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Factors Affecting the Export Demand for U.S. Pistachios

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Abstract

This study evaluates the U.S. role in world production and trade of pistachios and identifies major factors affecting export demand for U.S. pistachios. We incorporate 21 major markets accounting for 78 percent of total U.S. pistachio exports. The impacts of market conditions and the effects of food safety shocks are investigated. The results indicate U.S. pistachio producers should take advantage of their advanced technology and reputation for higher food safety standards to enhance international market share. Necessary ingredients for a successful marketing strategy include compliance with marketing order regulations, improved food safety, and product diversification.

Keywords: export demand, food safety, marketing orders, pistachio nuts

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Introduction

Due to high levels of aflatoxin, the European Union (EU) rejected a large pistachio shipment from Iran in September 1997, then the world's largest producer and exporter of pistachios. Since this incident, European countries have shifted their original importing source for pistachios from Iran to the United States (U.S.), which has created a large market for U.S. growers. This food safety incident caused catastrophic and long-lasting effects on pistachio markets. Iran's pistachio export market share stopped growing after the incident and has fluctuated around 150,000 metric tons (Figure 1).

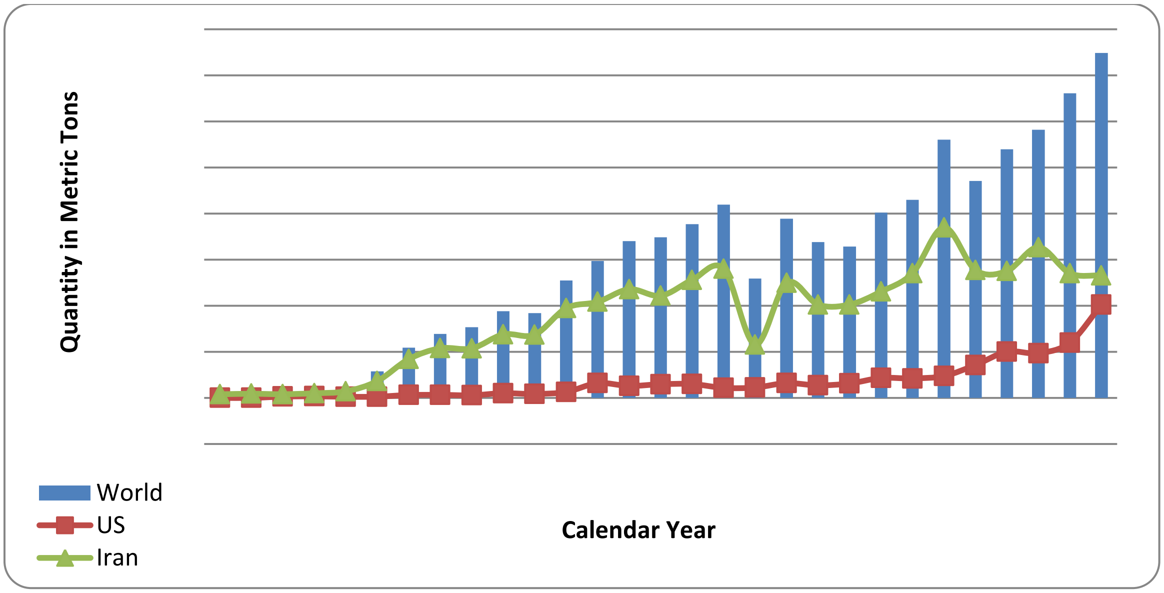

Figure 1. The U.S., Iran, and World Pistachio Exports in Quantity, 1980-2009.
Source. FAO TradeSTAT

This incident highlights the significance of food safety in international trade – food scares can radically change the competitive environment. It certainly changed the world pistachio export market situation. As shown in Figure 1, the U.S. has experienced a much faster growth rate in pistachio exports since the incident and has been catching up with Iran from 1998 to 2008. Yet there are many confounding factors that are important in this U.S. export growth. This research investigates the factors that have affected the U.S. pistachio industry's growth.

As Iran's major competitor in the world pistachio export market, it is important for the U.S. industry to understand the factors that cause it to maintain or increase its global export share for pistachios. As a result, a comprehensive econometric model is established including variables such as U.S. pistachio export price, Iran's pistachio export price, foreign markets' GDP, the real exchange rate between foreign currencies and the U.S. dollar, U.S. export prices of substitutes (almonds, walnuts, and pecans,) and two indicator variables specifying the impact of food safety shocks. Data for the 21 major exporting destinations, which together account for 78 percent of the total U.S. pistachio exports, are used in the analysis.

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The next section presents background information on the U.S. pistachio industry, including production, exports and food safety considerations. The third section provides a discussion of current food safety issues, a description of each food safety incident that occurred during the studied period, and an explanation of the role of pistachio marketing orders. Then the analytical framework used to estimate the effects of selected variables on U.S. pistachio exports is presented. This is followed by empirical results and elasticity analysis. The paper ends with conclusions, agribusiness and marketing implications, limitations and suggestions for future studies.

Back ground

According to the United States Department of Agriculture (USDA), approximately 98% of U.S. pistachios are produced in California; other states producing pistachios include Arizona, Nevada, New Mexico and Texas. According to Food and Agricultural Organization (FAO) Production Indices, the top four world pistachio producers in 2008 were Iran at 192,269 metric tons (mt) (35% of the world's production), the U.S. at 126,100 mt (23%), Turkey at 120,113 mt (22%), and Syria at 52,600 mt (9.6%). Figure 2 shows the dominant position of Iran and the U.S. in world pistachio production. As shown, the production growth rate slowed in Iran after 1997, while the U.S. experienced faster growth.

