Food Safety Concerns and other Factors Affecting Iran's Pistachio Exports to EU, Australia, and Japan

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ABSTRACT

In this paper, the impact of food safety concerns on Iran's pistachio export demand was investigated. Panel data and panel cointegration analyses were used to estimate the export demand function of Iran's pistachio nuts to the European Union (EU), Japan, and Australia for the period of 1997 to 2006 so that the relationship between factors affecting Iran's pistachio exports can be examined. The results show the existence of long-run relationships among the variables that have a significant impact on Iran's pistachio exports. The empirical results indicate that food safety shocks had a statistically significant negative impact on the import demand of those countries.

Keywords: food safety, pistachio, Iran's export demand, panel cointegration, EU countries, Japan, Australia
JEL classification: Q17, Q18, M38, F10

INTRODUCTION

The main exporters of pistachio nuts in the world are Iran, the US, Turkey, Syria, China, Greece, and Italy. Iran is known as a major producer of pistachio worldwide. Pistachio has a long history in the country, and pistachio nuts play a major role in Iran's non-oil exports. The country ranks first in the production of pistachio nuts in the world and generates significant revenues from these exports. Iran was the biggest exporter of pistachios in the world, having no serious rivals until 1982. In the 80s and 90s, the US gained a significant growth in pistachio exports and became Iran's largest rival.

Iran's pistachio nuts have three different markets. The first group includes high-income European countries, Japan, Australia, and Canada, countries that insist on healthy and high quality products. The second group, composed of Arabic countries, demands delicious taste and good shape. The third group, which includes East Asian countries, is more price-sensitive and demands low-priced pistachio nuts. Nowadays, most of Iran's pistachios are exported to Arabic countries and East Asia.

Pistachio exports accounted for the highest share of non-oil export revenue of Iran's gross domestic product (GDP) during the last two decades, and is valued at more than 1 billion US dollars (USD) in 2007 (Iranian Custom Organization 2007). While pistachio export expansion is supported by the government, exports have had a declining trend in terms of value, in both nominal and real prices, and volume since 1990 (FAO [Food and Agriculture Organization of the United Nations] 2007). This decline is mostly due to the discovery of high aflatoxin levels in pistachios and the emergence of new competitors in the international markets, such as the US Aflatoxin is a kind of toxin which splatters from a group of molds. The toxins produced remain on food products for a long time. Increasing levels of aflatoxin in food may have serious consequences on human and animal health. Aflatoxins are probably the most studied and generally known mycotoxins that were first noted in the early 1960s. They are a major food safety concern.

Food safety is an important factor that impacts public concern regarding products that can damage consumers' health, and can thus lead to a decrease in demand. In the last decade, aflatoxin levels have been a particular concern for Iran's pistachio exports intended for the European Union (EU) and Japan, as an increasing number of consignments have been rejected. High aflatoxin level threatens the health of consumers and can result in severe losses to producers. Governments often attempt to improve food safety by mandating standards and inspection of food products to supplement the efforts by private firms and industries. Following a brief 1997 ban on the exports to the EU, efforts have been made to improve the screening of export shipments to those countries. However, it appears that infection levels increase during shipments, and a particularly alarming number of containers have been rejected since 2003.

Another part of this declining trend in Iran's exports is attributed to emerging new producers and exporters. The emergence of the US and China in the pistachio world trade, for instance, has resulted in a decrease in Iran's world export market share. The US joined the exporter countries in 1982 and since then has become Iran's main rival and competitor in international markets.

The main objective of this study is to evaluate the factors affecting Iran's pistachio exports and investigate how food safety concerns have impacted Iran's export demand for pistachio nuts. First, non-stationary panel data analysis is applied to examine whether particular variables (export price, exchange rates, and gross domestic product) are stationary or integrated of order one, I(1). Second, panel data analysis based on cointegrating relationships is utilized. Finally, each variable's impact on Iran's export demand is evaluated.

