies or lessen competition. Evidence of marketing orders' controversial nature has been replete in the popular press. Investigating the controversial California-Arizona Citrus order in 1993, a *Los Angels Times* reporter wrote that a legal challenge to the order had "spilled not just into the courts but onto supermarket shelves, where supplies historically have been smaller, prices higher and selection arguably narrower than they would be in a market where growers could sell as many oranges as they wanted" (Woutat, p. D3). Similarly, a reporter for the California farm journal, *Insight*, wrote "... while this valley is one of the richest agricultural regions in the world, it is also consumed by a rot both literal and metaphoric. Here tons of choice fruit and nuts are left to spoil in the fields or are fed to cattle, not because they are unfit for human consumption, but because agribusiness cartels say they must. . . . Welcome to the world of 'marketing orders,' which are more aptly termed anti-marketing orders" (Lochead, p. 13). Even academic journals contain examples where the monopoly power of these cartels is taken as a datum. Recently, for example, Filson *et al*. examined how marketing orders form, taking the existence of market power under such an order as a given: "An agricultural cartel operates like a dominant firm facing a competitive fringe: the cartel can adjust the amount it ships to the fresh market to influence price, while growers outside the regions covered by the marketing order are price takers" (p. 466).

Perhaps because it seems reasonable to presume the existence of market power in the presence of a legal cartel, we should not be surprised that there has been sparse research on the amount of market power accruing to these legal cartels. Nonetheless, of the handful of studies that have examined marketing orders, findings of market power have hardly been overwhelming.

Studies by Kwoka and by Ippolito and Masson have shown that marketing orders for U.S. dairy products have been anticompetitive. For example, Kwoka concluded that, from 1960 to 1970, fluid milk prices were 7 to 15 percent above competitive levels. On the other hand, French and Nuckton examined the marketing order for California raisins and found that the marketing board's policies, while stabilizing prices, had not lead to any real market power. Powers (1992) investigated the California-Arizona navel orange order and found that this order successfully exercised monopoly power in allocating oranges between fresh and processed uses. However, Thompson and Lyon determined that suspension of this same order in 1985 only caused a penny-per-pound reduction in the farm-retail price spread, suggesting that previous diversions from the retail sector had little effect on the retail price (see also the critique by Powers and other examinations of the citrus orders by Rausser, Shepard, and Kinney *et al.*). These few studies suggest it may not be enough to determine whether marketing orders can create a price wedge (few people would probably doubt that), but whether that price wedge is consistent with that which would be created under a true, profit-maximizing cartel.

The Almond Board's Reserve Policy

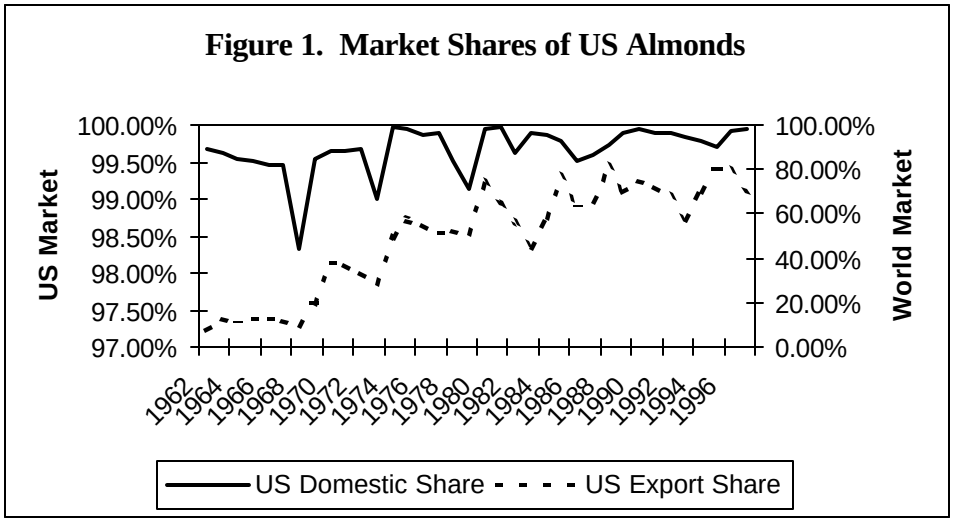
Under the federal marketing order for almonds, the Almond Board of California is allowed to divert almonds from the market by setting a reserve on the almond inventory each year. Almond reserves take two forms: unallocated and allocated reserves. With the permission of the Secretary of Agriculture, an unallocated reserve may later be released for sale. An allocated reserve "must be disposed of in certain approved outlets, such as the almond butter market, sale to oil presses, or use as animal feed" (Kinnucan and Christian, p. 122). The Almond Board's marketing order also allows for but does not require the allocated reserve to include the export

