Time-Series Analysis of U.S. Pistachio Export Demand in North America

Zijuan Zheng and Sayed Saghaian

This study identifys the main factors influencing U.S. pistachio export demand in North America—i.e., to Canada and Mexico. A double-log econometric model is estimated using data for 1989–2009. The main findings indicate that Canadian GDP, U.S. walnut export prices, and food safety concerns explain the majority of the pistachio import demand variation in Canada, whereas Iranian pistachio export prices, the real exchange rate between the Mexican peso and the U.S. dollar, and U.S. pecan export prices explain the majority of the Mexican pistachio import demand variation. The paper also investigates the impact of food safety issue on export demand. In order to maintain its export market, the U.S. has to find solutions to current food safety problems.

The major pistachio producing countries in the world are Iran and the U.S. These two countries account for roughly 60 percent of world's pistachio trade (USDA-ERS 2010b). However, pistachio production yields in Iran, especially in recent years, have been lower than the world average, while both U.S. pistachio production and export quantities showed an increasing trend (Chizari and Somaieh 2007) from 1989 to 2007 (Figure 1). This study examines the main factors in U.S. pistachio export demand variation in North American countries—Canada and Mexico. Specifically, the effects of the following variables are analyzed: 1) U.S. pistachio export prices, 2) Iranian pistachio export prices, 3) GDP in the importing countries, 4) real exchange rate between the U.S. dollar and foreign currencies, 5) U.S. walnut export prices, 6) U.S. pecan export prices, and 7) food safety shocks in the U.S.

Figure 1 shows U.S. pistachio production, consumption, and trade from 1989 to 2007. Imports were relatively low and steady; however, domestic consumption corresponds to production. There is a big dip in consumption and production every other year. This is pistachios, like other tree nuts, typically have an on-and-off-year cycle in production, which means that one year there would be a high amount of pistachios produced and the next year would be a smaller volume. At the same time, exports increased gradually and were not affected by these dips in production because the U.S. government holds a stockpile to keep export prices steady.

As can be seen from Figure 2 and Figure 3, both Canadian and Mexican pistachio imports from the U.S. trended upward from 1989 to 2009, indicating an increasing import demand for U.S. pistachios.

Model Specification

Export price, competitor's export price (in this case, Iranian pistachio export price), GDP, substitutes for a product (walnuts and pecans, in this case), and real exchange rate are all important factors influencing export quantity. As stressed in the literature, food safety shocks can also threaten consumers' confidence, especially in purchasing an infrequently consumed product; as a result, a dummy variable is created to investigate the effect of such concern:

$$(1) \quad \ln(Q_i) = \beta_0 + \beta_1\ln(REP_i) + \beta_2\ln(RCEP) + \beta_3\ln(RGDP_i) + \beta_4\ln(RER_i) + \beta_5\ln(RPW) + \beta_6\ln(RPP) + \beta_7(FS) + \beta_1\ln(REP_i) + \varepsilon,$$

where Q_i is U.S. export quantity of pistachios to country i, REP_i is real export price to country i, RCEP is real competitor's (Iranian) export price, $RGDP_i$ is real GDP of country i, RER_i is real exchange rate of country i, $\ln(RPW_i)$ is U.S. export price of walnuts to country i, $\ln(RPP_i)$ is U.S. export price of pecans to country i, FS is food safety shock, and ε is an error term.

Using logarithms makes the functional form of the equation more flexible and makes interpretation of the coefficients as elasticities much easier. The first step is investigating heteroskedasticity and autocorrelation problems.