LITERATURE REVIEW

Konandreas, Bushnell, and Green (1978) estimated export demand functions for US wheat. Their major finding indicates that exchange rate changes have had a substantial impact on US wheat exports. The results of this study suggest that US export demand for wheat is responsive to price and exchange rate changes, but a US policy on implementing price cuts to stimulate and increase commercial exports might be less effective than the estimates suggested by the paper. Meanwhile, Arize (2001) assessed the stability of export demand functions in Singapore over the period 1973–1997. The determinants of exports considered were (1) real world income, (2) export price, and (3) competitors' export price. The research found that cointegrating relationships existed even when structural changes were taken into account. It also found that the estimation of Singapore's export demand model required the inclusion of some dummy variables to achieve not only cointegration but also long-run parameter stability. Straub (2002), on the other hand, investigated the stability of export functions for the US, Canada, and Germany for the years 1975–2000. He used the vector error correction model due to the non-stationarity of the data and found that cointegrating relationships existed for each country. Lastly, Christopoulos and Tsionas (2004) investigated the long-run relationship between financial depth and economic growth. They used threshold cointegration tests, and dynamic panel data estimation for a panel-based vector error correction model. The long run relationship was estimated using fully modified ordinary least squares (OLS), a method used for estimating and testing hypotheses for cointegrating vectors in dynamic panels. Results showed that cointegrating relationships implied unidirectional causality from financial depth to growth.

Zheng, Saghaian, and Reed (2012) studied international pistachio markets. They investigated factors affecting the US pistachio exports and also evaluated the US role in the world production and trade of pistachios. They especially focused on the impact of market conditions and food safety shocks on pistachio export markets. Their results indicate that US pistachio producers' advanced technology and good reputation for higher food safety standards have helped improve their international market shares. Sherzeyi and Ghanbari (2000) analyzed the factors that affect pistachio demand and supply. The results showed that the demand and cost variables have a positive and meaningful effect on the supply and demand of pistachios.

Apergis and Payne (2009) employed a panel cointegration and error correction model to infer causality and examine the relationship between energy consumption and economic growth for six Central American countries over the period 1980–2004. Cointegration was present between real GDP, energy consumption, and labor force; real gross fixed capital formation with its respective coefficient was positive and statistically significant. The Granger-causality results indicated the presence of both short-run and long-run causality from energy consumption to economic growth which supported the growth hypothesis.

Hamori and Matsubayashi (2009) used panel data to empirically analyze the stability of the export functions of less developed countries (LDCs) for the period 1980–2004. They found that the use of panel data for the LDC countries supports a cointegrating relationship. Auteri and Costantini (2010) investigated the relationship between government spending and private consumption by panel cointegration method.

Results indicated Edgeworth substitutability between private and public spending. El Shazly (2013) analyzed the demand for electricity and provided out-of-sample forecasting at the sectoral level using a panel cointegration approach. The empirical model produced reliable ex-post forecast near the end of the full sample period.

In the next section, the model and econometric approach are described. The following section reports the empirical estimation results and a conclusion is then presented.

MODEL DEVELOPMENT AND DATA DESCRIPTION

Based on the literature reviewed, the demand for pistachio exports is treated as a function of gross domestic product of each importing country, exchange rates for export destinations, and relative prices of each country. Food safety is presented as a dummy variable:

$$EX_{it} = f(RP_{it}, GDP_{it}, EXR_{it}, FS)$$

where EX_{it} is real pistachio imports of each country from Iran, RP_{it} is the relative price (Iran export price that is different for each country divided by the US export price of pistachios. Both prices are expressed in dollars so the relative price is unit-free), GDP_{it} is gross domestic price, and EXR_{it} is the USD exchange rate (each country has a value relative to the USD and these exchange rates were used for each country). According to the literature, the reason for choosing the exchange rate variable is that in practice, imports are expected to decrease as the currency of an importing country depreciates if everything else is held constant (Schuh 1974). *FS* is the food safety variable presented as a dummy variable. The value one is set for the years that Iran's pistachios had high aflatoxin levels, and zero otherwise. Subscripts *i* and *t* indicate destination country and time, respectively. For empirical estimation, the pistachio export demand function is specified as follows:

$$\ln(EX_{it}) = \alpha_0 + \alpha_1 RP_{it} + \alpha_2 GDP_{it} + \alpha_3 EXR_{it} + \alpha_4 FS + \mu_{it}$$

Four different formats of pistachio export demand functions have been selected: (1) all variables in logarithmic form, (2) left part of the demand function in logarithmic form, (3) right part of the demand function in logarithmic form, and (4) all variables in normal form. To choose the optimal model among these, the Cox Box method is employed. The model in the equation above has been chosen as the optimal model.

