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# Industry-mandated testing to improve food safety: the new US marketing order for pistachios

## Verbesserte Lebensmittelsicherheit durch kollektives Handeln in der Ernährungsindustrie: Die neue Vermarktungsregelung für Pistazien in den USA

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### 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 aid food safety by mandating standards and inspection of food products to supplement the efforts by private firms and industries. This article 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, which sets quality standards and inspection to reduce the likelihood of dangerous or poor quality pistachios. 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. In the case of California pistachios, collective action is likely to be a helpful tool to ensure a safe product and increase benefits to producers and consumers.

### Key words

food safety; food scare; collective action; marketing orders; pistachios; public good; food regulations; cost-benefit analysis

### Zusammenfassung

Lebensmittelskandale bedrohen nicht nur die Gesundheit des Verbrauchers, sondern verursachen oft auch enorme Verluste bei den Produzenten. Zusätzlich zu Initiativen von Firmen und Wirtschaftszweigen versuchen Regierungen, den Verbraucherschutz durch Produktstandards und Qualitätskontrollen zu gewährleisten. Dieser Artikel untersucht eine Form des kollektiven Handelns, die zwischen Aktivitäten einzelner Firmen und den Handlungen der Regierung angesiedelt werden kann. Die kalifornische Pistazienindustrie hat vor kurzem unter nationalem Recht eine Vermarktungsverordnung eingeführt, die durch Qualitätsstandards und Kontrollen das Vorkommen gesundheitsschädlicher und minderwertiger Pistazien reduzieren soll. Simulationsergebnisse zeigen, dass über das gesamte Spektrum der in der Analyse verwendeten Parameter eine Nutzen-Kosten-Analyse immer positive Nettoeffekte ergab. Kollektives Handeln erscheint daher als ein nützliches Instrument für die Vermarktung eines gesunden Produktes mit positiven Wohlfahrts-effekten für Produzenten und Konsumenten.

### Schlüsselwörter

Unbedenklichkeit der Nahrungsmittel; Lebensmittelskandal; kollektives Handeln; Vermarktungsregelung; Qualitätsstandards; Pistazien; Kalifornien; Nutzen-Kosten-Analyse; Absatzregelung

### 1. Introduction

Outbreaks of foodborne illnesses affect some consumers directly and affect both producers and consumers through economic relationships. A food safety event can damage an individual consumer's health and the public's perception of a product, which leads to a decrease in demand and financial losses to the industry.

Many and varied food scares have occurred in recent years in the United States and in other countries. For the period from 1990 to 1999, the Center for Science in the Public Interest (CSPI, 2002) lists 55 cases in the United States alone. Well-known international events have related to outbreaks of Bovine Spongiform Encephalopathy (BSE) in Europe, Japan and recently in North America.

The U.S. government attempts to assure the safety of food products by imposing standards and mandating inspection and labeling. Individual growers and their commodity associations have also responded to increased concerns about foodborne illnesses by improving their food safety system. Grower organizations have developed testing practices and trace-back systems to protect the reputation of their particular products, often under federal oversight. The U.S. pistachio industry offers a recent example. The industry implemented a federal marketing order to mandate tighter quality standards and inspection to assure consistency in the quality of pistachios. The main provisions of the proposed marketing order set standards and require the testing for quality and aflatoxin, a cancer-causing mold found in many nuts and grains.

After presenting a background on food safety events and on how industries can deal with such issues, this paper addresses the rationale for collective action in the form of a marketing order. We then describe the California pistachio industry and the likely economic consequences of the newly established federal pistachio marketing order developed to reduce the chances of a negative food safety event.

### 2. Food safety issues

A food safety event not only endangers the health of consumers but can also have severe economic impacts on the

producer of the affected food product. Negative publicity involving a product damages consumer trust in that product affecting demand and consequently producer profits. The gravity of such an impact depends on the nature of the food safety event and on the importance of the affected food product in consumer's diets. These two points also influence the short and long-term consequences of a particular food safety event. Obviously, a food scare that involves severe health consequences or even the death of consumers is likely to receive more intense and widespread coverage by the media. In such instances, the government or industry organization might also intervene to recall the affected product. Examples of such a case are recent produce-related food scares involving cantaloupes and *Salmonella* and strawberries and *Cyclospora*. Because of potential health risks, in 2000, 2001 and 2002 certain cantaloupe brands were recalled nationwide (UNITED STATES FOOD AND DRUG ADMINISTRATION, 2003). In 1996, the California strawberry industry lost an estimated five percent in total revenue due to the *Cyclospora* scare (details can be found in CALVIN, 2003).