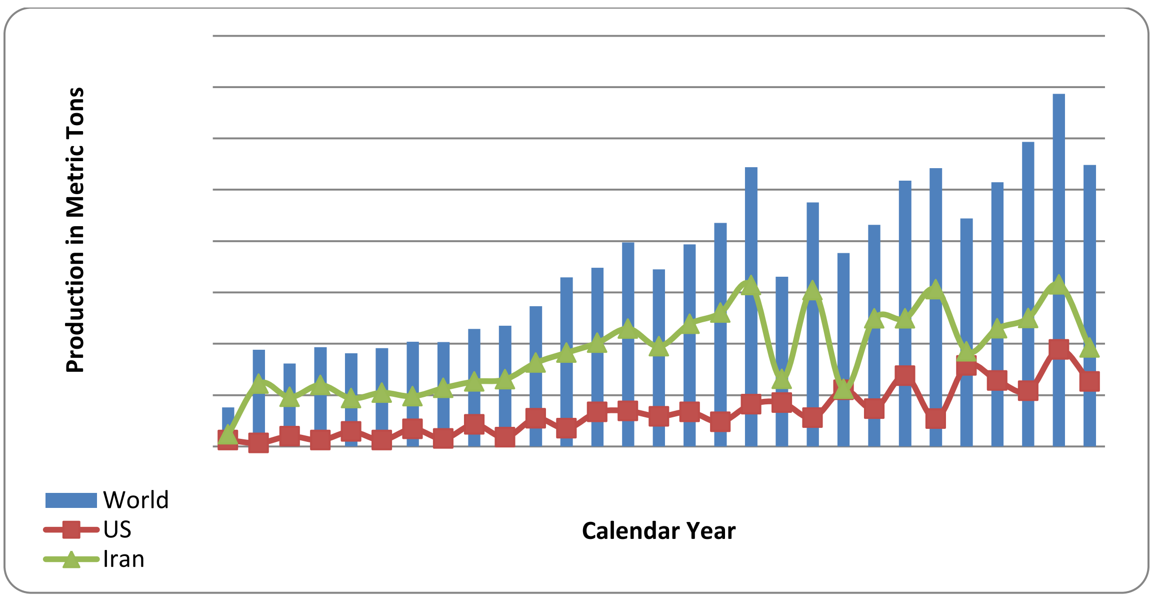

Figure 2. Iran, the U.S., and World Pistachio Production Situation, 1980-2008.
Source. FAO Production Indices

Iran has a much larger pistachio harvested area than the U.S. because of its desirable climate and long history of pistachio production. Pistachio harvested area in Iran has been steady over the decade. Virtually all the commercially produced pistachios in the U.S. are grown in California (USDA). Although having great advantages in harvested area, the yield in Iran has declined over time, whereas yield in the U.S. has been increasing. The U.S. has been making much better use of its existing harvested area by adopting advanced technology and more skilled labor, and its production has been catching up with Iran, especially in recent years.

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Alternate Bearing

There are significant variations in production of pistachios every year. Pistachios like many tree nuts, suffer from 'alternate bearing,' which means if there is a large crop in one year, there will be a smaller crop the following year. In order to stabilize the price, the U.S. established a marketing order that holds a reserve pool to compensate for shortages in the "off" years. Jolly and Norris (1992) modeled this by simulating U.S. pistachio prices using a simple linear regression model to estimate the relationship between production and bearing acres. Their results showed the effect of bearing acreage on production is highly significant. This implies the importance of proactive management such as pistachio carryover stocks in "on" years in order to counter the "off" years' effects on price variations.

Pistachio Shell Splitting

Most of the time, pistachio shells split naturally just prior to harvest with the hull covering the intact nut, protecting the kernel from invasion by molds and insects until harvest. For nuts with poor hull protection in the orchard, contamination is much more likely to occur. However, "early splits" can happen, resulting in the splitting of both the hull and the shell. Approximately one to five percent of the nuts are early splits. Sommer, Buchanan and Fortlage (1986) and Doster and Michailides (1995) examined the effects of early splits and found that about 20 percent of early splits were contaminated with aflatoxin, while the rate was zero percent in nuts with intact hulls. Aflatoxin and insect contamination caused by early splitting have posed a great danger to consumer health and it is very difficult to detect when nuts have become contaminated by early splits.

Furthermore, early split nuts not infected in the orchard could still become contaminated during processing, transportation, and storage if the environment is humid and warm. Late harvesting, bird damage and cracking may also cause hull rupture. The navel orange worm (NOW) sometimes damages the hulls of nuts and can cause aflatoxin contamination. Fortunately, NOW-infected nuts are easy to prevent and they can be eliminated by hand sorting. Hence, the timing of splitting is of great importance in pistachio production. On one hand, early splits increase the risk of aflatoxin contamination; yet late splitting leads to market discounts because of the extra cost incurred when opening the shells mechanically. This shows the importance of timing the shell splitting in order to minimize aflatoxin contamination and to maximize the market value of the nuts. For U.S. tree nut production, the total loss in sales to aflatoxin contamination averages up to $50 million per year and is much higher in years with greater insect damage (Cardwell et al. 2001).

Improved timing of pistachio shell splitting requires future research by biologists and agricultural engineers. Before harvest, 'early splits' caused by insect damage is an important factor leading to aflatoxin contamination. As a result, developing better insect control in pistachio orchards has become more and more important because of the increased resistance to pesticides (Varela et al., 1993). After harvest, sorting will greatly reduce the aflatoxin counts in pistachios. Campbell et al. (2003) documented the major sorting steps. They are (in order): "trash removal, water flotation to segregate empty-shell and immature nuts, hull removal, drying to 5-6% water content, sorting to remove closed-shell (again somewhat immature) nuts, electronic color sorting to seg-

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regate and remove stained shell nuts and, if required, hand sorting to complete the electronic process and also remove nuts with visible insect damage. Finally, nuts are size sorted." P. 251.