market instructing the ABC to take steps to "prevent sale within or reimportation into the United States" (Almond Marketing Order, §981.66(b)).

Because of the two types of reserves, stocks are not constant throughout a given crop year. These fluctuations occur as the ABC re-estimates the harvest and likely demand as new information becomes available and decides whether or not to release portions of the unallocated reserve. As set out in the Almond Marketing Order (§981.17), the ABC uses the following formula to set its reserves. Beginning with an estimate of marketable new harvests, the ABC adds in stocks that were carried in from the previous year's unallocated reserves and estimates how much crop will be stored by individual handlers this year to get a prediction of this year's total supply. Next, it estimates what either U.S. or world demand (depending on whether the ABC is going to use the export market as part of its reserve plan) will be for U.S. almonds. The reserve pounds to be set aside are simply the estimated supply minus the estimated demand. For instance in the first quarter of the 1998/99 crop year, the ABC estimated demand at 655,014,016 pounds and supply at 633,000,000 pounds leaving a reserve of -22,014,016 pounds (Almond Board of California, 1998). If the reserve calculation is positive, it is stored (the unallocated reserve) or diverted into other uses, which may include the export market (allocated). If the reserve calculation is negative then the ABC petitions the Secretary of Agriculture to allow it to release a portion of previous unallocated reserves onto the market.

Based on the calculation as presented above, if the ABC is, in fact, setting supply so that it meets demand, then it would seem to be acting as a benevolent cartel: trying to achieve some price parity around the point where price is equal to aggregate supply (i.e. aggregate industry marginal cost). After all, if the ABC were acting as a true, profit-maximizing cartel, then why would it reallocate the reserves at all? As French points out, a board that is trying to stabilize

prices attempts to cut off "both the peaks and troughs of supplies" whereas a monopoly "cuts off only the peaks" (p. 918). The section that follows looks for evidence to determine which policy most closely matches that of the ABC.



The Models

Because the ABC is allowed but not required to use its export market for its allocated reserve, the question of whether marketing orders provide growers (through their elected boards) with market power hinges on where such market power may arise, the domestic or the export market. This is also an important question in the case of almonds as the U.S. has supplied greater than 97% of the domestic market and two-thirds of the world market over the last few decades (see figure 1). The only other major competitor is Spain (Italy's almonds, while once slightly competitive, are now consumed almost entirely in that country's domestic market; see Murua, Carman and Alston). However, even at home, the U.S. cannot completely ignore Spanish almond production. Nevertheless, because of its scope and because of the ABC's ability to set

quantity, it seems reasonable to model the U.S. industry as a large-country price leader facing a competitive fringe of foreign producers. Unfortunately, although we have tried to obtain them, we do not have historical records of when the ABC used the export market as part of its reserve and when it did not. Thus, we will develop models for the domestic market and the export market separately in order to examine whether market power is created in either of these two markets. This need not be a drawback as one advantage of modeling both markets is that the analyses may be compared for consistency.

The models use a method developed by Bresnahan (see also Lau) and adapted by Buschena and Perloff showing that it is possible to identify the degree of market power using estimated market demand functions even when marginal costs are unknown. Models of these types are increasingly referred to as models of new empirical industrial organization (NEIO).

Identification of market power requires that the demand function be non-separable for certain components. If variables enter into the demand function interactively so that they not only shift the demand function, but alter its slope as well, then these variables can be used to determine whether market power exists. Simply, Bresnahan and Lau demonstrate that if changes in an exogenous variable cause the demand function to rotate, then we can use this rotation to ascertain whether market power exists. Consider the polar cases of perfect competition and monopoly. A rotation of the demand function around equilibrium will have no effect on price and quantity under perfect competition. However, under monopoly, price and quantity are set where the marginal revenue curve intersects the marginal cost curve, thus, in this case, there will be an effect on equilibrium values when the demand curve rotates.

