Demand Enhancement through Food-Safety Regulation: Benefit-Cost Analysis of Collective Action in the California Pistachio Industry

Julian M. Alston
Department of Agricultural and Resource Economics
University of California, Davis
julian@primal.ucdavis.edu

Henrich Brunke
University of California Agricultural Issues Center
brunke@primal.ucdavis.edu

Richard S. Gray
Department of Agricultural Economics
University of Saskatchewan
grayr@duke.usask.ca

Daniel A. Sumner
Department of Agricultural and Resource Economics
University of California, Davis
University of California Agricultural Issues Center
dan@primal.ucdavis.edu

Contributed Poster Paper prepared for the 26th Triennial Conference of the International Association of Agricultural Economists, Queensland, Australia, August 12-18, 2006

Revised: April 25, 2006

Acknowledgements -- Alston and Sumner are members of the Giannini Foundation of Agricultural Economics. The authors gratefully acknowledge financial support from the University of California Agricultural Issues Center, the Giannini Foundation of Agricultural Economics, and the California Institute for the Study of Specialty Crops. The opinions expressed in this paper are not necessarily those of the supporting agencies.

Abstract

Food safety shocks can threaten the health of consumers, create havoc within an industry and result in severe losses to producers. Governments often attempt to enhance food safety by mandating standards and inspection of food products to supplement the voluntary efforts by private firms. This paper assesses a form of collective action that falls between typical government mandates and purely private action. The California pistachio industry recently established a U.S. federal marketing order. This order sets quality standards and requires inspection and certification, aiming to reduce the likelihood of dangerous or poor quality pistachios being sold to consumers and to provide some quality assurance to consumers. Simulation results indicate that, across the full range of parameters used in the analysis, the benefit-cost analysis was always favorable to the new policy. Continuing work is extending the analysis to account for some particular features of the pistachio industry, to consider alternative policies, and to draw inferences for the application of similar policies to other California specialty crops.

Key words: Food Safety, Collective Action, Specialty Crops, Government Regulation, Marketing Orders, Pistachios

JEL Codes: Q18, Q13, I18, H4

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1. Introduction

In August 2005, the U.S. pistachio industry, one of the youngest, fastest-growing specialty crop industries located almost entirely in California, implemented a federal marketing order that would mandate quality standards and an inspection program to assure consistency in the quality of California pistachios. The main provisions of the marketing order set standards and require the testing for toxins called *aflatoxins* that are produced by fungi (*Apergillus flavus and Aspergillis parasiticus*) and have been found in a wide range of commodities used for animal and human consumption. Proponents argued that the marketing order would increase consumer confidence and reduce the chance of an aflatoxin event in the pistachio market, and thereby stimulate demand and enhance consumer benefits and producer returns.

In this paper we summarize the issues and the results from a study that is reported more fully in a monograph and book chapter (Gray et al. 2004; Alston et al. 2005). We briefly discuss the food safety issues that led to the development of the marketing order for pistachios. We then turn to the economic rationale for an industry, in this case the California pistachio industry, to act collectively and ask the government to impose additional regulations on it. We then present our analysis of its costs and benefits for producers, consumers and society as a whole. In a final section we discuss work in progress, which is extending the current analysis in several dimensions, including a consideration of the potential for application of similar policies to other specialty crops. This ongoing work will be completed by mid-2006, and will be incorporated into a revision and extension of this paper.

2. Food-Safety Issues and Aflatoxins in Pistachios

Concern about aflatoxins was the main issue behind the new marketing order. An event of aflatoxin poisoning in pistachios or some other product, or simply concern about the possibility of such an event, could have adverse effects on demand.[1] Many produce-related food scares have occurred in recent years. For the period from 1990 to 1999, the Center for Science in the Public Interest (CSPI) lists 55 cases in the United States alone. The main event that directly related to pistachios occurred in Europe. Iranian pistachio imports were banned in the European Union in September 1997 because shipments exceeded allowed levels of aflatoxins (Economist, 1997). The ban lasted for nearly three months, and was lifted in December of 1997 (European Commission: Food and Veterinary Office). However, the demand for pistachios was affected for a longer period. The Food and Agricultural Organization of the United Nations (FAO) presents data showing that aggregate imports into the European Union, including those from the United States, the main alternative source, fell about 40 percent from 102,698 metric tons in 1997 to 59,619 metric tons in 1998.