Aside from the health impacts of an actual food safety event, simply raising the concern of a potential risk can have enormous impacts on markets. A well-known event demonstrating the public's sensitivity towards food quality was the famous alar scare in apples in 1989, when a television broadcast reported that alar (a chemical used to influence the rate of growth) was used in apple production and that it was the most cancer-causing substance in the food supply. Apple demand dropped dramatically overnight, and apple growers suffered losses estimated at hundreds of millions of dollars (details can be found in VAN RAVENSWAAY and HOEHN, 1991).<sup>1</sup> The AMERICAN COUNCIL ON SCIENCE AND HEALTH (ACSH, 1999) reported that even five years later, the effects from the scare could still be felt and that the market had not fully recovered.

The publicity surrounding a food safety event depends on the importance of the affected product in diets and on the public perception of the food. It also may depend on who consumes the product. The huge furor surrounding the alar scare likely derived from the wholesome reputation and every day nature of apples and their importance in the diet of children. Food scares involving products that are consumed on a less frequent basis by fewer consumers might receive less media coverage. However, the economic consequences of a food scare involving a less common product, pistachios for example, may be even more severe within the industry if the product has a less familiar place within the diet and other products are potential substitutes.

Industries affected by food scares may bear long-term consequences of the negative publicity. Public statements by producers or governments to assure the public of safe food supplies are often ineffective in restoring consumer confidence in the product following the discovery of a food safety problem (SMITH, VAN RAVENSWAAY and THOMPSON, 1988). Thus, the impacts of food safety problems depend to a large extent on the intensity of the media coverage and the

basic theme of that coverage. Frequent and negative coverage of a food safety problem has a larger effect on the demand for the affected product and that effect can only partially be compensated by positive coverage from governmental or industry sources.

### 3. Aflatoxins in pistachios

Aflatoxicosis is poisoning that results from ingestion of aflatoxins in contaminated food or feed.<sup>2</sup> The aflatoxins are a group of structurally related toxic compounds produced by certain strains of the fungi *Aspergillus flavus* and *A. parasiticus*. Under favorable conditions of temperature and humidity, these fungi grow on certain foods and feeds, resulting in the production of aflatoxins. The most pronounced contamination has been encountered in tree nuts, peanuts, and other oilseeds, including corn and cottonseed. Aflatoxins produce acute necrosis, cirrhosis, and carcinoma of the liver in a number of animal species, and it is logical to assume that humans may be similarly affected. Aflatoxicosis in humans has rarely been reported; however, such cases are not always recognized. One of the most important accounts of aflatoxicosis in humans occurred in more than 150 villages in adjacent districts of two neighboring states in northwest India in the fall of 1974. According to one report of this outbreak, 397 persons were affected and 108 persons died. A 10-year follow-up of the Indian outbreak found the survivors fully recovered with no ill effects from the experience. In rich countries, aflatoxin contamination rarely occurs in foods at levels that cause acute aflatoxicosis in humans, but there have been aflatoxin events in pistachios that violated government standards and caused negative demand shocks.

Pistachios can be contaminated with the mold containing aflatoxins if practices during the harvest or storage allow the nuts to become wet or get in contact with dirt. Moderate temperatures, high humidity and poor ventilation during storage lead to a corresponding increase in the volume of the toxin.

Iranian pistachio imports were banned in the European Union (EU) in September 1997 because of excessive levels of aflatoxins in Iranian pistachio shipments (THE ECONOMIST, 1997). The ban lasted for nearly three months, and was lifted in December of 1997 (EUROPEAN COMMISSION: FOOD AND VETERINARY OFFICE, 1998). 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 imports into the European Union dropped 42% from 102 698 metric tons in 1997 to 59 619 metric tons in 1998.