Many of the NEIO models are forced to use aggregated data in order to test the hypothesis of market power by individual firms. In such cases, assumptions must be made about

firm symmetry so that the estimated parameters represent industry averages. However, in this case, because we are looking for the effects on industry profits from the ABC's reserve setting, aggregation is not an issue. In other words, if the ABC is acting like a true profit-maximizing cartel holding supplies off of the market in order to maximize joint industry profits, it makes sense to use aggregate data and the aggregate demand curve and no assumptions of firm symmetry need be made. If the ABC is acting like a cartel, quantity will be determined where aggregate industry marginal revenue (derived from the residual demand facing the U.S. industry and, hence, the ABC) is equal to aggregate marginal cost. On the other hand, if the ABC is merely trying to smooth price fluctuations, we should expect the reserve to be set more in line with where the aggregate demand curve intersects the aggregate marginal cost (industry supply) curve. We assume in this paper that, although the ABC's reserve setting may affect prices, individual farmers and handlers are price takers; a reasonable assumption given the homogeneity of almonds and the fact that there are hundreds of individual almond handlers. Further, because of the existence of overseas fringe producers, we use an extension of Bresnahan's technique as detailed in Buschena and Perloff.

The Domestic Market Analysis

The total U.S. demand for almonds is given by equation (1):

(1) $$Q_t^u = Q^u(P_t^u, X_t^u, Z_t^u).$$

P_t^u is the U.S. price for almonds in period t; X_t^u is a vector of shift variables, and Z_t^u represents an exogenous variable that both shifts the demand curve and enters interactively with P_t^u to rotate the demand curve, as well.

The portion of U.S. domestic demand that is supplied by imports from the competitive

fringe (mostly from Spain) is given by equation (2):

(2) $$Q_t^m = Q^m(P_t^u, X_t^m),$$

where X_t^m is a vector of supply variables that affect the amount of almonds imported by the United States.

The residual demand facing the ABC in the domestic market is given by equation (3):

(3) $$Q^{rd}(P_t^u, Z_t^u, X_t^u, X_t^m) = Q^u(P_t^u, Z_t^u, X_t^u) - Q^m(P_t^u, X_t^m).$$

Q_t^{rd} is the amount of almonds demanded in the domestic market that must be supplied from U.S. producers under the constraints of the ABC's reserve policy. Again, because almonds are homogeneous, handlers are presumed to act competitively, thus any quantity decision that might lead to market power is assumed to come from the ABC.

In order to perform the empirical tests, marginal cost must be specified. In keeping with the spirit of the NEIO methodology, we assume that industry-level marginal cost facing U.S. producers is unknown, but that it can be approximated by the linear relationship,

(4) $$MC_t^u = b_0 + b_1 Q_t^{rd} + b' C_t^u,$$

where C_t^u is a vector of cost-related variables.[1]

If the ABC is acting like a profit-maximizing cartel then it will maximize industry profits by setting its marginal revenue from its residual demand equal to the U.S. industry's marginal cost. Because we cannot estimate the industry marginal cost directly, we measure the degree of market power, which we define as the markup of price over marginal cost, which arises in the

[1] A note on almond production costs: typically, almond trees become viable producers four years after planting. Thus, harvests, and their related costs may be taken as exogenous in any supply framework. In the model presented here, supplies are made endogenous by the usage of the previous year's stocks and this year's inventory that is carried out. However, if the ABC's reserve behavior is typified by *revenue* maximization, then the optimal reserve occurs where marginal revenue is zero. In this case, the parameters on the marginal-cost variables in equation (4), C_t and Q_t^u, should be zero, but the markup equation will remain unchanged.