3. Rationale for Collective Action in Pistachio Markets

Mandated collective action programs, such as the California Pistachio Commission and the federal marketing order for California pistachios, use the coercive powers of the state or federal government to oblige individual producers to participate and pay assessments. The programs are voluntary in the sense that their establishment requires the support of a sufficiently large majority of producers, but they do not require unanimous support; and consumers, who pay a portion of the costs, do not have voting rights. Even among producers, unlike truly voluntary collective action programs, such as cooperatives or clubs, once they have been established, these programs are mandatory for all producers of the commodity in the defined area.

[1] Aflatoxicosis is poisoning that results from ingestion of aflatoxins in contaminated food or feed. Depending on the levels, the toxins can severely affect the liver and they are a known human carcinogen. The most pronounced contamination has been encountered in tree nuts, peanuts, and other oilseeds, including corn and cottonseed. Aflatoxicosis in humans has rarely been reported; however, such cases are not always recognized. In many developing countries aflatoxin contamination is a major health risk to humans and animals due to the high levels of contaminated product consumed. In rich countries, aflatoxin contamination rarely occurs in foods at levels that cause acute aflatoxicosis in humans, but there have been important aflatoxin events affecting pistachios. (Information here is taken from http://vm.cfsan.fda.gov/~mow/chap41.html .)

The conventional in-principle economic justification for the use of the government's taxing and regulatory powers in this fashion is that there are collective goods within the industry – research, promotion, grade standards, packing regulations, public relations, and the like – that will be undersupplied otherwise. In practice, whether the pistachio marketing order will yield net benefits to producers, consumers, the state, and the nation as a whole, will depend on the nature and extent of external costs and benefits when individual firms are compelled to comply with minimum quality standards and mandatory testing for aflatoxin, along with the other provisions of the order, and the costs of implementing the program.

The regulations under the marketing order include various elements that have different types of collective-good characteristics, some more easily justified than others. Standardized grades and packaging have a collective-good role in that they will reduce transaction costs (e.g., see Freebairn 1967, 1973). An argument for quality regulation can be made where quality is hidden and the market can be spoiled as a result of the distortions in incentives to provide and communicate information about quality (e.g., Akerlof 1970). The externality aspect is that when consumers experience the quality of pistachios from one supplier, this affects their subsequent demand for pistachios from other suppliers as well. Thus a bad experience associated with any pistachios can affect the whole industry and the impacts can be large and long lasting, but individual producers will not take these industry-wide consequences of their actions entirely into account.

An industry-wide food safety issue could arise as a result of evidence of death or illness associated with consumption of pistachios containing aflatoxin. As with other food scares, there may be consequences for demand experienced throughout the industry, not just by the firms directly responsible for the incidents in question. The same type of market problem can arise even without a case of actual food poisoning. It could result from an actual aflatoxin event involving the discovery of aflatoxin in excess of the 20 parts per billion allowed by the Food and Drug Administration. Even in the absence of an aflatoxin event in pistachios, there may be adverse effects on the pistachio market from the perception of such a threat – for example, based on adverse publicity associating aflatoxin with pistachios or for some other reason, such as when excess amounts are discovered in other products in the United States or anywhere else in the world. Negative consequences could result from negative perceptions among final consumers resulting in their choosing not to purchase products, negative perceptions among market middlemen such as retailers resulting in their choosing not to stock a product that might be subject to recall or lawsuits, or from governments choosing not to allow products to be sold because of heightened concerns over food safety.

Perceptions of a food quality problem are not specific to individual suppliers, but affect the industry in a collective way. Therefore, the private incentive to assure high quality nuts that are perceived as safe does not reflect the full, industry-wide or public benefit of these actions. In such cases, voluntary actions, motivated by private incentives will provide less safety and quality assurance than would be in the interest of the industry (and, perhaps, the general consuming public). In this case, all farms and firms would benefit from a stronger reputation for pistachios in general, but their own actions cannot assure such a reputation, unless the rest of the industry matches those actions. Individual farms and firms have the private incentive to keep their own direct costs low and invest less in safety testing and quality assurance than would be optimal from the view of the whole market, giving rise to a free-rider problem.