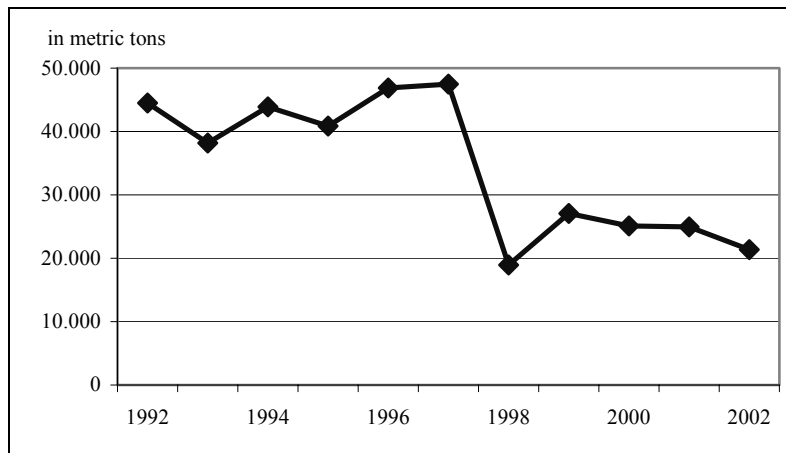
In 1997, an importing year that was shortened by the ban, Germany imported 47 494 metric tons of pistachios worth \$175.3 million (FAO), and the five-year average leading up to that year (1993-1997) was 43 459 metric tons per year (FAO). In 1998, Germany imported only 18 937 metric tons, just 40% of the quantity in the previous year (figure 1). German imports during the next two years were also well below 1997 quantities. In 1999, 27 059 metric tons were

<sup>1</sup> Additional studies of demand impact of food safety events and information on demand can be found in BROWN and SCHRADER (1990), RICHARDS and PATTERSON (1999) and PIG-GOTT and MARSH (2004).

<sup>2</sup> Much of the technical information here is from UNITED STATES FOOD AND DRUG ADMINISTRATION, CENTER FOR FOOD SAFETY AND APPLIED NUTRITION (2004).

imported and in 2000 only 25 090 metric tons. The value of the imports fell to \$78.9 million, or just 45% of the value in 1997. This drastic and protracted fall in the quantity of imports after the ban was lifted points to a decrease in consumption, perhaps resulting from negative publicity the ban received in the media. In 1999, HERMES sampled pistachios from supermarkets for Öko-Test, a German consumer report, and found that eight out of eleven samples had higher than allowed aflatoxin levels, and that the highest levels were found in Californian pistachios.

**Figure 1. German pistachio imports, by quantity, 1992-2002**



Source: UN-FAO (2003)

In the years since 1997, pistachios have exceeded maximum aflatoxin levels on several occasions and in several countries. This has made headlines worldwide. In 2000, in Germany alone, several articles were published in national (DER SPIEGEL, 2000; SÜDDEUTSCHE ZEITUNG, 2000) and regional newspapers, following findings of high aflatoxin levels in pistachio ice cream. Surveys of industry and government information indicates the continued appearance of high levels of aflatoxins in countries worldwide (REINECKE, 2002). For example, one case in Australia dealt with the recall of pistachios following the detection of high levels of aflatoxins. In February of 2000, health officials in Japan found high levels of aflatoxin in pistachios, which resulted in a recall of the product. Retailers were questioning pistachios from Iran and California. Also in 2000, testing in France found high levels of aflatoxins in pistachios.

A recent report noted that "the European Union extends its deadline for Iran to clean up its pistachios. With the strictest standard for aflatoxin levels – 4 ppb – compared with 10-15 ppb in other importing nations, the EU would like to cut back on its current level of 100% pistachio inspections and so it extends its deadline for six months and offers Iran its technical services to find a solution" (WILLARD THOMPSON'S FIELD TALK, 2004).

The impact of the 1997 food safety event involving pistachios in Europe was severe in the short term and in the longer term. As described above, pistachios are not a typical ingredient of an everyday diet for most Europeans, but rather, a snack food consumed at irregular intervals. Because of the specialized demand and close substitutability with other nuts and snack foods, the losses for pistachios in the EU market were larger than observed in some other food scares in the United States. Other differences related

to institutions and consumer behavior between the United States and Europe may also help to explain differences in responses to food scares.