Zheng is a master's student and research assistant and Saghaian is Associate Professor, Department of Agricultural Economics, University of Kentucky.
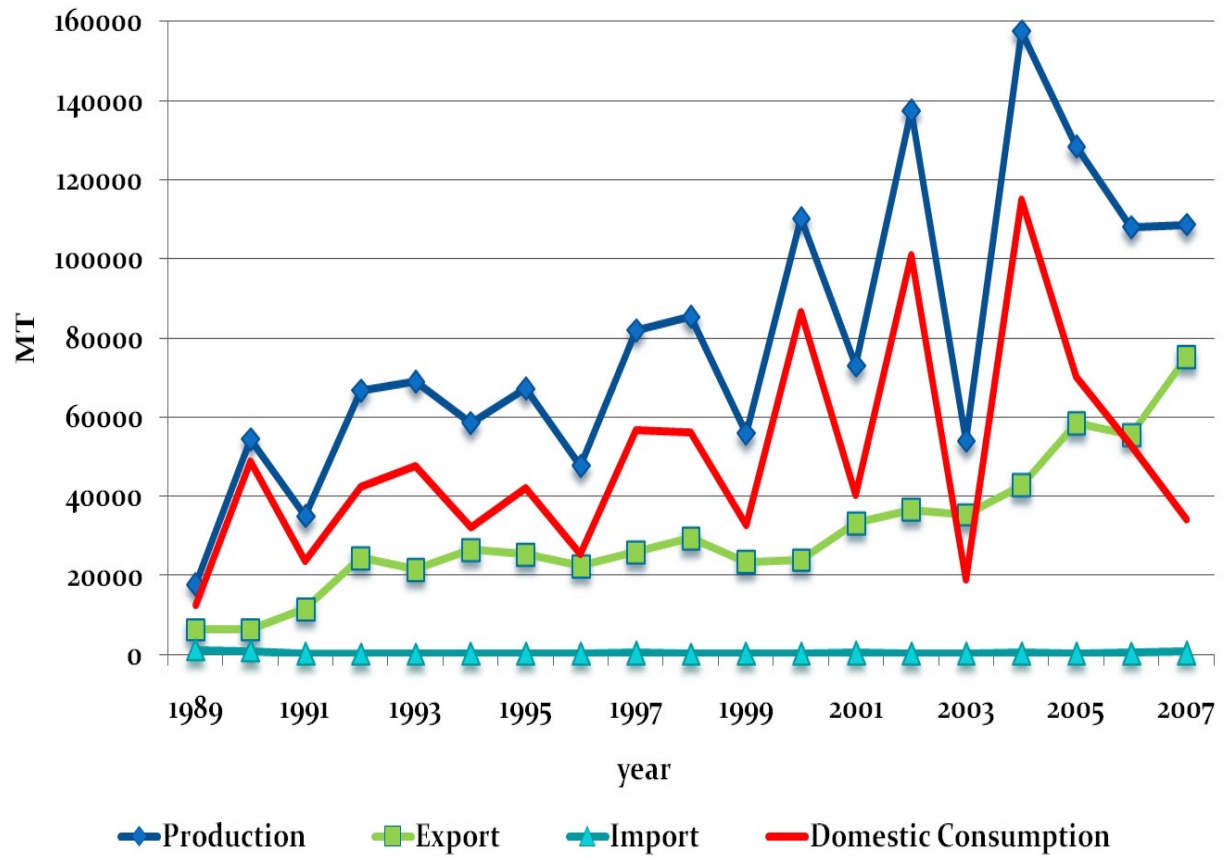
Figure 1. U.S. Pistachio Production, Consumption, Import, and Export Trends, 1989–2007.

First, a RESET test and a VIF test are conducted. Results from RESET test imply that there is no sufficient evidence that the model is suffering from either missing variables or misspecification error. The VIF test indicates no multicollinearity problem in the data. Second, a Breusch-Pagan test and a Durbin-Watson test are conducted. Both the B-P test and DW test indicate that the best approximation process for the two countries is Ordinary Least Squares (OLS).

Data

Using U.N. Food and Agriculture Organization statistics (FAO n.d.) and United States Department of Food and Agriculture GATS (General Agreement

on Trade in Services) statistics (USDA-FAS 2010), Canada and Mexico are selected as main importing markets. Data for the variables mentioned above are collected for 1989–2009. Variables in the model are divided by their corresponding values in the base year 2000 in order to format them as real values. Using the real form not only helps to make each time series equivalent in magnitude but also helps to incorporate the data in a parsimonious way and thus helps to minimize specification errors.