domestic market due to the ABC's reserve setting behavior. The first-order condition facing the ABC can be expressed using equations (3) and (4) as:

$$P_t^u(Q_t^{rd}, Z_t^u, X_t^u, X_t^m) = MC_t - l\,\frac{\partial P_t^u}{\partial Q_t^{rd}}\,Q_t^{rd}\,, \tag{5}$$

where $P_t^u(Q_t^{rd}, Z_t^u, X_t^u, X_t^m)$ is the inverted residual demand curve from equation (3). The reader will note that equation (5) is simply a reformulation of the Lerner index, $(P - MC)/P$, where the coefficient $l \in [0,1]$ is the ABC's estimable "conduct" parameter (treated as constant).[2] In other words, l is equal to one if the ABC uses its reserve policy to act as a profit-maximizing cartel in the domestic market but l should be close to 0 if the ABC's reserve policy is merely stabilizing prices.

To make the model operational we specify linear demand and import supply functions (see Crespi and Sexton for justifications on the use of the linear demand model for the U.S. almond market) as follow. The total U.S. demand equation (1) is estimated as:

$$Q_t^u = a_0 + a_1 P_t^u + a_2 P_t^u \cdot Z_t^u + a_3 INC_t^u + a_4 ADV_t^u + a_5 Z_t^u\,. \tag{1'}$$

Q_t^u is U.S. domestic almond consumption calculated from stocks carried in minus stocks carried out plus harvests and imports and less exports (the stock variables are the reserves as well as any private inventories by handlers). Harvests and stocks on hand are obtained from the ABC's annual position reports. Import and export data come from the U.S. Department of Commerce's *Foreign Agricultural Trade of the United States* yearbooks. In the domestic model, quantities are divided by the U.S. population as reported in the International Monetary Fund (IMF)'s *International Financial Statistics* yearbooks. P_t^u is the real (1998) U.S. farm price ($/lb.) for

[2] This assumes that the ABC is maximizing profit without considering the effects of today's actions on future production. While dynamic considerations will be discussed later in this paper, such a static assumption is not

almonds as reported in the U.S. Department of Agriculture (USDA)'s *Fruit and Tree Nuts* yearbooks.

One of the biggest hurdles in estimating NEIO models of this sort is to find a non-trivial Z_t^u that satisfies the non-separability requirement. Buschena and Perloff use time trends, Deodhar and Sheldon use an income measure and Aw uses a substitute good price. We follow Aw and use the price of another good, here, the real per-pound price of hazelnuts as reported in the *Fruit and Tree Nuts* yearbooks.[3] The other components in equation (1') are INC_t^u, measured in real dollars using the per-capita private domestic consumption expenditures as reported in the IMF yearbooks, and almond advertising, ADV_t^u, measured as total domestic expenditures on advertising by the ABC and the industry's largest cooperative, Blue Diamond Almonds, and come from a study by Crespi and Sexton. Unfortunately, the advertising data exist only for crop years 1962/63 to 1997/98, thus giving the time period for these estimations.

The fringe import supply equation (2) is estimated as:

$$Q_t^m = m_0 + m_1 P_t^u + m_2 W_t^m + m_3 FRT_t + m_4 XRTSPN_t + m_5 TREND_t + m_6 TREND_t^2 . \tag{2'}$$

As Spain is the largest producer of almonds outside of the U.S., along with the price of almonds in the U.S., the variables include an index for the Spanish wage rate in real pesetas, W_t^m (as a proxy for Spanish farm-labor costs), the shipping rate from Europe to the U.S., FRT_t, the peseta/dollar exchange rate, $XRTSPN_t$, as well as a trend variable and its square to account for unobserved technological changes in the import supply equation. W_t^m and $XRTSPN_t$ come from

altogether unrealistic. For example, using a dynamic analysis, Berck and Perloff look at the effect of marketing orders on entry deterrence and conclude that an order will, in fact, seek to maximize instantaneous profits.

[3] We chose the hazelnut price because Alston et al. had also examined hazelnuts as substitutes for almonds. Another possibility for Z would be advertising, however, while we do have such data, because our advertising variable is generic advertising, the amount each year is a function of the year's crop since the advertising revenue is collected

the IMF yearbooks. FRT_t is the average, real price per ton of wheat shipped from the U.S. to Rotterdam as listed in the FAO *Trade* yearbooks.