#### 4. Government and industry responses to food safety issues

In the United States as elsewhere, national legislation and regulation addresses food safety issues. In the United States, federal agencies, often in collaboration with their counterparts at the state level, are charged with protecting consumers against impure, unsafe and fraudulently labeled foods. The Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture, for example, has the responsibility to ensure that meat, poultry and egg products are safe and accurately labeled (FOOD AND DRUG ADMINISTRATION, 2000). FSIS operates under the authority of the Federal Meat Inspection Act and sets public health performance standards for food safety. It regulates all raw and processed meat, poultry products and egg products sold in U.S. interstate and foreign commerce. Another agency, outside of USDA, the Food and Drug Administration (FDA) regulates the use of food additives or drug residues in food items. The FDA also sets tolerance levels for pesticide residues or foodborne toxins.

Industries and firms also invest resources to prevent pathogens, carcinogenic chemicals and other harmful substances from entering their food products. Incentives to comply with the mandated regulations and to invest in additional food safety measures include the benefits of the reputation for supplying safe products and the fear of legal action from the sale of potentially harmful products. However, firms may have an incentive to underinvest in safety if there are industry-wide reputational externalities or if regulations are imperfectly enforced.

Several U.S. commodity industries have collective action programs supported by federal or state legislation. These programs are industry-initiated and financed by product-specific assessments. Initiation requires a positive vote by growers representing a majority of the industry. Once approved by the industry and by regulators the rules and assessments are mandated and enforced by the government on all industry participants. Continuation of a marketing order requires positive support by the industry in votes held periodically. Below we provide more specifics on the new U.S. marketing order for pistachios.

State marketing orders are authorized by the California Marketing Act of 1937, whereas commodity commissions and councils are instituted by specific laws. Each administrative body is authorized to collect assessments from producers and, in some cases, handlers, based on units or value of the commodity at the first-handler level. These assessments are used to fund activities, which may include quantity controls, market promotion, research and development, container or pack regulations, and quality standards and inspection. Although the largest and most important pro-

grams relate to dairy, the majority of California's state marketing programs are for fruits, nuts, and vegetables, and the lion's share of the expenditure is for promotion programs in most cases, although not in every case.

Federal marketing orders are authorized by the Agricultural Marketing Agreement Act of 1937. They are similar to state marketing orders, and the enabling legislation was enacted at nearly the same time, but there are some differences. Federal marketing orders tend to focus on quality regulations, and sometimes volume controls, while state programs tend to focus more on research and promotion. Federal marketing orders that set standards for quality and related requirements are in place for many California fruits and vegetables. In addition, the USDA provides testing and grading services for many commodity markets (USDA-AMS, 2003).

The majority of marketing orders in the United States do not directly regulate the price and quantity. They instead facilitate research and promotion of a commodity or impose safety or quality standards as in the case of pistachios. Such measures indirectly affect the price and quantity of a commodity. Dairy marketing orders are important exceptions. They set minimum prices in order to price discriminate across end-uses of milk and regulate location of marketing.

Most of the budget and related activity for these programs relate to product promotion, research, supply control and pricing, and general quality issues. However, some of the programs deal with food safety. LEE et al. (1996) documented and described the different forms of mandated marketing programs in California and their legal basis, as well as the amounts spent under each program and the allocation between research, promotion, and other activities. They reported that in May 1995 there were 48 state marketing programs (including state marketing orders, commissions, and councils) and a further 13 federal marketing orders in California, covering about half of California's agricultural production and spending more than \$100 million. Since then, there have been some changes in the programs, and the total program spending has grown to more than \$170 million in 2002/03. Extensive background information on California marketing orders and commodity programs can be found in KAISER et al. (forthcoming 2004).

## 5. Economic rationale for collective action relevant to food standards

Mandated collective action programs, such as the California Pistachio Commission and the federal California pistachio marketing order, use the coercive powers of the state or federal government to oblige individual producers to participate and contribute 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, 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.

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. This is the standard public-good argument for government intervention. The goods in question are public goods, in the sense that they are non-rival and non-price excludable, but these public-good benefits are confined to the producers and consumers of a particular commodity, and are associated with consumption or production of the commodity. The collective goods could be provided using the general revenues of the relevant state or national government, but it is likely to be fairer and more efficient to finance their provision using a tax on the commodity with which the collective goods are associated.