U.S. Pistachio Consumption and Exports

U.S. exports are not significantly affected by these production dips because of the reserve pool held by the marketing order to mitigate price swings, and have been growing steadily. Also, consumption in the U.S. used to be relatively low, but it has been growing progressively over time as production has gone up. Per capita consumption of pistachios reached 0.23 pounds in 2007 (Economic and Research Service, ERS). Moreover, nutritional research has helped increase the consumption of tree nuts as people are pursuing healthier diets. Karim and Vardan (2003) documented a long term study showing that consuming nuts at least five times a week reduces the risk of heart disease. U.S. pistachio production, consumption, and export from 1989 to 2008 are presented in Figure 3. The data shows that domestic consumption while growing over time, has slowed in recent years, and in contrast exports have gone up sharply, suggesting export expansion has moved the inventory resulting from increased production.

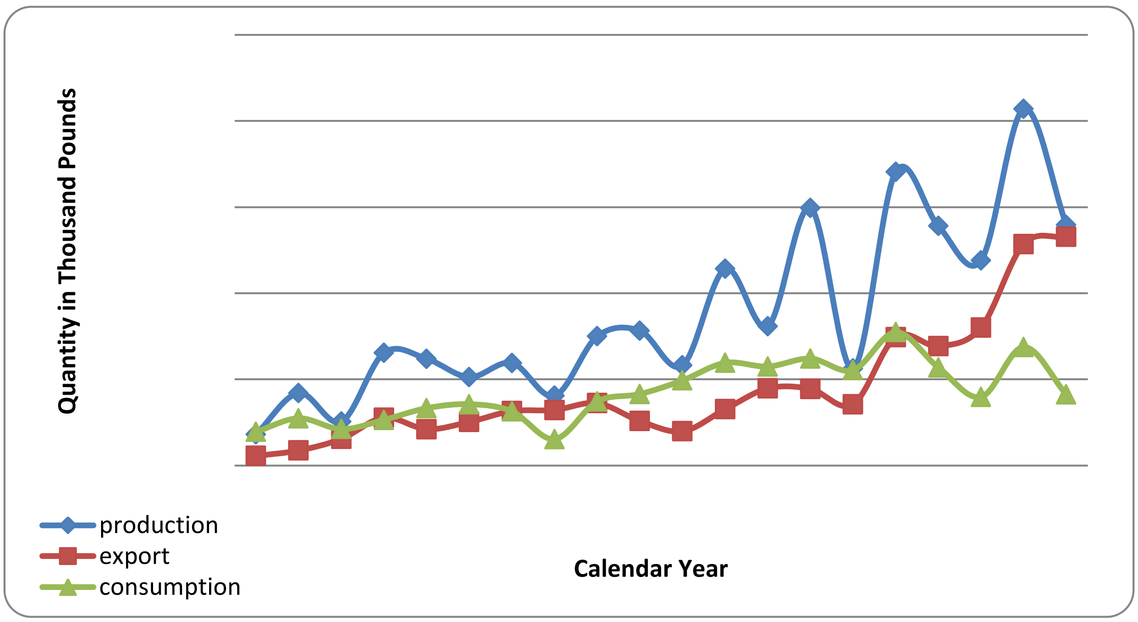

Figure 3. U.S. Pistachio Production, Export, and Consumption, 1980-2008.
Source. USDA

The food safety scare pulled U.S. producers into the world market and they have been increasingly successful because of higher production levels. In the 1980s, Iran dominated world pistachio exports, while export growth in the U.S. was progressive and slow. However, the market situation experienced a dramatic change in the 1990s, when Iran's exports were stagnant and U.S. exports began to catch up with Iran, especially in 1998, a year after the Iranian aflatoxin incident. Politics might have also contributed to this shift. In the 1980s and 1990s the U.S. banned importation of Iranian pistachios twice, once in 1979-1981 during the hostage crisis, and another time in 1987-2000 during the Iran-Iraq war. Also, a ban was imposed on importation of

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Iranian pistachios into the U.S. in 2010, which increased U.S. domestic market share significantly. According to the Western Pistachio Association (WPA), on the average 262,000 pounds of Iranian pistachios have entered into the U.S. each year since 2000 and this increased to almost a million pounds during the 2009-2010 period. They argue that the recent U.S. ban on Iranian pistachios has little impact on their pistachio pricing. However, the trade embargo has prevented market access for the U.S.'s major competitor, Iran, and has left the whole U.S. pistachio market, worth $700 million, to domestic pistachio growers, which benefits domestic pistachio farmers and processors. The trade embargo can create opportunities for rent seeking, and influence the commodity terms of trade in the international markets. This policy can have welfare implications and affect both consumer and producer surplus. Currently, one billion pounds of pistachios are sold globally with 35 percent of U.S. pistachio production (about 130 million pounds) sold domestically and 65 percent exported (WPA).

The EU's shift from Iran to the U.S. as their primary importing source of pistachios created a large export market regulated by stricter aflatoxin standards. European countries, including Belgium, Luxembourg, Netherlands, Germany, France, Spain, Italy, and United Kingdom, account for a large proportion of total U.S. exports. The maximum allowable concentration of aflatoxin set by U.S. Food and Drug Administration is 20 parts per billion (ppb), but European markets usually reject shipments with concentrations of 4 to 15 ppb according to their new community regulation on aflatoxin levels. This shift to stricter standards explains the main reason for the change in U.S. and Iran's market share in the world pistachio trade. According to Campbell et al. (2003), "The low thresholds for aflatoxin contamination have significantly increased the probability for rejection of tree nut shipments by the major importing nations of the EU and Japan." Figure 4 shows the dramatic increases in U.S. exports to EU countries, especially in the last decade, using ten year intervals.