Collective action or government mandates are not always necessary to achieve socially optimal food quality and safety assurance. The use of private brands combined with product liability laws is one way of internalizing within firms the benefits and costs of their investments in food safety and food safety assurance. The extent to which these factors reduce externalities and market failures in any particular setting will depend on the extent to which instances of food poisoning and its human health consequences can be observed and traced to particular sources, and the extent to which consumers distinguish the brand specific and generic aspects of food safety associated with particular foods. Such incentives seem to work well for large food retail chains, for instance, for whom brand name and reputation are very valuable, but perhaps not as well in more atomistic industries.

Two characteristics of the pistachio market make the market failure concerns particularly important in the context of food safety assurances and quality standards. First, as with many fresh fruits and nuts, there is little brand identification with pistachios. Thus, a customer who has an unsatisfying experience with a purchase of pistachios or who hears negative news about the safety of consuming pistachios is unlikely to associate this with a specific brand or supplier. Unlike branded, packaged consumer items, any negative news would not just affect a specific supplier, but rather would affect the industry at large. Second, many pistachio purchasers consume the product infrequently, purchase relatively small quantities, and have relatively little knowledge about pistachios. One would therefore expect the industry-wide reaction to an aflatoxin event in pistachios to be large, compared with more familiar foods, especially in the context of food safety concerns. The wholesale trade would be even more sensitive to an event if a recall were necessary. Consequently, the pistachio industry has strong in-principle reasons for acting collectively to assure industry-wide compliance with quality and food safety standards. But this is only an in-principle case. Whether collective action of this type would provide net benefits to the industry depends also on how effective the program would be in reducing the likelihood of a food scare, or its severity, and on the costs of the program.

4. A Model of the Industry and the Impacts of the Marketing Order

We developed a multi-period stochastic dynamic simulation model and used it to simulate the markets for California pistachios and project production, prices, and allocation of pistachios for 50 years, beginning in the year 2000. Yields vary over time to reflect alternate bearing and random influences. Aflatoxin events also occur at random. In our model, both the probability of an event and the severity of the demand response to a given event are lower with the marketing order in place. For each "draw" of a time series of future yields, we simulated the outcomes for economic variables in the industry with and without the marketing order in place. By considering 100 draws of future time paths of yields, we were able to estimate the effects of the marketing order on measures of interest, for average values and the range of outcomes (or other measures of variability).

We specified equations representing the domestic and export demands for pistachios, including storage demand, using estimates of elasticities and data on market shares, quantities and prices. The marketing order applies solely to the domestic market. It imposes regulations, which entail costs of compliance with requirements for aflatoxin testing and meeting quality standards, borne in the first instance by processors, and other (relatively minor) costs to be financed by an assessment on processors. Based on interviews with processors we find that the weighted cost of compliance, which varies among processor depending on size and extent to which testing is already done, is $0.0035 per pound across the entire California pistachio production.

The potential increases in demand, on average, relative to a scenario without a marketing order include the effects of (1) a reduced probability of a negative shock to demand associated with an aflatoxin event, and a reduction in the size of the negative shock associated with a given event, and (2) an increase in demand in every year owing to greater consumer confidence in the product and greater buyer confidence in the product associated with the USDA testing and certification.

To calibrate the potential effects of a pistachio food scare we used information from other produce-related food scares in the United States, along with information from an event involving pistachios in Germany, and we conducted sensitivity analyses in which we varied the relevant parameters. Based on that approach we assumed that an aflatoxin event in the domestic market for U.S. pistachios in year *t* would cause a 30 percent reduction in demand in the year of the event (i.e., $\delta_t = 0.3$, where δ stands for the proportion by which demand decreases in year *t*). The German evidence suggests that the negative demand effects from a single aflatoxin event would continue to affect demand for several years. In the model the negative demand shock decays at a rate of 30 percent per year (i.e., $\delta_{t+n} = 0.7^n\delta_t$).