Standardized grades and packaging have a public 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 "public good" element is that when consumers experience the quality of pistachios from one supplier, this affects their subsequent demand for pistachios from other suppliers as well. Especially in the case of a food quality issue, a bad experience associated with any pistachios will likely 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. Therefore, the private incentive to assure high quality products 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 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. This is a classic "free-rider" problem where individuals cannot be precluded from sharing in the benefits even if they fail to make contributions, and where one individual benefiting from the better reputation does not preclude benefits to others. For a more de-tailed discussion of the economic rationale for collective action, see ALSTON et al. (2004).

Regulations over visual standards – such as freedom from blemishes or minimum size regulations – are less easy to justify, generally, on the grounds of public goods since they relate to aspects of quality that are not hidden from consumers. Such regulations may play a role of de facto supply control by diverting some of the volume to non-food uses. They may also be a form of de facto price discrimination by diverting a larger proportion of the crop (for example, pistachios) to the processing market, which has a more elastic demand response.<sup>3</sup>

<sup>3</sup> ALSTON et al. (1995) analyze the impacts of the allocated reserve policy applied by the Almond Board of California under a federal marketing order, an example of this type of supply control, which can be mimicked by the use of quality regulations to divert some fraction of production from the market. CHALFANT and SEXTON (2002) analyze an interesting example

## 6. The California pistachio industry

World production of pistachios has grown rapidly during the past 20 years, and U.S. production has increased as a share of that growing total. Iran is still the largest producer but the United States is established as the second-largest pistachio producer in the world, followed by Syria and Turkey and is now the second-largest exporter after Iran.<sup>4</sup>

Almost all US pistachios are produced in California.<sup>5</sup> California's production has grown more than 200-fold since 1976, when its first commercial crop of 1.5 million pounds were harvested.<sup>6</sup> Table 1 presents time-series data on the industry. Normally it takes a pistachio tree 7-8 years to mature before it produces an economically significant crop, and 12-15 years to reach full potential (CALIFORNIA PISTACHIO COMMISSION, 2002). The longer-term trends have shown steadily growing acreage, yields, quantity, and value of production, and corresponding downward trends in prices, with important fluctuations around those trends. The growth in area and production has been steady for the past

22 years and is expected to continue, with non-bearing acreage having reached 23 000 acres in 2002 (CALIFORNIA AGRICULTURAL STATISTICAL SERVICE, 2002). The trend for the past 22 years in price per pound (even in nominal terms) has trended gradually downward from the high in 1980 of \$2.05 a pound to \$1.11 per pound in 2002. We have also seen steady growth in California exports as a share of world trade and California exports as a share of production.

## 7. The new marketing order for California pistachios

In order to establish a marketing order, an industry must first submit a preliminary proposal to USDA that indicates the degree of industry support and the problem the program would address. Next, if the preliminary proposal is accepted, USDA conducts a hearing at which opponents, proponents and others are allowed to testify. The proponent group bears the burden of proof of positive benefits to the industry and consumers. In addition, for a positive ruling,

the hearing record must generally include evidence that the proposed marketing order will not disadvantage small businesses and generally has widespread support. Based on the evidence from the hearing, the USDA issues a recommended decision and then, after allowing time for comment, a positive final decision by USDA allows the proposed order to be put to a grower referendum. Finally, at least two-thirds of the growers voting by number or by volume represented must approve the proposal before the Secretary of Agriculture can issue the marketing order.

The pistachio industry spent several years preparing to submit its marketing order proposal and was successful in making its case to the USDA. In July of 2002, hearings were held in Fresno, California on a proposal to establish a federal marketing order for pistachios grown in

California. The hearing included economic testimony based on analysis by SUMNER, which supported the argument that the order would benefit producers and consumers and not burden small businesses (2002). After the hearing, the proposed order was recommended by the USDA-AMS and released for comment in 2003 and grower vote in 2004. On March 1, 2004, the USDA-AMS reported that valid ballots representing 338 California pistachio producers were cast. Of those voting in the referendum, 90.8% favored establishing the order (these voters represented 90% of the total volume of production voted in the referendum). Overall the process took more than three years from the beginning of active preparation to approval.<sup>7</sup> Producers are required to