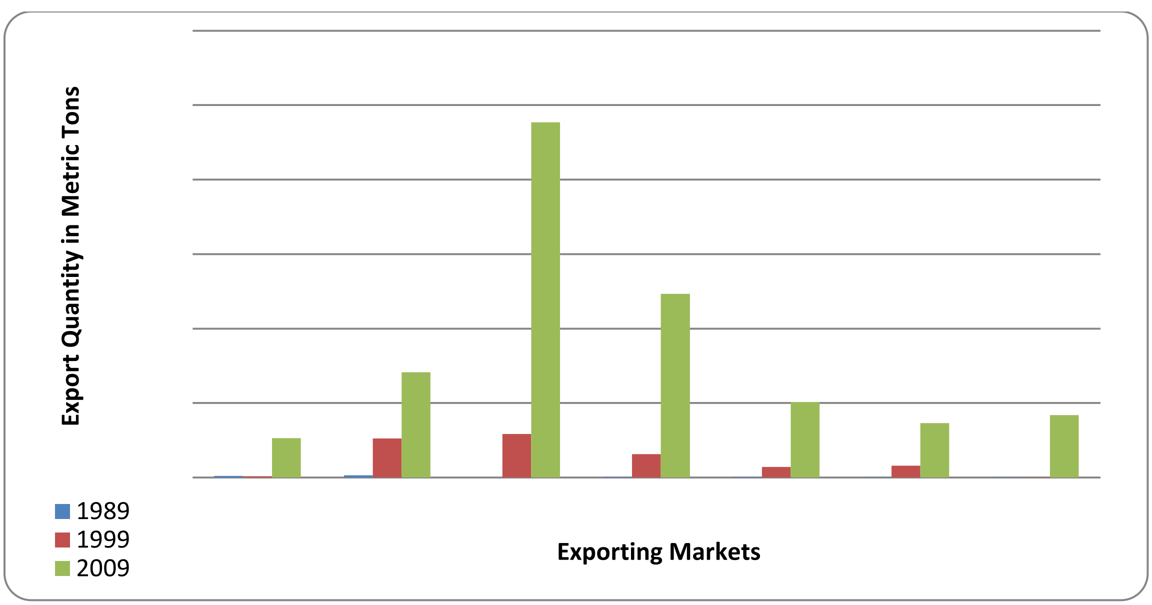

Figure 4. Percentage Growth of Export Share in European Markets, 1989, 1999, and 2009.
Source. USDA-ERS-GATS

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Food Safety Events in International Pistachio Markets

Food safety has received more and more attention by industries, consumers, and policy makers in recent years. As mentioned by Buzby et al. (2008), food safety concerns may have far-reaching implications such as reduced demands, altered international trading patterns, and limited access to foreign markets for the rejected products. As transportation infrastructure and marketing networks develop, as well as per capita income and consumer demand increase, international food trade is expanding along with the pace of globalization (Buzby et al. 2008). The globalization of the food supply chain can spread food safety risks to a much wider geographic area. The most far-reaching food safety concern for pistachio consumption originated from the 1997 Iran aflatoxin contamination. Iran's production share fell from 53.7% in the 1980s to 44.6% after 2000; their export share fell from 64.3% in the 1980s to 54.5% since 2000. In contrast, the U.S. experienced a steady growth in production share from 11.0% in the 1980s to 23.5% after 2000; U.S. export share increased from 6.8% in the 1980s to 14.9% after 2000. The change due to the food safety incident in Iran caused significant market share loss for Iran and gains for the U.S. Figure 5 and Table 1 illustrate the change in both production and export market shares of Iran and the U.S. in the last three decades.

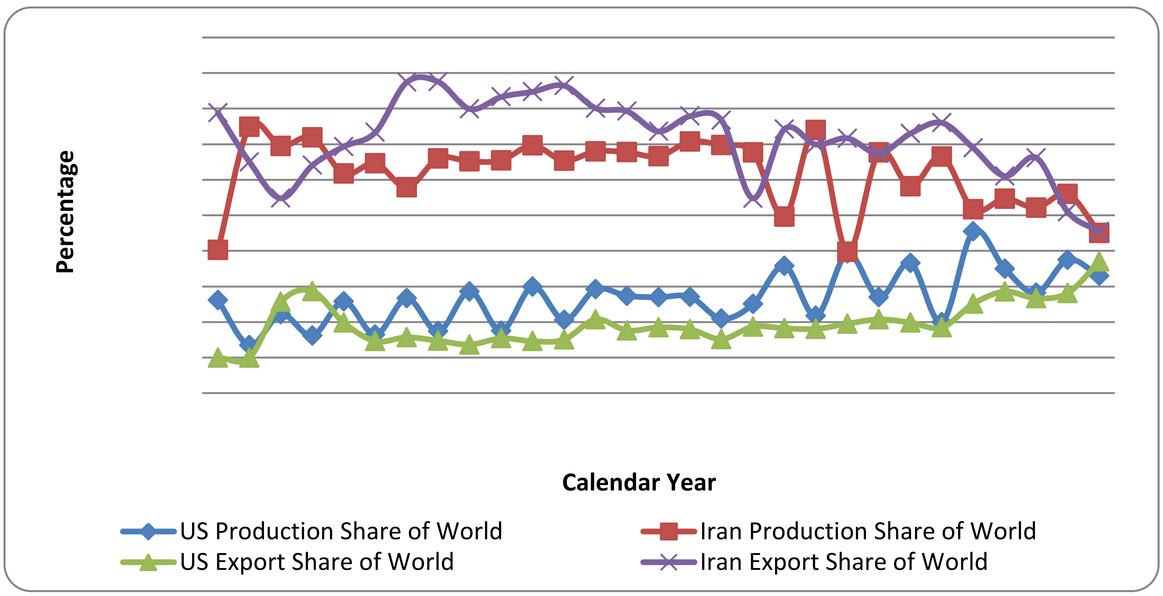

Figure 5: Production and Export Shares for Iran and the U.S., 1980-2009.
Data Source. FAO Production Indices and TradeSTAT

Table 1. World Production and Export Share for the U.S. and Iran, 1980-2009.