Aflatoxin events do not happen every year, but the market always faces some probability of a food scare. The marketing order cannot eliminate the chance of a food scare associated with aflatoxin in pistachios, but it does have provisions that make such an event less likely. The benefit from additional testing is a reduction of the probability of an aflatoxin event or food scare. For the counterfactual base case of no mandatory testing, we used an annual probability of 4 percent of an outbreak that affects demand as specified above. We assumed that with mandatory testing the chance of an aflatoxin outbreak would fall to 2 percent and that the events, when they do occur, would have smaller effects on demand. We assumed an initial downward shock of 15 percent with a marketing order rather than the 30 percent that would apply otherwise. The demand for pistachios might be greater as a result of the official USDA certification ensuring a good quality product. To reflect this certification effect we allowed for a small increase in demand in every year, relative to the base case, in response to the introduction of the marketing order: an increase in U.S. consumers' willingness to pay for pistachios equal to 1 cent per pound (about 1 percent of recent prices).

5. Benefit-Cost Analysis

To estimate the impact of the marketing order we computed and compared a pair of fifty-year simulations (i.e., one with and one without the marketing order) using the "baseline" values for the parameters, as shown in Table 1. For each year of the fifty-year simulation, the model determines a market clearing price, bearing acres, acres planted, yield, production, domestic quantity demanded, export quantity demanded, ending stocks, revenue, and consumer surplus. To capture the effects of random yield variability and aflatoxin-related demand shocks, the 50 years of simulated equilibrium values were calculated for a set of 250 equally likely futures, which differ in terms of values for randomly generated yields and aflatoxin shocks. Hence, in a given scenario, each simulated variable of interest has a fifty-year time path, with a random distribution in each period that is affected by the marketing order. As the summary statistics and average impacts are reported below it is important to keep this time path and the random nature of the variables in mind.[2]

The impacts of the marketing order are reported in the first column of numbers in Table 2. To summarize the effects of the marketing order over the 50-year simulation we report average effects over the 50 years for some variables and for others we report the net present value in 2003 of the effects over the 50 years. The policy would modestly increase the average price received by growers (by 0.5 cents per pound, or 0.6 percent), along with the average number of bearing acres (by 1,870 acres or 1.3 percent) and production (by 12.6 million pounds per year or 1.5 percent). These increases in production are associated generally with increases in domestic consumption (by 11.5 million pounds per year or 2.8 percent) and in exports (by 1.0 million pounds per year or 0.2 percent) and decreases in stocks (by 0.6 million pounds per year or 0.3 percent). These averages mask the fact that, as noted above, the effects on some of these variables change over time both because of trends (the production response to the policy increases with time whereas the domestic demand response begins immediately) and from year to year (through the interaction of policy-induced changes in bearing acreage and variable yields). This is true in particular for the effects of the policy on exports – the small average effects reflect negative impacts in some years, especially initially, and positive impacts in others, especially in the later years.

The dynamics of the impact of the marketing order on revenue per bearing acre, bearing acres, and domestic consumer surplus are particularly interesting. The marketing order increases grower price and revenue per acre by increasing consumer confidence and reducing the odds and the impact of

[2] Further details on the simulation model and alternative parameterizations may be found in the more comprehensive full report on the study (Gray et al. 2004).

an aflatoxin event. The impact on revenue is greatest in the first few years after the introduction of the marketing order because supply is unaffected for this period of time. The increase in revenue per acre eventually causes an increase in the time path of bearing acres. The increase in bearing acres results in increased production, driving down prices and revenue per acre, and dissipating the benefits for producers. Consumers gain initially from the improved food safety and these benefits are then augmented by the subsequent reductions in prices resulting from the increases in production.

The net benefits from the policy – reflecting the consequences of both the assessment and regulations, and the demand and supply responses to them – are expressed as present values (in 2003) of changes in economic surplus accruing to different groups. These net benefits include $68.9 million to domestic producers and $165.4 million to domestic consumers, yielding a total national net benefit of $234.2 million.[3] From a global perspective, the U.S. net benefits are slightly offset by net losses in foreigner surplus (the "consumer surplus" measured off the demand for U.S. exports) worth $25.0 million, leaving global net benefits with a present value in 2003 equal to $209.2 million.[4]

We also estimated the total cost of the policy (in terms of expenditure incurred by processors in compliance), which had a present value in 2003 of $36.7 million. The initial incidence of this cost is on processors, but this incidence is redistributed over time through supply and demand responses. To evaluate the final incidence, we ran a simulation with just the assessment (modeled as a reduction in domestic buyers' willingness to pay of 0.525 cents per pound) and, in present value terms, we found

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[3] On 78,000 bearing acres in 2001, the producer benefit is worth $2,120 per acre, but the benefits would not be confined to these acres.