**Table 1. Data on California pistachio area, production, yield, and value, 1980-2002**

Year	Bearing (acres)	Non-bearing (acres)	Production (mil lbs)	Yield (lbs/acre)	Value (mil \$)	Avg Return (\$/lbs)
1980	25,773	8,989	27.2	1,055	55.8	2.05
1985	32,332	18,739	27.3	838	36.6	1.37
1990	53,700	11,100	117.3	2,375	129.6	1.02
1991	55,700	13,300	76.4	1,465	100.7	1.25
1992	56,500	13,900	146.5	2,592	150.9	1.03
1993	57,000	15,700	150.9	2,648	161.5	1.07
1994	57,507	16,633	128.3	2,232	118.1	0.92
1995	60,300	13,400	147.7	2,449	160.9	1.09
1996	64,300	17,100	104.3	1,622	121.0	1.16
1997	65,373	17,062	179.5	2,746	202.9	1.13
1998	68,000	19,300	187.5	2,757	193.1	1.03
1999	71,000	21,000	122.4	1,724	162.8	1.33
2000	74,578	21,730	241.6	3,239	239.2	1.01
2001	78,000	23,500	160.3	2,055	166.7	1.01
2002	83,000	23,000	302.4	3,644	335.7	1.11

Source: CALIFORNIA AGRICULTURAL STATISTICAL SERVICE (2002); CALIFORNIA PISTACHIO COMMISSION (2002)

of de facto price discrimination associated with grade standards in the California prune industry.

<sup>4</sup> Iran's exports peaked in 1996 when it exported 308 million pounds of pistachios, but fell to 127 million pounds in 1997, when Iranian pistachios were banned in the European Union because of aflatoxins. Iranian exports returned gradually to near pre-ban levels in the following few years.

<sup>5</sup> In 2000, Arizona had 2,700 acres and produced 4 million pounds of pistachios, just 1.5% of national production in that year (AASS, 2003), and too small to have significant impacts on the national market for pistachios. New Mexico had 391 acres of pistachios in 1999, less than half a percent of total acreage (NEW MEXICO AGRICULTURAL STATISTICS, 2003).

<sup>6</sup> Pistachios exhibit alternate bearing with low yields tending to follow high yields, thus 2001 was a relatively low-yield, low-production year. The yield cycle is an important factor in quantity produced, price received, total value of the crop, and gross revenue per bearing acre.

<sup>7</sup> The order was scheduled to become effective on August 1, 2004. Upon a request of the California pistachio industry, the USDA-AMS moved the implementation date for the regulations to Feb. 1, 2005.

conduct a referendum every six years to ascertain continuance of the marketing order. The marketing order will be eliminated if the provisions are not favored by a two thirds majority of voting producers or a two thirds majority of volume represented.

Under the new pistachio marketing order no handler may ship for domestic human consumption pistachios that exceed an aflatoxin level of 15 parts per billion (ppb).<sup>8</sup> The marketing order further outlines the procedures for aflatoxin testing necessary to obtain an aflatoxin inspection certificate. The aim is to be able to trace every certified lot of an individual handler from testing through to shipment (FEDERAL REGISTER, 2004). The marketing order imposes similar testing and certification requirements to ensure the quality of the product through maximum defect levels and minimum size levels.

Maximum aflatoxin standards, inspection and certification have a food-safety role, as well as an industry collective good element, because aflatoxin is a serious, and in some cases, deadly poison. However, the standards proposed by the marketing order are in addition to and tighter than those the U.S. government already has in place for food safety. 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 based on adverse publicity associating aflatoxin with pistachios. Negative consequences could result from three channels: a) negative perceptions among final consumers resulting in them choosing not to purchase products; b) negative perceptions among market middlemen such as retailers resulting in them choosing not to stock a product that might be subject to recall or lawsuits; or c) from governments choosing not to allow products to be sold because of heightened concerns over food safety.

Two characteristics of the pistachio market make the industry-wide collective good concerns particularly important in the context of food safety assurances and quality standards. First, as with many fresh fruits and nuts, there is little if any 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 have only begun to consume pistachios recently. They 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.

The result of this reasoning is that the pistachio industry had 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.

## 8. Model

In GRAY et al. (2004) we provide details on a multi-period stochastic simulation model of the pistachios market. Although there is not space in the present article to provide details on the model itself we can suggest the essence of the relationships using a simple static representation of how the supply and demand functions are affected by the marketing order.