Country	Production Share in 80s	Production Share in 90s	Production Share after 2000	Export Share in 80s	Export Share in 90s	Export Share after 2000
Iran	53.7%	56.9%	44.6%	64.3%	65.8%	54.5%
US	11.0%	16.5%	23.5%	6.8%	7.5%	14.9%

Source. FAO Production Indices and TradeSTAT

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The first EU ban on Iranian pistachio imports in September 1997 was lifted in December when Tehran assured customers that it would improve food safety inspections and product quality. However, EU import demand for Iranian pistachios was affected for a much longer period. According to FAO TradeSTAT, exports to EU countries dropped from 102,698 mt in 1997 to 59,619 mt in 1998. This was the first of many food scares for pistachios. According to a South Korean newspaper, Thrifty Payless Ice Cream was discovered to have potentially dangerous bacteria contamination in November 1997. The six contaminated flavors include Pistachio Nut, Medieval Madness, Chocolate Chip, Cookies and Cream, Strawberry, and Strawberry Cheese. In 1999, a German inspection group reported that eight out of eleven sampled pistachios from supermarkets contained higher than allowable aflatoxin levels and that the highest levels were found in California pistachios. In 2000, several articles were published in Germany's *Der Spiegel* and *Sueddeutsche Zeitung* as well as regional newspapers reporting discoveries of high aflatoxin levels in pistachio ice creams. Surveys indicated the continued reoccurrence of high levels of aflatoxins worldwide. For example, pistachios were recalled in Australia, Japan and France due to high levels of aflatoxin later that year.

In September 2007, a shipment of pistachios from the U.S. was rejected by China because it contained ants. In August 2008, a U.S. newspaper reported that "popcorn, pistachios, Tic Tacs, and Skittles are the latest threat to local children". In March 2009, Kraft recalled its Nature Nantucket Blend trail mix, which contained pistachios that might have been tainted with salmonella. As mentioned earlier, the effects of each food safety incident differ from case to case. The 1997 aflatoxin event in Iran and South Korea led to disastrous and long-lasting consequences; while the other incidents, which were discovered quickly and solved right away, did not spread concerns among consumers. Although it is difficult to see direct correlation between food safety incidents and pistachio exports from the above figures because of confounding factors, it is of obvious importance to regulate food safety standards in order to prevent such disastrous food safety incidents from happening in the future. Table 2 provides an overview of the food safety incidents associated with pistachios in the studied period. The third column describes the location of the incident. The fourth column describes the severity of each event in terms of its effects on export quantity and price. The right column states the source of pistachios that are contaminated.

Table 2. Pistachio Food Safety Incidents

Year	# of Incidents	Country	Severity	Source of Pistachios
1997	2	Iran/S. Korea	High/High	Iran/US
1999	1	Germany	Low	US
2000	3	Australia/Japan/France	Low/Low/Low	US/US/US
2007	1	China	None	US
2008	1	US	None	US
2009	1	US	None	US

Source. Google News Timeline

In 1981, California pistachio producers formed the California Pistachio Commission (CPC) to provide support through government relations, marketing, and research funding with $0.035 per pound collected from pistachios produced in California. The timing of this event was important for expanding U.S. export markets. According to Alston, et al. (2005), the CPC has sponsored

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research on a wide variety of production challenges such as disease and insect control, methods of increasing production yields, and cultivar improvement. The CPC receives funding under the USDA's Market Access Program to promote pistachio exports to Japan, Korea, China, Malaysia, Philippines, Thailand, Canada, and the United Kingdom. Market Access Program funds to the pistachio industry averaged about one million dollars per year during the four years ending in 2009 (USDA, FAS). This funding has been important to U.S. pistachio promotional efforts.

Furthermore, the pistachio marketing order was established in August 2005 to enhance better product quality by setting a maximum aflatoxin tolerance level as well as inspections for defects and size. A federal marketing order is a collective action taken by an industry, with support of the federal government, to increase consumer demand, consumer confidence and producer returns by controlling quality standards through inspection and packing regulations, and investing in market promotion, research, and development. Marketing orders allow industries to regulate the product quantity available in the market through volume controls, which include production limitations, diversions of some products to reserve pools, and market allocation restrictions (Berke and Perloff 1985).

Analytical Framework and Data

Model Development

The behavior of both exporters and importers are addressed mainly in the international trade literature. Export demand estimation methods have been commonly used to investigate different agricultural commodities. For example, Eenoo, Peterson, and Purcell (2000) investigated economics of export demand for U.S. beef, Hussein (2009) examined structural changes in the export demand function for Indonesia, and Bahmani-Oskooee (1984), studied the determinants of international trade flows. The vast majority of the previous literature on commodity export models has focused on how the importing countries' income and exchange rate affect export demand. Senhadji and Montenegro (1999) used time series techniques to estimate the aggregate export demand elasticities for 53 developing and industrial countries and found a significant effect of the trading country's income and relative prices on export demand, especially in the long run. Cosar (2002) studied the price and income elasticities of Turkish aggregate export demand using cross sectional data and concluded that Turkish export demand is elastic with respect to foreign income but inelastic with respect to the real exchange rate in both the short run and the long run.

In 2005, Alston et al. developed a stochastic simulation model of supply and demand to assess the impact of the proposed federal marketing order for California pistachios. They estimated the effects of the marketing order over a 50 year period by comparing the two simulations of outcomes generated from economic indicators in the industry with and without the marketing order. The cost-benefit analysis showed that the measured benefits from the marketing order would greatly exceed the costs for producer compliance.

However, there is a lack of more comprehensive empirical research exploring effects of more factors on export demand variations for pistachios. This paper offers new evidence in explaining the variations of export demand for US pistachios. The export demand function used in this article takes the traditional form and includes all the variables typically included in such equations (Arize, 2001). Export demand is a simple linear regression relating U.S. pistachio exports to the

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effects of food safety shocks and several independent variables, including pistachio export price, the major competitor's export price (i.e., Iran), the average U.S. export price of substitute tree nuts (almonds, walnuts and pecans), importing country's GDP, and the real exchange rate between the country's currency and the U.S. dollar. As previously stressed, food safety shocks affect export demand by threatening consumer confidence; as a result, two indicator variables, one for Iran and the other for the U.S., are created to investigate the effects of such concerns. Hence, the model incorporates all the important variables mentioned in the literature, such as the effects of substitutes or complements, as well as food safety shocks.