[4] The positive effect on export quantity seems to contradict the higher average price and the reduction in foreign "consumer" surplus associated with the policy. The effect on foreign "consumer" surplus is complicated. First, there are some benefits to foreigners from the policy because in the baseline, there is a spillover of an aflatoxin event from U.S. demand to foreign demand and the policy-induced reduction in probability and severity of an aflatoxin event applies to export markets as well as domestically. These benefits are offset at least somewhat by the larger domestic demand responses, driving up prices, especially in the early years; in the later years those effects in turn are offset at least somewhat by the consequences of U.S. supply response to the policy. The benefits to foreigners are greater in the earlier years, and given discounting, the net present value is negative even though the average effect on the quantity of exports, undiscounted, is slightly positive.

that 15 percent of the cost was borne by growers, 85 percent by domestic and foreign consumers combined, and 95 percent by domestic consumers (foreign consumers are net beneficiaries of a tax on domestic consumers). Hence the incidence of the global cost of $36.7 million was $39.7 million on the United States, including $5.5 million on U.S. producers. By dividing each measure of net benefits by the corresponding measure of the incidence of the costs we obtained a ratio of net benefits to costs (i.e., (B-C)/C) to which we added one to compute conventional benefit-cost ratios (B/C) for domestic producers (13.5), the United States (6.9) and the world (6.7).

To examine the general sensitivity of results to modeling assumptions, we devised a "high-impact" scenario and a "low-impact" scenario, and the summary results for the simulations under these scenarios are reported in second and third columns of numbers in Table 2. The benefit-cost ratios are all well greater than zero, even in the low-impact scenario, indicating that the policy entails substantial net benefits for both producers and the nation as a whole.

6. Results and Implications

An aflatoxin event could impose serious costs on the California pistachio industry. The marketing order is intended to reduce the odds of an event, to mitigate the consequences if an event should occur, and to provide some quality assurance to buyers so as to offset the negative consequences of concerns over the potential for a food scare affecting pistachios. In this study we have modeled the market for California pistachios to provide an ex ante assessment of the benefits and costs and other consequences of the marketing order looking forward for 50 years from its introduction. Our approach uses a stochastic, dynamic simulation of the industry, under scenarios with and without the proposed marketing order in place, to compare the stream of simulated outcomes and the consequences for measures of economic welfare of producers in the industry, consumers, the nation as a whole, and globally.

To assess the implications of the marketing order required incorporating into the simulation a number of parameters representing the odds of an aflatoxin event, its consequences for demand, and the extent to which a marketing order would reduce those magnitudes. Many of these parameters are hard to estimate because relevant historical data are not available on pistachios. As well as simulating the consequences implied by "best-guess" values for key parameters, we undertook sensitivity analysis. Across the full range of parameters used in the analysis, the benefit-cost analysis was always favorable to the policy: the measured benefits to producers, the nation, or the world always well exceeded the corresponding measure of costs, typically by many times. The benefit-cost ratios were generally greater than 5:1 and often greater than 10:1, which means there is substantial leeway to accommodate potential errors in assumptions and yet have favorable findings. In present value terms, the benefits to producers were estimated at $68.9 million. Two-thirds of the benefits, $165.4 million would accrue to domestic consumers. These are significant values, and are large relative to the cost of compliance with the program, which is a very small amount – about half of one percent of the current value of domestic sales.

7. Further Issues

A number of questions remain unanswered about whether the regulatory provisions under the marketing order for California pistachios provide the most appropriate correction for the information problems they are meant to address. Similar questions may arise in other industries that might contemplate similar policies. The essential issue with food safety and safety assurance is one of information. If food safety were visibly obvious to consumers or easily detected, there would be no problem. Even when food safety is invisible (the more relevant case), if a case of food poisoning could be traced to its source with certainty, and firms could be made fully liable for the costs, then incentives would work and government intervention would be unnecessary.

Continuing work under this project is exploring further aspects of safety assurance for California pistachios, and alternative policies or private actions that might be used to address the particular information problems in the pistachio market, such as (a) public education, (b) alternative mandated grading requirements, or (c) a mandated requirement to identify products with a brand.