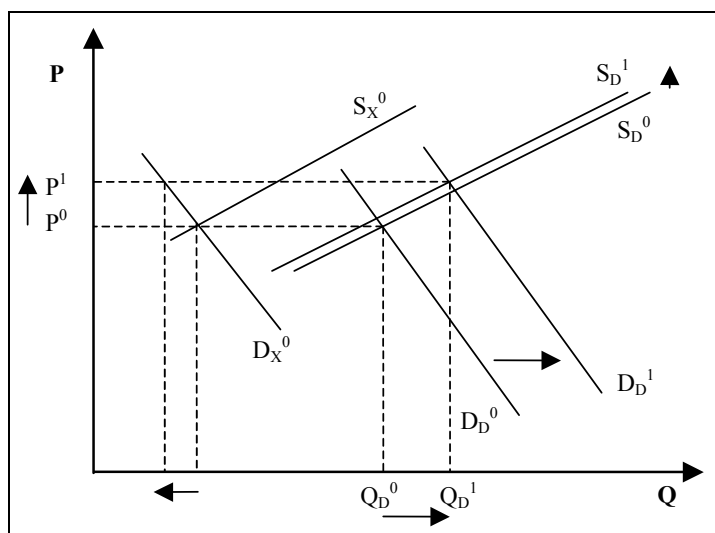
In figure 2,  $S_D$  represents the supply of US pistachios to the domestic market. Marginal cost rises from  $S_D^0$  to  $S_D^1$  because of the required testing under the marketing orders. Domestic demand shifts out from  $D_D^0$  to  $D_D^1$  to reflect the reduced likelihood of a food safety event, the improved quality and improved consumer confidence from USDA certification. Note that export supply  $S_X^0$  and export demand  $D_X^0$  do not shift because new rules do not apply. The figure is not drawn to scale and sizes of shifts are exaggerated to be visible. Furthermore, total demand and total supply are not shown to avoid clutter.

The figure does not deal with supply dynamics, storage demand and the impact of the marketing order on export demand. Nor does it give a sense of the complex price and quantity dynamics that follow from stochastic demand shocks, perennial crop supply response and alternate bearing. All these issues are dealt with in the full simulation model.

The GRAY et al. (2004) model is used to simulate the markets of California pistachios and project prices, quantities and welfare aggregates of pistachios for 50 years into the future, beginning in the year 2000. Yields vary over time to reflect trends, alternate bearing and random influences. Aflatoxin events also occur at random. 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, the model is used to simulate the outcomes for economic variables in the industry with or without the marketing order in place. The effects of the marketing order on measures of interest are determined by considering 100 draws of future time paths of yields for expected values and the range of outcomes (or other measures of variability).

<sup>8</sup> This is a tighter standard than the current maximum allowed by the U.S. Food and Drug Administration (FDA) of 20 ppb. The marketing order applies to pistachios shipped to the domestic market only, but often processors already tested the pistachios destined for exports, because international standards are stricter than in the United States. The maximum level for pistachios shipped to the European Union, for example, is 4 ppb.

**Figure 2.** Simplified illustration of the supply and demand relationships in the market for US pistachios under the marketing order



Source: author

Equations representing the domestic and export demands for pistachios and storage demand are specified using estimates of elasticities and data on market shares, quantities and prices. The proposed marketing order affects the demand for pistachios by reducing the probability of an aflatoxin event and the severity of the demand response to a given event, as well as by providing higher average quality to the market and USDA certification about these improvements. The introduction of the marketing order also affects producer and processor costs. These additional costs relate mainly to aflatoxin testing and meeting quality standards. To pay for itself, the marketing order must generate a demand response sufficient to offset the added costs.

Simulation results, discussed next, illustrate the orders of magnitude of the impacts under a range of parameter values. These give a quantitative sense of the relationships.

## 9. Simulated impacts of the pistachio marketing order

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 2. 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 100 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, which is affected by the marketing order. It is important to keep this time path and the random nature of the variables in mind.