Export demand specification is crucial for meaningful export forecast, international trade planning and policy formulation (Arize, 2001). The critical economic indicators affecting export demand are hypothesized to be own price, cross prices, importer's GDP, the real exchange rate, and food safety shocks (Bahmani-Oskooee, 1984; Peterson, and Purcell, 2000; Arize, 2001; and Hussein, 2009). Equation (1) specifies the export demand function for U.S. pistachios:

$$(1)\ \ln(Q_{i,t}) = \beta_0 + \beta_1 * \ln(EP_{i,t}) + \beta_2 * \ln(CEP_t) + \beta_3 * \ln(PNUTS_{i,t}) + \beta_4 * \ln(GDP_{i,t}) + \beta_5 * \ln(RER_{i,t}) + \beta_6 * FS1_t + \beta_7 * FS2_t + \varepsilon$$

The average price of other tree nuts is

$$(2)\ PNUTS = \frac{PA_{i,t}+PW_{i,t}+PP_{i,t}}{3}.$$

The real exchange rate is

$$(3)\ RER = \frac{P_d}{e*P_f},$$

where $e = \frac{F_c}{\$}$ or foreign currency per U.S. dollar

In equation (1), $Q_{i,t}$ is US exports of pistachios to country i in time t; $EP_{i,t}$ is U.S. pistachio export prices to country i in time t; CEP_t is Iran's pistachio export price in time t; $PNUTS_{i,t}$ is the U.S. average export price of other tree nuts to country i in time t. In equation (2), $PA_{i,t}$ is the U.S. almond export price to country i in time t; $PW_{i,t}$ is the U.S. walnut export price to country i in time t; $PP_{i,t}$ is the U.S. pecan export price to country i in time t; $GDP_{i,t}$ is GDP of country i in time t; $RER_{i,t}$ is the real exchange rate between country i's currency and the U.S. dollar in time t. In equation 3, P_d is the domestic price level in the importing countries; P_f is the price level in the U.S.; e is the nominal exchange rate, which is defined as the number of units of the domestic currency (F_c) that can purchase a unit of a given foreign currency ($);$FS1_t$ is a zero-one dummy variable, one for the food safety incident at the time of the event and zero otherwise, and identifies a food safety shock from Iran in time t, assuming the value of one for 1997; $FS2_t$ is also a zero-one dummy variable that identifies a food safety shock from the U.S. in time t, assuming the value of one for years 2007 through 2009.

The model utilizes a logarithmic functional form, which is more flexible and the coefficients are elasticities. Among all the variables, the competitor's export prices and food safety shocks are time variant but cross sectional invariant. All other variables are both time variant and cross sectional variant, making it a panel data set. The own price elasticity is expected to be negative; the

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cross price elasticity is expected to be positive; the Iranian export price is used as a proxy for all U.S. competitors and its coefficient is expected to be positive; the income elasticity is expected to be positive; the expected sign for RER is negative; and the food safety shock in Iran should positively influence exports, while the food safety shock in the US should negatively impact exports.

Data Description

Twenty-one major importing markets are selected as the studied sample: Canada, Mexico, Brazil, Venezuela, United Kingdom, Germany, Belgium and Luxembourg, Netherlands, France, Italy, Spain, Australia, Taiwan, Hong Kong, South Korea, Japan, Philippines, Singapore, the United Arab Emirates, Israel, and Egypt. Annual data for the studied variables are available from 1989 to 2009. Data for Iranian pistachio export values and quantities were collected from Food and Agriculture Organization (FAO) TradeSTAT. Data for the real exchange rates and GDPs were acquired from USDA and are in real U.S. dollars with 2005 as the base year. Data for export quantities and values for almonds, pecans, and walnuts to each country were from USDA General Agreement on Trade and Services (GATS) statistics. Total price and quantity values are the sum of all types of nuts, which are fresh/dry/shell, fresh/dry/no-shell, and preserved. Export prices are the average values calculated by dividing the total export values by the total export quantities. Data for food safety shocks were collected using Google News Timeline. All the variables were formatted as indexed values with year 2000 as the base. This makes each time series unit free and allows a closer comparison among countries with different prices and exchange rate units. (The descriptive statistics of the model variables are excluded from this article because of its large size, but it is available upon request.)

Empiricial Results

There are two types of models for panel data analysis: the fixed effects model and the random effects model. A Hausman test is used to determine the best fitting model with unbiased, consistent, and efficient estimators. The test determines whether there is a significant difference between the fixed and random effects estimators by testing the null hypothesis that the difference between the fixed and random effects is zero. A random effects estimator is more efficient than fixed effects estimator by saving degrees of freedom and correcting the composite errors. In the model the Hausman test is chi-square distributed with 6 degrees of freedom, which is the number of time-varying regressors. The test result generated by Data Analysis and Statistical Software (STATA) is chi-square (6) = 3.77 with p-value = 0.7077, indicating no evidence to reject the null hypothesis. Therefore, the random effects estimator is chosen. Moreover, the random effects estimator allows estimation of coefficients on time-invariant variables as well, so their effects are not eliminated. Although the random effects model has the above advantages, it should only be used when the Hausman test supports it.

Point Estimates

The results from the regression analysis are reported in table 3. U.S. pistachio export price and the real exchange rate have a statistically significant negative impact at the 1% level, as expected, whereas the average export price of other tree nuts and the importing regions' GDP are

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positive and significant at the 1% level. A food safety shock in Iran has a negative and significant impact at the 1% level, the food safety incident in Iran affected consumer confidence in consuming U.S. pistachios. Consumers must associate food safety problems from Iran to the rest of the world. Since Iran is the largest pistachio producer and exporter, it is understandable that consumers reduced their confidence in all pistachio products after the 1997 incident. The coefficient for various U.S. food safety shocks has an unexpected positive sign that is significantly different from zero, but its absolute value is less than one. This is an indication that the food safety incident was not severe in terms of its effects on U.S. export volume and prices. The results for Iran's pistachio export demand was consistent with a previous research indicating that pistachio food safety shocks had a negative and highly significant impact on Iran's pistachio export demand (Shahnoushi et al. 2011).