This paper analyzes the pistachio export demand functions of Iran over the period 1997 to 2006 (annual data) for seven EU countries (France, Germany, Spain, Italy, Poland, Romania, Switzerland), Japan, and Australia, which have been selected based on data availability. The data for real pistachio exports and pistachio export prices were obtained from FAO and the World Development Indicators of the World Bank.The relative export price was calculated as the ratio of Iran pistachio export prices to the US pistachio export prices.

Panel Method

The panel method is used for estimating pistachio export demand. Panel data estimation is often considered to be an efficient analytical method in handling econometric data. The combined panel data matrices' set consists of a time series for each cross-sectional member in the data set and offers a variety of estimation methods. In this case, the number of observations available increases by including developments over time.

Test for Poolability

The question of whether to pool the data or not naturally arises with panel data. The restricted model is the pooled model representing an equation with the same parameters over time and across regions. The unrestricted model, however, is the same equation but with different parameters across time or across regions (Baltagi 2005). To test the poolability of data, the test presented by Chow (1960) is employed and extended to the case of linear regressions:

$$F_{obs} = \frac{\frac{(e'e - e_1'e_1 - e_2'e_2 - \cdots - e_N'e_N)}{(N-1)K'}}{\frac{(e_1'e_1 + e_2'e_2 + \cdots + e_N'e_N)}{N(T-K')}}$$

Under H_0, F_{obs} is distributed as $F((N-1)K', N(T\text{–}K'))$. Hence, the critical region for this test is defined as:

$$\{F_{obs} > F((N-1)K', NT - NK'; \alpha_0)\}$$

where α_0 denotes the level of significance of the test. Here, the null hypothesis is to pool the data set and the alternate hypothesis is the ability not to pool it. For each estimation, a residual sum of squares from restricted regression (RRSS) that shows the goodness of fit for that estimation is observed. The RRSS for the Chow test is employed. Chow's test for poolability across countries provides an observed F-statistics of 0.04387, which is distributed as $F(40,45)$ under $H_0{:}\delta_i = \delta$ for $i = 1,\ldots,N$. The RRSS = 9.868541 is observed for pooled OLS, and the URSS = 9.498099 is obtained for summing the RSS from the OLS regressions of each of the nine countries. There are 40 restrictions and the test does not reject poolability across countries for all coefficients.

Panel Unit Root Tests

There are a variety of panel unit root tests which include Breitung (2000), Hadri (2000), Choi (2001), Levin, Lin, and Chu (2002) and Im et al. (2003), among others. Considering the following autoregressive specification:

$$Y_{it} = \rho_i Y_{it-1} + \delta_i X_{it} + \varepsilon_{it}$$

where $i = 1,\ldots,N$ for each country in the panel; $t = 1,\ldots,T$ refers to the time period; X_{it} represents the exogenous variables in the model including fixed effects or individual time trend; $\rho_i s$ are the autoregressive coefficients; and $\varepsilon_{it} s$ are the stationary error terms. If $\rho_i < 1$, y_{it} is considered to be weakly trend-stationary, whereas if $\rho_i = 1$, then y_{it} contains a unit root.

$$Y_{it} = \rho_i Y_{it-1} + \sum_{j=1}^{p_i} u_{ij} e_{it-j} + \delta_i X_{it} + u_{it}$$

where p_i represents the number of lags in the Augmented Dickey–Fuller (ADF) regression. The null hypothesis is that each series in the panel contains a unit root ($H_0{:}\rho_i = 1$). The alternative hypothesis is that at least one of the individual series in the panel is stationary (H_0: $\rho_i < 1$). The empirical model indicates that the null hypothesis of a unit root is accepted for each variable (Table 1). Thus, empirical results for the unit root tests are found to be robust with the chosen sample period.

Breitung (2000) suggests a test statistic that does not employ a bias adjustment for unit root. The null hypothesis of the Breitung test is that each series in the panel contains a unit root. If the p-values for EX_{it}, RP_{it}, GDP_{it}, and EXR_{it} are not significant, then the test cannot reject the null hypothesis. Pesaran and Shin propose an alternative testing procedure based on averaging individual unit root test statistics. The null hypothesis is that each series in the panel contains a unit root. Here, the p-values for EX_{it}, RP_{it}, GDP_{it}, and EXR_{it} are not significant and thus, the test cannot reject the null hypothesis.