Of relevance to this discussion is the observation that pistachio safety is at least to some extent visible and avoidable (such that the risk of aflatoxin poisoning can be reduced by educating consumers about the existence of the risk and how to avoid it by inspecting the nuts and by advising them not to eat nuts that taste bad). Policies designed to correct market failures associated with invisible quality seem inappropriate in such a setting. Rather than mandating inspection policies and grade standards, the government could require firms (a) to grade out nuts that are discolored or have other external evidence that might suggest a risk of aflatoxin contamination prior to sale (perhaps using optical sorters), and (b) to provide information with products about safe approaches to consuming them. A role for the government here could be in developing the information resources and in obliging firms, across the range of related industries, to provide the appropriate, balanced, information. This is a solution that the industry might not favor, since rather than encourage consumption it might cause some consumers to become less-confident in the safety of the product, and the extent to which consumers would absorb and act on information provided in this fashion is open to question.

A second pertinent observation is the so-called "one-nut" problem, associated with the discrete nature of the nut, the disease, and the samples used to test for it. In the case of pistachios, a single nut (out of many thousands) might contain sufficient aflatoxin to be very dangerous, and pistachios are consumed as single nuts. Quality assessments based on small samples rest on an assumption that the sample is representative, and that may not be the case. The power of the tests for pistachio safety based on small samples may be very low, and reducing the maximum standard might not enhance the actual safety much. In future work we will use data from the inspections under the marketing order and other information on the distribution of aflatoxin problems among pistachios to delve more deeply into the extent to which inspection programs actually increase food safety in the case of products like pistachios that are consumed as discrete units. From this work we will re-examine the appropriate values for parameters to reflect the effects of the policy on the odds of an event and quality assurance.

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Table 1: *Key Parameters for the Simulation Model*

Parameter	Baseline Value
Underlying Market Conditions	
Elasticity of domestic demand	-1.00
Elasticity of export demand	-3.30
Elasticity of demand for stocks	-2.00
Long-run annual growth rate of demand (percent)	3.60
Elasticity of new plantings response to profitability	1.00
Impact Parameters without a Marketing Order	
Probability of an aflatoxin event (percent per year)	4.00
Initial impacts of an event (percentage reduction in domestic demand)	30.00
Foreign demand shock/ domestic demand shock (percent)	21.50
Impact Parameters with a Marketing Order	
Probability of an aflatoxin event (percent per year)	2.00
Initial impacts of an event (percentage reduction in domestic demand)	15.00
Initial impacts of an event (percentage reduction in foreign demand)	21.50
Compliance costs (cents per pound)	0.525
Domestic demand enhancement from certification (cents per pound)	1.00

Table 2: *Simulation Results: Benefit-Cost Analysis of the Pistachio Marketing Order*

Consequences of the Marketing Order	Baseline	High Impact	Low Impact
Average of Annual Values, 2000-2050, Induced Changes in			
Price of California pistachios (real cents per pound)	0.501	0.726	0.371
Bearing area of California pistachios (acres)	1,866	2,716	1,279
Production of California pistachios (million pounds)	12.55	18.31	8.63
Domestic consumption of California pistachios (million pounds)	11.54	16.91	8.15
Exports of California pistachios (million pounds)	1.01	1.40	0.51
Stocks of California pistachios (million pounds)	-0.62	-1.05	-0.47
Present Values in Year 2000, Net Benefits, $million			
Changes in U.S. consumer surplus (CS)	165.4	246.7	109.8
Changes in California producer surplus (PS)	68.9	103.7	49.6
National benefits (NS = CS+PS)	234.3	350.4	159.4
Net changes in foreign surplus (FS)	-25.0	-36.5	-19.2
Global net benefits (GS = NS+FS)	209.3	313.9	140.2
Present Values in Year 2003, Costs of Marketing Order, $million			
Cost of compliance (CC)	36.7	34.9	38.4
Benefit-Cost Ratios			
Global B/C ratio (1+ [GS/CC])	6.7	10.0	4.7
National B/C ratio (1 + [NS/1.1CC])	6.9	10.2	4.8
Grower B/C ratio (1+ PS/0.15CC])	13.5	20.8	9.6