Of all the parameter estimates, only the price of other tree nuts is not significant. This indicates no apparent correlation between U.S. pistachio exports and the export price of other tree nuts. An increase in other tree nut prices will not encourage countries to import more pistachios. A depreciation of the US dollar (higher aggregate U.S. prices or lower aggregate importer prices) will lead to a higher real exchange rate and more pistachio exports.

Table 3. Parameter Estimates for the Overall Export Demand Function

Variable	**Parameter**	**Expected Signs**	**Estimate**	**95%LB**	**95%UB**
US Pistachio Export Prices	β_1	-	-1.786 **	-2.469	-1.102
Iran's Pistachio Export Prices	β_2	+	1. 353**	0.440	2.267
GDP's in importing countries	β_3	+	1.111**	0.359	1.863
Real Exchange Rate	β_4	-	-1.592**	-2.323	-0.862
Other Tree Nuts Export Prices	β_5	+/-	0.221	-0.089	0.531
Food Safety Shocks in Iran	β_6	+/-	-1.079**	-1.716	-0.443
Food Safety Shocks in the US	β_7	-	0.789**	0.474	1.104
Constant	β_0	n.a.	-0.651 **	-1.082	-0.220

Note. **: statistically significant at the one percent level; withinR^2: 26.94%; between R^2: 1.33%; Overall R^2: 17.67%; χ^2_6: 143.63, $p < .0001$.

As mentioned earlier, the model is a double log function so coefficients are elasticities. The own export price elasticity is -1.79, the cross price elasticity is 1.35, though it is not significantly different from zero. A 1% increase in foreign income increases exports by 1.11%, while a 1% increase in the real exchange rate will decrease exports by 1.59 % (which is close to the own price elasticity). All of these elasticities are greater than one, which indicates that US pistachio export demand is own-price elastic, cross-price elastic, income elastic, and real exchange rate elastic. These results are reasonable because pistachios are not a necessity and have plenty of substitutes in the market. Pistachios are more expensive than most tree nuts (see Table 4), so they are favored as consumer incomes grow. Finally, there is little brand identification with pistachios (Brunke et al., 2004) and there is competition among alternative suppliers, so one would expect demand to be elastic.

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Table 4. Tree Nut Retail Prices (in Dollars Per Ton)

Tree Nut	Price
Almond	3,500
Groundnut	450
Hazelnut	2,410
Pecans	4,600
Pistachio	4,440
Walnut	2,110

Source. National Agricultural Statistical Service (2010)

Summary and Management Implications

Estimation results show that pistachio's own-price and the real exchange rate between foreign currencies and the U.S. dollar have a negative effect on the amount demanded by international markets; the elasticities are estimated at -1.79 and -1.59, respectively. Foreign GDP and Iran's price are affecting the quantity demanded positively; their elasticities are estimated at 1.11 and 1.35, respectively. These results answer the first objective. The variable identifying Iranian food safety scares is negative, indicating the spillover effect of the 1997 food safety incident from Iran to the U.S. The food safety shock coefficient for the U.S. is positive, meaning food safety concerns benefit U.S. exports. It seems that the first scare from Iran, the largest pistachio producer and exporter, was the only incident that negatively affected U.S. pistachio exports. After that, other countries (particularly Europe) established stricter aflatoxin standards and the market became more confident in U.S. suppliers. Pistachios are more expensive than most tree nuts and they seem to be a luxury food item. The fact that EU countries consume more pistachios is in part due to their higher income levels (Karim and Vardan, 2003), and as incomes grow throughout the world, there should be more pistachio consumption. This increased consumption of pistachios will likely drive growth in the U.S. industry, increasing labor demand and employment.

The U.S. has been taking advantage of its modern technology in production and packaging, higher than average expertise in product marketing and advertising, and higher standards for food safety. These are the underlying factors that led to the U.S.'s success. However, compared to Iran, its biggest competitor with 45% of world production and 55% of world exports, both U.S. production and export shares are still lagging. Moreover, the variety of pistachio products in the U.S. market is limited. The most commonly seen products are salted/unsalted or shelled/unshelled. In contrast, there is a much wider variety of products in Iran -- for example, different shapes, flavors, colors, and packages . There is much scope for the U.S. industry to expand into high-valued processed pistachio products which will increase profits and exports. There are many roasted flavors in Iran, such as lemon juice sprinkled with salt, smoked, garlic onion, chili lemon and saffron flavors. The colors vary for decorative purposes from the natural color to red, orange, green and purple.

The added flavors and shell colors make the nuts much more fun to consume. The packages of Iranian pistachios are fancy and beautiful as well and they have become an art in the Iranian culture. Product shapes vary as well. Round, long, and jumbo Fandoghi (round) pistachios are the most widely available and account for 40% of all pistachio orchards in Iran. Kalleh Ghouchi

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(Jumbo) pistachios account for 20% and they have become popular among farmers because of high yields. Akbari (long) pistachios account for 15% and are the longest type of pistachio and the easiest to open. Aghaei (long) pistachios account for 12% with high yield rates, shorter times to maturity, and the whitest shells. These pistachio products are the second leading export item from Iran (after oil). In order for the U.S. to capture these higher valued international markets, growers should focus on market segmentation and product diversification as the next step. It may be difficult to develop different product shapes in a short period of time, but improving roasting techniques and expanding flavors, colors, and packaging choices are much easier, and there is great potential in the U.S. market for expanded pistachio sales. U.S. pistachio producers must understand consumer attitudes toward these various flavors and colors in light of health concerns and the demand for fresher, healthier, less processed products. Market segmentation and product diversification can help to satisfy different consumer demands and increase consumer and producer surplus.