Table 1. Panel unit root test

Variables	Log(EX_{it})	RP_{it}	GDP_{it}	EXR_{it}
Breitung *t*-stat	–0.9505 (0.1709)	1.2639 (0.8969)	4.1289 (1.000)	0.5394 (0.7652)
Im, Pesaran, and Shin W-stat	–1.1395 (0.1272)	–0.005 (0.4982)	0.79223 (0.7859)	0.4905 (0.6881)
ADF-Fisher chi-square	32.0193 (0.0219)	20.7786 (0.2907)	10.5996 (0.9106)	11.5103 (0.8715)
PP-Fisher chi-square	36.4344 (0.0062)	41.3537 (0.0014)	19.6806 (0.3511)	16.5103 (0.5461)

Note: Probability values are reported in parenthesis

The augmented Dickey-Fuller test (ADF)-Fisher regression tests the null hypothesis that each series in the panel contains a unit root, but the *p*-values for EX_{it}, RP_{it}, GDP_{it}, and EXR_{it} are not significant and so the test cannot reject the null hypothesis. Fisher-PP tests the null hypothesis that each series in the panel contains a unit root. *P*-values for EX_{it} and RP_{it} can reject the null hypothesis, but those for GDP_{it} and EXR_{it} cannot reject it. According to all tests, it would not be sound to rely on just the PP-fisher test, and so the panel cointegration test is used to find the relationship between variables.

Panel Cointegration Tests

The motivation for testing for cointegration is primarily linked to investigating the problem of spurious regressions, which exists only in the presence of non-stationary data. Given the presence of heterogeneity in both dynamics and error variances in the panel, the heterogeneous panel cointegration test advanced by Pedroni (1999, 2004), which allows for cross-section interdependence with different individual effects, is employed as the following:

$$Y_{it} = \alpha_{it} + \delta_{it} + \gamma_{1t}E_{it} + \gamma_{2t}L_{it} + \gamma_{3t}K_{it} + \varepsilon_{it}$$

where i=1,…, N for each country in the panel and t=1,…,T refers to the time period. The parameters α_{it} and δ_i allow for the possibility of country-specific fixed effects and deterministic trends, respectively. ε_{it} denote the estimated residuals which represent deviations from the long-run relationship. E, L, and K represent energy, labor, and capital, respectively. To test the null hypothesis of no cointegration, ρ_i=1, the following unit root test is conducted on the residuals:

$$\varepsilon_{it} = \rho_i \varepsilon_{it-1} + \omega_{it}$$

Pedroni (2000, 2004) also proposed several tests for the null hypothesis of cointegration in a panel data model that allows for considerable heterogeneity. His tests can be classified into two categories. The first set (within dimension) involves averaging test statistics for cointegration in the time series across cross-sections. For the second set (between dimensions), the averaging is done in pieces so that the limiting distributions are based on limits of piece-wise numerator and denominator terms.

Cointegration tests were performed for the export volume, gross domestic product for each importing country, exchange rates of all destinations, and relative prices of each country. Here, seven tests were considered: the panel ν-test, panel ρ-test, panel PP-test, panel ADF test, group ρ test, group PP test, and group ADF-test. In the null hypothesis, the residuals are considered to be non-stationary (i.e., there is no cointegrating relationship). In the alternative hypothesis, the residuals are considered to be stationary (i.e., there is a cointegrating relationship).

Table 2 shows the results of panel cointegration tests. Export volume, gross domestic production, exchange rates, and relative prices have a cointegrating relationship. Having found that the existence of the cointegrating relationship is supported, the export demand functions were then estimated.

Model Estimation

The model can be estimated in different panel methods. In general, simple linear panel data models can be estimated using three different methods: (1) with a common constant as in the equation, (2) allowing for fixed effects, and (3) allowing for random effects. The fixed effects estimator is also known as the least-squares dummy variables estimator, because in order to allow for different constants for each group, it includes a dummy variable for each group. An alternative estimation method is the random effects model. The difference between the fixed effects and the random effects methods is that the latter handles the constants for each section as not fixed but as random parameters. If the unobserved group-specific effects are correlated with the explanatory variables, then the estimates will be biased and inconsistent.