Subtracting equation (2') from (1') produces the residual demand facing U.S. producers in the domestic market. From this and using the equation for marginal cost, we can derive equation (5) as

$$(5') \qquad P_t^u = b_0 + b_1 Q_t^{rd} + b_3 RAIN_t^u + b_4 HC_t^u + b_5 TREND_t - \frac{l}{(a_1 - m_1 + a_2 Z_t^u)} Q_t^{rd},$$

where $RAIN_t^u$ is February rainfall in California (in inches) as reported in the National Oceanic and Atmospheric Administration's *Climatological Data Annual Summary* for California. Rainfall data are included because Alston *et al*. determined that February rainfall was an important supply factor for almonds. It is important to note the relationship of this rainfall to supplies, however. Greater rainfall results in *lower* harvests since pollination occurs in February and bees prefer to remain in the hives if there is rain. Harvest costs per acre, HC_t^u, are derived from the variable cost per acre as given in various crop budgets developed by the University of California Cooperative Extension Service (the formulation is given in Alston *et al.*, pp. 25-26). A trend variable is also included to account for other technological changes over time.

Equations (1'), (2') and (5') are estimated simultaneously using non-linear, three-stage least squares taking quantities, prices and advertising as endogenous. The hypothesis of interest is H_0: $l = 1$, which would indicate that the ABC's reserve policy is consistent with that of a profit-maximizing cartel facing a competitive fringe. Summary statistics for the domestic model are given in Table 1.

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by a per-unit assessment. The Bresnahan technique requires that the variable be exogenous in demand and not part of the marginal cost function. Generic advertising violates both of these requirements.

Table 1. Domestic Model: Nonlinear Simultaneous Equation System Estimates, 1962-1997

	Coefficient	t-Statistic
U.S. Demand for Almonds (Domestic Demand)		
Intercept	1.059	62.009
Real Price of Almonds	-0.285	-44.317
*Real Almond Price * Real Hazelnut Price*	0.106	16.308
Real Per Capita Income	9.916E-06	15.658
Real U.S. Almond Advertising Expenditures ($ millions)	6.549E-03	30.751
Real Hazelnut Price	-0.377	-25.848
Correlation between actual and predicted values = 0.93		
Durbin-Watson = 2.34		
Fringe Supply Equation (Fringe Imports)		
Intercept	1.990E-03	26.689
Time Trend	2.915E-04	23.869
Time Trend Squared	-4.049E-06	-24.738
Spanish Wage Index	-6.715E-05	-27.119
Real Price of Almonds	2.702E-04	10.952
Freight Rate	-3.710E-05	-22.197
Exchange Rate	1.110E-05	23.559
Correlation between actual and predicted values = 0.45		
D-W = 1.51		
ABC's Hypothetical First-Order Condition (Real Price of Almonds)		
Intercept	3.612	126.201
Quantity of U.S. Almonds allowed on the Domestic Market by the ABC	-2.170	-16.619
February Rainfall in California (inches)	0.032	22.568
Harvest Costs ($ per Acre)	2.277E-04	16.526
Time Trend	0.012	15.792
l	0.364	13.786
Correlation between actual and predicted values = 0.85		
D-W = 2.14		

All estimated coefficients are significant at the 0.001 hypothesis level. Because R^2 is unbounded in iteratively determined systems, the correlation between the actual and predicted values is presented instead. In general, the correlation is high on the demand and first-order condition estimates, but lower on the fringe supply equation. The Durbin-Watson (D-W) statistic obtained for the fringe supply equation lies in the uncertain region of the D-W bounds, but for the other

equations, the D-W statistics suggest no autocorrelation. Coefficients are of the expected signs in the demand equation with a negative correlation between the price of almonds and the quantity demanded (the marginal effect here must also take into account the price of hazelnuts and the coefficient on the interaction variables; the average price for hazelnuts is $0.79 per pound in this sample implying an average marginal effect of –0.285+0.106(0.79) = –0.2). The correlation between both income and advertising on almond demand is positive. The negative correlation between the price of hazelnuts and almond demand suggests the two nuts are complementary (given an average price of almonds of $2.20 per pound, the marginal effect of the hazelnut price on almond demand is –0.377+0.106(2.2) = –0.14). While suggesting that the two nuts may be complements, this result, is possibly due to the heavy usage of both nuts in the confectionary industry, so that changes in demand for both nuts are likely correlated with overall changes in demand for confectionary goods. However, the important result for this analysis is that both the coefficient on the price of hazelnuts and that on the interaction term are significantly different from zero, allowing us to estimate the market power parameter.