Table 2 provides one set of parameters under which the marketing order reduces the annual probability of an aflatoxin event from 4% to 2%, and reduces the demand impact of such an event by half from an initial drop of 30% in demand to 15%. In addition, in the case presented in table 2, the marketing order increases domestic consumer willingness to pay for pistachios by 1 cent per pound to reflect additional confidence and improved quality. The cost of compliance with the marketing order, 0.525 cents per pound consumed domestically, is reflected as an increased cost for domestic sales. The cost data are based on detailed surveys of growers and industry information on specific costs of individual components of the newly required procedures (SUMNER, 2002). We have much less information on the demand parameters. The values shown were derived from consideration of other recent foodborne illness events and the responses of pistachio demand to the European aflatoxin finding in pistachios. In addition,

we considered aspects of the pistachio demand discussed above. Considerable sensitivity testing of results was conducted to reflect the potential range of values for these demand parameters.

**Table 2.** Key parameters for the simulation model

Parameter	Baseline Value
<b>Underlying market conditions</b>	
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
<b>Impact parameters without a marketing order</b>	
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
<b>Impact parameters with a marketing order</b>	
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

Source: authors' compilation

Table 3 reports the impacts of the marketing order in the first column of numbers. 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 (0.6%), along with the average number of bearing acres (1.3%) and production



(1.5%). These increases in production are associated generally with increases in domestic consumption (2.8%) and in exports (0.2%) and decreases in stocks (0.3%). These averages mask the fact that, as noted above, the effects on some of these variables change over time (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.

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 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). In present value terms, we found that 15% of the cost was borne by growers, 85% by domestic and foreign consumers combined, and 95% 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. Conventional benefit-cost ratios (B/C) are as follows: domestic producers (13.5), the United States as whole (6.9) and the world as a whole (6.7).

Simulations of high impact and low impact scenarios are reported in the second and the third columns of numbers in table 3. For the high-impact scenario we altered most of the parameters of the model by 10% in the direction that would increase the impact of the policy; for the low-impact scenario we altered the parameters by 10% in the opposite direction. These scenarios reveal how the results would be affected by a modest but consistent upward or downward bias in parameter values. As shown at the bottom of the table the combined effect of the parameter changes creates a larger than 10% variation in the estimated impacts of the marketing order. Compared with a benefit-cost ratio for producers of 13.5 in the base scenario, the ratio is 20.8 in the high-impact scenario and 9.6 in the low-impact scenario. Similarly for the United States as a whole, the ratio is 10.2 in the high-impact scenario and 3.8 in the low-impact

scenario. Nevertheless, 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.

**Table 3. Simulation results: benefit cost analysis of the pistachio marketing order**

Consequences of the marketing order	Baseline	High impact	Low impact
<b>Average of annual values, 2000-2050, induced changes in</b>			
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
<b>Present values in year 2000, net benefits, \$million</b>			
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
<b>Present values in year 2003, costs of marketing order, \$million</b>			
Cost of compliance (CC)	36.7	34.9	38.4
<b>Benefit-cost ratios</b>			
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

Source: authors' calculations based on simulation results

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.<sup>9</sup> 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.<sup>10</sup>

<sup>9</sup> 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.

<sup>10</sup> 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 “con-

sumer” 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 quantity of exports, undiscounted, is slightly positive.

## 10. Conclusion

Food scares can damage the health of consumers. Depending on the nature of the scare and the affected product, consumer trust in the product and demand for the product both fall affecting producer and consumer well-being.

Governments regulate food production and marketing by imposing standards and inspection requirements. Industries also undertake voluntary actions, which determine standards or similar measures for a product. However, such voluntary industry actions and agreements between market participants face free-rider problems. Individual members of an industry often have the private incentive to invest less in safety testing and quality assurance than would be optimal from the view of the whole market. One response to this free-rider problem is collective industry action under a government mandate in the form of a marketing order.

A useful example of such collective action is the newly introduced marketing order for California pistachios. An aflatoxin-related food safety event could impose serious costs on the pistachio industry. The marketing order is intended to reduce the odds of an event, mitigate the consequences if an event should occur, provide some quality assurance to buyers, and 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 in 2004. Our approach uses a stochastic dynamic simulation of the industry under scenarios with and without the 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.

Assessing the implications of the marketing order requires 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 median 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 total benefits (\$165.4 million) would accrue to domestic consumers. These are significant values, and are large relative to the costs of compliance with the program.

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