The Hausman test

The Hausman test is formulated to assist in making a choice between the fixed effects and random effects approaches. Hausman (1978) adapted a test based on the hypothesis of no correlation. For the panel data, the appropriate choice was between the fixed effects and the random effects methods, which investigates whether the regressors are correlated with the individual (unobserved in most cases) effects. The Hausman test uses the following test statistic:

$$H = \left(\hat{\beta}^{FE} - \hat{\beta}^{RE}\right)' \left[\mathrm{Var}\left(\hat{\beta}^{FE}\right) - \mathrm{Var}\left(\hat{\beta}^{RE}\right)\right]^{-1} \left(\hat{\beta}^{FE} - \hat{\beta}^{RE}\right) \sim \chi^2(k)$$

If the value of the statistic is large and the difference between the estimates is significant, then the null hypothesis that the random effects model is consistent is rejected and the fixed effects estimators are used instead. With the given data set, the resulting Hausman test statistics is 14.8694 (p<0.01), and thus, the null hypothesis of no correlation between the individual effects and the X_{it} is rejected. For testing panel with fixed effects, the model with fixed effects was estimated and then the redundancy of fixed effects was tested. The F-statistic was significant (p=0.0043).

RESULTS AND DISCUSSION

In the previous section, the long-run relationships between variables were supported. Table 3 illustrates the results of the demand function estimation. All the coefficients have the expected signs except exchange rates.

Table 2. Panel cointegration tests

Within Dimension Test Statistics		Between Dimensions Test Statistics	
Panel v-statistic	–2.19184 (0.0361)	Group ρ-statistic	3.790277 (0.0003)
Panel ρ-statistic	2.624790 (0.0127)	Group PP-statistic	–26.39093 (0.0000)
Panel PP-statistic	–28.35757 (0.0000)	Group ADF-statistic	–8.010806 (0.0000)
Panel ADF-statistic	–4.566898 (0.0000)		

Note: Probability values are reported in parenthesis

Table 3. Panel results (fixed effects within regressions results)

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
Intercept	5.338125	0.762636	6.999573	0.0000
EXR	0.076614	0.036163	2.118591	0.0379
GDP	7.36^{-13}	4.22^{-13}	1.745339	0.0856
RP	–0.275273	0.283281	-0.971732	0.3347
FS	–0.162387	0.091979	-1.765481	0.0867
Weighted Statistics				
R-squared	0.951969		Mean dependent var	8.353118
Adjusted R-squared	0.941781		S.D. dependent var	5.704296
S.E. of regression	0.712506		Sum squared resid	33.50591
F-statistic	93.43718		Durbin-Watson stat	1.877122
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.916940		Mean dependent var	6.320300
Sum squared resid	35.37951		Durbin-Watson stat	1.729220

We separated the exchange rate variable and estimate it for each country as a specific variable. Results of this change, as reflected in Table 4, show that GDP affects the pistachio market shares and has a positive effect for each country. This means that by increasing the gross domestic product of a country, demand for Iranian pistachio will increase.

Table 4 shows that the exchange rate has a negative effect on the demand in some countries such as Switzerland, Australia, Spain, France, Italy, and Poland. The coefficient of the exchange rate is negative, but its weak significance casts doubts on this observed relationship. In other words, the changes in exchange rates are completely reflected in the export prices. Exchange rate for Spain, Italy and Germany does not have a significant effect on their pistachio demand, but it does for Japan and Romania. Exchange rate coefficient is expected to have a negative sign; however, a positive coefficient is also emphasized by Yang (1998). It means that exporters try to strengthen the exchange rate fluctuations by increasing the export price when its value rises. The same results are seen in Yang (1998). Knetter (1989) discusses that the positive coefficient of exchange rate is an optimizing behavior when exporters perceive demand to be less elastic as prices increase. Knetter further identified different pricing policies by exporters in different industries. He showed that the different empirical results of the pricing-to-market behavior under exchange rate changes can be traced back to market concentration as well as other market structure conditions. The explanation developed by Knetter (1989) can be used for the empirical results of this study.