Proper packaging is important to improve food safety. Improperly packaged pistachios can be contaminated during processing, transportation or storage. Therefore, safer packaging techniques and marketing management from farm to warehouse will reduce losses from unsafe products. The California pistachio marketing order, which was established in the mid-2000s, sets regulations for pistachio inspection and safety. It reduces the risk of aflatoxin contamination affecting pistachios. It provides quality assurance to domestic pistachio consumers and consumers in importing countries. These standards ensure higher quality pistachios and reduce the negative consequences of food safety concerns. Those factors indirectly affect the price of pistachios in international markets (Alston et al. 2005).

U.S. producers must continue to be vigilant about food safety. Pouliot and Summer (2008) show traceability improvement is a way to clarify liability in which the traceability system not only motivates suppliers to improve food safety, but also reduces liability. Hobbs (2004) also mentions that the traceability system "provides ex post information" that helps consumers and suppliers to specify allocation of liability and stimulates compliance with food safety regulations. Thus it is beneficial to consumers, marketers and farmers for policy makers to consider mandatory traceability. It is beneficial for firms and marketers because the system clarifies liability and stimulates firms to implement stricter food safety rules. It is beneficial for consumers because they can consume safer food and, in case of a food safety event, they will have much better chances of getting compensated, leading to improved consumer confidence.

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References

Alston, J. M., H. Brunk, R. S. Gray, D. A. Summer, and A. K. A. Acquaye. 2005. *Economic Consequences of Mandated Grading and Food Safety Assurance: Ex Ante Analysis of the Federal Marketing Order for California Pistachios.* University of California.

Amirtaimoori, S. and A. H. Chizari. 2007. The USA and Iran's Status in Pistachio Export: A Comparative Advantage and Specialization Approach. *American-Eurasian Journal Agricultural and Environment Science* 2(6):775-783.

Arize, A.C, 2001. Traditional Export Demand Relation and Parameter Instability. *Journal of Economic Studies* 28(6):378-396.

Bahmani-Oskooee, M. 1986. Determination of International Trade Flows. *Journal of Development Economics* 20:107-123.

Berck, P. and J. M. Perloff. 1985. A Dynamic Analysis of Marketing Orders, Voting, and Welfare. *American Journal of Agricultural Economics* 67: 487-96.

Brunke, H., J. M. Alston, R. S. Gray, and D. A. Sumner. 2004. Industry-Mandated Testing to Improve Food Safety: the New US Marketing Order for Pistachios. *German Journal of Agricultural Economics* 53: 334-43.

Buzby, C. J., L. J. Unnevehr and D. Roberts. 2008. *Food Safety and Imports: An Analysis of FDA Food-Related Import Refusal Reports.* Economic Information Bulletin No. 39, U.S. Department of Agriculture.

Campbell, B. C., R. J. Molyneux, and T. F. Schatzki. 2003. Current Research on Reducing Pre- and Post-harvest Aflatoxin Contamination of US Almond, Pistachio, and Walnut. Toxin Reviews. *Journal of Toxicology* 22(2 & 3): 225-66.

Cardwell, K. F., A. Desjardins, S. H. Henry, G. Munkvold, and J. M. Robens. 2001. "The Cost of Achieving Food Security and Food Quality."APS*net* Features. doi: 10.1094/APSnetFeature-2001-0901(accessed October 2011).

Cosar, E. E.. 2002. Price and Income Elasticities of Turkish Export Demand: A Panel Data Application. *Central Bank Review 2*: 19-53.

Doster, M. A.and T. J. Michailides. 1995. The Relationship Between Date of Hull Splitting and Decay of Pistachio Nuts by Aspergillus species. *Plant Disease* 79(8): 766-769.

Eenoo, E.V., E. Peterson, and W. Purcell. 2000. Impact of Exports on the U.S. Beef Industry. Paper presented at the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, Chicago, April 17-18.

Hausman, J. A. 1978. Specification Tests in Econometrics. *Econometrics* 46(6):1251–1271.

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Hobbs, J. E. 2004. Information Asymmetry and the Role of Traceability Systems. *Agribusiness 20*: 397-415.

Hussein, A. 2009. Structural Change in the Export Demand Function for Indonesia: Estimation, Analysis and Policy Implications. *Journal of Policy Marketing* 31: 260-271.

Jolly, A. D. and K. Norris. 1992. Models Simulate US Pistachio Prices. *California Agriculture*: 46(3):14.

Karim, K. MH and E. U. E. Vardan. 2003. Global Pistachio Production and Marketing Challenge. University of S and B, Iran (http://economics.ca/2003/papers/0460.pdf) (accessed in October 2011.

Pouliot, S. and D. A. Summer. 2008. Traceability, Liability, and Incentives for Food Safety and Quality. *American Journal of Agricultural Economics* 90(1): 15-27.

Senhadji, A. S. and C. E. Montenegro. 1999. Time Series Analysis of Export Demand Equations: A Cross-Country Analysis. IMF Staff Papers 46:3.

Shahnoushi, N., S. Saghaian, and N. Ashktorab. 2011. An Analysis of Aflatoxin Food Safety Concerns and other Factors Affecting Iran's Pistachio Exports to European Union and Japan. Presented at the 21th Annual World Forum and Symposium, International Food and Agribusiness Management Association (IFAMA), June 20-23, Frankfurt, Germany.

Sommer, N. F., J. R. Buchanan, and R. J. Fortlage. 1986. "Relation of Early Splitting and Tattering of Pistachio Nuts to Aflatoxin in the Orchard." *Phytopathology* 76(7): 692-694.

Western Pistachio Association, (http://www.westernpistachio.org/pdf/EmbargoQA.pdf) (accessed in March, 2012.)

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