While the fit for the fringe supply equation is not as high as that of the demand equation, the coefficients are of the expected signs. Increases in Spanish labor costs and the freight rate to the U.S. are correlated with lower export supplies, while an increase in the U.S. price of almonds and an appreciation of the dollar result in greater supplies shipped to the U.S.

The implied first-order condition facing U.S. almond producers shows that marginal costs decrease with quantity (an unexpected finding, though it more likely reflects a long-run correlation; Buschena and Perloff also found such a negative relationship in their model). As expected, February rainfall is positively associated with prices as greater rainfall is associated with a shifting up of the marginal cost function, as discussed above. Likewise, harvest costs per

acre are also positively associated with almond prices.

Finally, the market power parameter, l, is estimated at 0.36 and is significantly different from zero, providing evidence that the almond market is not purely competitive. While this finding offers some statistical evidence that the amount of almonds held off of the market does create a price wedge, the test of the hypothesis that l was equal to one was also rejected at the 0.001 significance level indicating that the ABC's reserve policy does not lead to the amount of market power that would be expected of a profit-maximizing cartel facing a competitive fringe.

The amount of the wedge between price and marginal cost can be determined from the Lerner index $(P - MC)/P = -l/e$, where e is the residual demand elasticity, $e = \frac{\partial Q_t^{rd}}{\partial P_t^u}\frac{P_t^u}{Q_t^{rd}}$; see equations (4) and (4'). On average, this residual demand elasticity is –1.33 implying a Lerner index of 27.4%. Compare this with the Lerner index under a true dominant-cartel facing this residual demand of $1/e$ = 75.2%, and one would conclude that, at least in the U.S. domestic market, the marketing order for almonds has not created a profit-maximizing cartel. Therefore, assumptions that the reserve setting results in monopoly behavior on the part of this legal cartel should be treated with some skepticism. We next look for evidence of cartel-like market power in the export market.

The Export Market

The above domestic model is justified if the ABC is using the export market as part of its allocation scheme. While there is some evidence that the ABC did this occasionally in the 1960s and 70s, the growth of the trade market for US almonds may have made dumping in the export market less worthwhile (see Bushnell and King). Thus, to complete our analysis, we examine whether the reserve policy is used to manipulate prices in the export market, rather than the

domestic market. We again follow Buschena and Perloff's model.[4] For the export market analysis, the system of equations (1'), (2') and (5') are augmented. The demand equation (1') now measures the world demand for all exported almonds. Because the advertising variable is only U.S. domestic advertising, it has been removed, but replaced with a time trend to account for overseas promotional expenditures (such as export enhancement funds) for which we do not have data. Most almond exports go to the confectionary and snack foods industries of Europe and Japan, therefore, the world demand equation includes the per-capita income figures for the principal almond importing countries of Europe (the United Kingdom, the Netherlands, Germany, Italy, France, and Spain) as well as for Japan. Since the income data have been converted from the import market currency to U.S. dollars, exchange rate movements are already incorporated into the world demand curve. Thus a depreciation of the dollar translates into a, *ceteris paribus*, increase in world income with respect to U.S. goods, such as almonds. The fringe supply equation (2') now measures quantity supplied by fringe exporters to all countries (not just the supply to the U.S.). We still use the Spanish wage and exchange rate variables, as Spain remains the most significant player outside of the U.S. As we are looking for evidence that the ABC's reserve setting behavior may be affecting prices on the world market, the ABC's hypothetical first-order condition in this section now represents the choice of U.S. export quantities and differs in form from equation (5') above with the inclusion of the freight rate from the U.S. to Europe, where the majority of the U.S. product is purchased.