Table 4 also shows the results for Iran's pistachio export demand, which indicate that pistachio food safety shocks have a negative and highly significant impact on Iran's pistachio export demand. FAO data show that the pistachio imports into the EU dropped by 42 percent in 1998 and that Japan had been reducing Iranian pistachio imports since 1997 before ending imports completely in 2006. Hence, Japan is one of the export market for pistachio that Iran had lost. However, the concerns do not last forever, and as the efforts such as technical and institutional supervisions increase to address the food safety concerns, the impacts dissipate and consumers revert back to their previous consumption levels over time. Relative pistachio export price has a negative sign, which means that by increasing Iran's price or decreasing US, demand for Iran's pistachio, exports decrease.

Table 4. Panel results (with specific exchange rate)

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
Intercept	7.114347	0.947936	7.505091	0.0000
GDP	6.92^{-13}	3.97^{-13}	1.745675	0.0862
RP	−0.338228	0.157299	−2.150230	0.0357
FS	−0.294058	0.101926	−2.885017	0.0055
EXR_SWiT	−4.959396	0.906917	−5.468411	0.0000
EXR_AUS	−2.014298	0.408914	−4.925963	0.0000
EXR_SPA	−0.402584	0.777736	−0.517636	0.6067
EXR_FRA	−3.670595	1.503520	−2.441335	0.0177
EXR_GER	0.113587	0.922927	0.123073	0.9025
EXR_JPN	0.086647	0.027238	3.181148	0.0024
EXR_ITA	−0.452006	1.417090	−0.318968	0.7509
EXR_POL	−0.389500	0.223923	−1.739434	0.0873
EXR_ROM	1.243627	0.371204	3.350253	0.0014
Weighted Statistics				
R-squared	0.970665	Mean dependent var		9.239660
Adjusted *R*-squared	0.959537	S.D. dependent var		7.951366
S.E. of regression	0.691341	Sum squared resid		27.721230
F-statistic	87.233330	Durbin-Watson stat		2.009140
Prob(*F*-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.928818	Mean dependent var		6.320300
Sum squared resid	30.320150	Durbin-Watson stat		1.589219

CONCLUSION

This study analyzed the factors that affect the export demand for Iran's pistachios. The empirical results showed that the coefficients of the export demand model were highly statistically significant and had good explanatory power. Results show that one of the factors impacting export destinations is concern for food safety. Food safety scares affect the health of consumers and can ruin export markets. Depending on the nature of the scare and severity of the affected products, consumer trust and demand for the products decrease, affecting both producers' and consumers' well-being and a society's welfare. Governments regulate food production, processing, and marketing by imposing standards, inspection regulations, and requirements.

An aflatoxin-related food safety incident could impose serious costs on the pistachio industry. Based on the results, Iran's pistachio industry has suffered heavily from aflatoxins in pistachios. Iran needs to have better planning in the production, processing, and marketing of pistachio nuts. The observation of health principles and food safety regulations are essential in gaining consumer trust and maintaining export market shares in the international market. Governments regulate food production and marketing by imposing standards and inspection requirements as well as by setting up protocols producers must follow. Industries also undertake voluntary actions to prevent food safety scares and implement standards and health measures for their products. The conditions of Iran and market facts call for such moves.

Given this investigation of the effects of food safety on pistachio exportation, sound strategies are required to address the problem. Some important strategies are as follows: (1) allocating appropriate financial support to food research divisions; (2) considering the rapid growth of high quality competing products; (3) using new technologies in the production, processing, and marketing of pistachios; and (4) applying innovative measures to accelerate international trade. Also, there is a need to determine how to reduce aflatoxin contamination in pistachio and other products, pay more attention to the customers' needs and requirements, and recognize competitors' pricing methods in foreign markets. The policies also need to concentrate on increasing yields and achieving higher quality standards, which are essential to sustain profitability and maintain the country's shares in the international market.

Every article has its own limitations and shortcomings; this paper is not exceptional in that regard. One is the choice of countries, which was dictated by the lack of relevant data. EU countries that import pistachio nuts from both Iran and the US simultaneously had to be selected. Future research can make use of more data to have a better indication of the factors that impact pistachio export demand. Also, it would be interesting to have a model that can account for product quality to evaluate the effects of Iran's pistachio quality differentiation on import demand. Furthermore, one can set up export demand equations for different export destinations as a set of simultaneous equations. In order to address the pistachio market, a general equilibrium model that has structural demand and supply equations could also be constructed.

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