Quantities in this model are now export quantities. U.S. export figures come from the

[4] Recently, Goldberg and Knetter raised a critique of Bresnahan-type models for determining market power in export markets because of the consistent finding of incomplete pass through in the trade literature. While we generally agree with this critique, we wanted to continue our analysis using the Bushcena and Perloff model for consistency, rather than introducing the reader to a new model. Goldberg and Knetter's critique would lead us to conclude that a finding of market power under the model we use here may be overestimating the amount of market power in the export market. As will be seen below, such an assertion bolsters rather than dilutes our general conclusion.

FATUS annual reports, while the figures for foreign export trade come from the Food and Agriculture Organization (FAO)'s web page. Income and population data come from the IMF yearbooks and all quantities are on a pound per person basis using the populations of the largest almond importers listed above. For consistency, the U.S. real farm price is again used as the price of almonds and the data span the same time period as the domestic model, above.[5] The analysis is again performed using non-linear, three-stage least squares treating prices and quantities as endogenous. The results are in many ways similar, as can be seen in table 2.

With the exception of the time trend on the ABC's first-order condition equation, all estimated coefficients are significant at the 0.001 hypothesis level. The correlations between the actual and predicted values are lower than those found for the estimations in domestic model and the Durbin-Watson statistics, suggest no concern over autocorrelation. Coefficients are of the expected signs in the world export demand equation with a negative correlation between the price of almonds and the quantity demanded. The correlations between both the European and Japanese income variables and quantity demanded are positive, and, again, the correlation between the price of hazelnuts and demand is negative. Once again, the important result for non-separability is that both the coefficient on the price of hazelnuts and that on the interaction term are significantly different from zero, as they are here.

[5] We chose to use the U.S. farm price both for consistency with the domestic model and because we are testing the assertion that the U.S. is the dominant exporter. The difference in the U.S. price and the landed price is theoretically incorporated in the constant and the freight rate.

Table 2. Export Model: Nonlinear Simultaneous Equation System Estimates, 1962-1997

	Coefficient	t-Statistic
World Export Demand for Almonds (World Exports)		
Intercept	0.7839	31.920
Real Price of Almonds	-0.2872	-26.430
*Real Almond Price * Real Hazelnut Price*	0.2108	18.364
Trend	-0.0027	-5.132
Real Per Capita Income – Largest European Importers	0.0005	74.484
Real Per Capita Income – Japan	0.0001	15.887
Real Hazelnut Price	-0.4788	-19.194
Correlation between actual and predicted values = 0.85		
D-W = 2.22		
Fringe Supply Equation (Fringe Exports)		
Intercept	0.4250	52.334
Time Trend	-0.0154	-11.249
Time Trend Squared	0.0003	17.047
Spanish Wage Index	-0.0012	-4.373
Real Price of Almonds	0.0568	21.983
Freight Rate	-0.0060	-33.196
Exchange Rate	-0.0004	-7.322
Correlation between actual and predicted values = 0.79		
D-W = 2.11		
ABC's Hypothetical First-Order Condition (Real Price of Almonds)		
Intercept	2.1461	40.730
Quantity of U.S. Almonds allowed on the Domestic Market by the ABC	-2.4508	-18.198
February Rainfall in California (inches)	0.0500	15.345
Harvest Costs ($ per Acre)	-0.0005	-15.654
Time Trend	0.0027	1.761
Freight Rate	0.0373	33.817
l	0.3290	12.303
Correlation between actual and predicted values = 0.62		
D-W = 2.31		

As in the domestic model, the fringe supply equation shows that increases in the price of almonds and the Spanish labor costs are positively correlated with quantities exported from the fringe. Higher freight rates, again, are negatively correlated with lower fringe exports. In this

model, however, an appreciation of the dollar with respect to the peseta is correlated with a lower, overall export supply; however, interpretation of this particular exchange rate is not as straightforward as in the previous model. In this case, a depreciation of the peseta would, logically be correlated with an increase in exports to the U.S. market, however, the relationship between the peseta-dollar exchange rate and the demand for exports to, say, Europe is not so clear.

Consistent with the domestic model, the implied first-order condition facing U.S. almond producers shows that marginal costs decrease with quantities exported, and February rainfall is again positively associated with prices. One area of concern in the export model is that harvest costs are negatively associated with almond prices, making the export model more open to skepticism than the domestic model.

Even given these concerns, the market power parameter, l, is very similar in magnitude to that found in the domestic model. In the export model, l is estimated at 0.33 and is significantly different from zero, again providing evidence that the almond market is not purely competitive. Of greater interest, though, is how closely the ABC fits the theoretical implication of a price-leading cartel. A test of the hypothesis that l was equal to one was rejected at the 0.001 significance level. Thus, as in the domestic model, we find statistical evidence that the ABC's reserve policy does not lead to profit-maximizing, cartel power in the export market. The residual demand in the export market is –1.66 implying a Lerner index in this case of 20.4% (compared with the implied price-leading cartel Lerner index of $1/e$ = 60.2%).[6] Thus, the implied price wedge in the export market is comparable (though slightly less) than that found in

[6] In comparison, Buschena and Perloff found a much higher Lerner index of 61% for the coconut oil export market. This comparison is highly relevant to the almond market as firms in the Philippines account for four-fifths of the world's coconut oil exports and 80% of the oil refining capacity is controlled by a centralized agency, thus making that market similar in scale and structure to that of the almond market.

the domestic market. Not only does this suggest some consistency between the two models, it again provides evidence that the ABC's reserve policy does not resemble that of a profit-maximizing cartel.

If not a monopoly, why not?

The two models presented above provide some evidence that the ABC is not a cartel in the traditional sense of the term, even though they have the legal authority to act like one. But, if this is the case, we are left asking "Why not?" Nothing legally prevents the Almond Board from holding more almonds off of the market, and Spain offers little in the way of an outside threat, so why does the ABC not set a larger reserve? Of course, more research is needed before an answer may be found, but we would like to suggest that future researchers might begin their investigation in the following two areas.

In the first place, even though quantity-restricting marketing orders like that for almonds allow a board to withhold product from the market, the orders do not prevent future plantings.[7] If the ABC withheld more almonds, raising prices, the result should be an increase in plantings; leading to the need to increase future reserves; leading, again, to greater plantings, and so on. Future investigations should allow for the possibility of such dynamics in the models. In the case of almonds, such a reserve increase followed by increased plantings followed by bigger reserves may have some justification, as plantings have increased over time (which may, in fact, contribute to the negative coefficient on production in the first-order conditions of the above models). For instance, as a response to large plantings in previous years, the ABC did make a determination to withhold a very large portion of the 1999 crop. This brings up the second

[7] One exception is the marketing order for cranberries, which can control production by ordering producers to flood their bogs early in the season.

reason why true cartel reserves may be difficult to maintain.

Faced with a record harvest, the ABC voted in 1999 to withhold twenty percent of that year's crop, making a record reserve, as well. This decision was extremely unpopular among certain handlers, in part, because the ABC chose to make this an unallocated reserve. Under the unallocated reserve, almond handlers are not allowed to sell the reserve almonds, but they are required to store them. This proved very costly for small handlers and politically costly for the 1999 board as several members who had voted in favor of the reserve were replaced in the next election (Schnitt). Thus, along with the production dynamics, future research into cartel behavior in marketing orders should take into account the elected boards' political reaction functions as well. Berck and Perloff and Filson *et al*. have made important, initial contributions to these areas.

Conclusion

This paper uses demand and supply systems for both the U.S. domestic and export trade of almonds to investigate the degree of market power exerted by the Almond Board of California on world almond markets. The motivation of the paper was the dearth of studies on market power in U.S. marketing orders and the conventional wisdom that market power must be exerted by these legal cartels. We chose to examine the marketing order for almonds because we feel it represents the cartel with the best opportunity for exerting a price wedge. Because the entire U.S. almond industry falls under the jurisdiction of the Almond Board of California and because U.S. almonds satisfy greater than ninety-five percent of U.S. demand and two-thirds of world demand, the notion that a legal cartel of almond producers would display profit-maximizing behavior in the face of a small, competitive fringe would seem to be obvious. Nevertheless, we

show that in neither the domestic market nor the export market are such cartel profits being made. While the estimations do provide some evidence that almond prices are above their competitive levels, the markups are on average 63% less in the domestic and 66% less in the export market than they would be were the Almond Board of California to exercise its near-monopoly power.

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