Food-Safety Issues

Aflatoxin contamination in tree nuts has become a growing international food safety concern for over a two decade period (Buchanan, Sommer, and
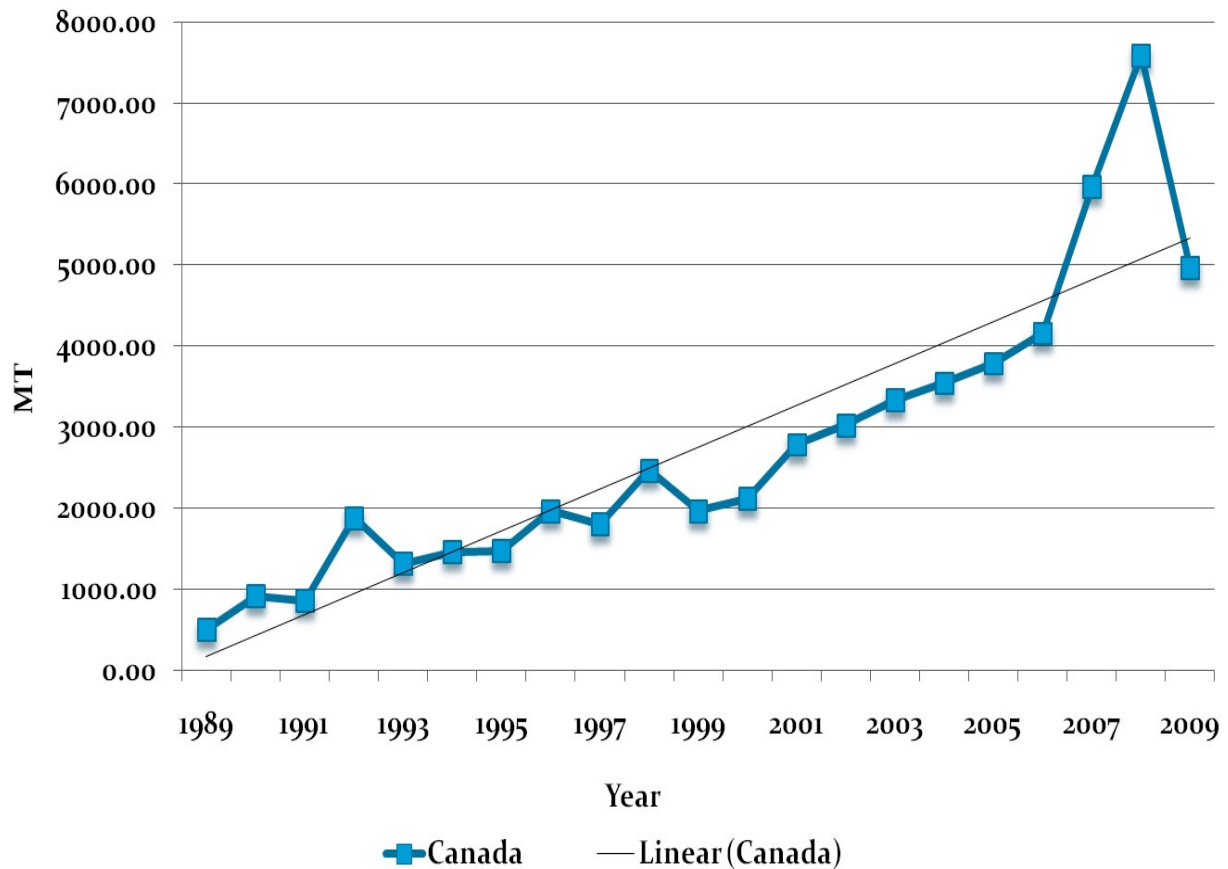
Figure 2. U.S. Pistachios Export Trend to Canada, 1989–2009.

Fortlage 1975). Aflatoxicosis is poisoning that result from ingestion of aflatoxins in contaminated food or feed. The aflatoxins are a group of structurally related toxic compounds produced by certain strains of the fungi Aspergillum's 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 (De Lloyd 2000).

Two characteristics of the pistachio market make market failure concerns particularly important in the context of food safety assurances and quality standards. First, as with many fresh fruits and nuts, there is little brand identification with pistachios. Thus a customer who has an unsatisfying experience with a purchase of pistachios or who hears negative

news about the safety of consuming pistachios is unlikely to associate this with a specific brand or supplier, but rather with the industry as a whole. Second, pistachios are purchased infrequently and often in relatively small quantities. Compared with more familiar foods, we would therefore expect a larger industry-wide reaction to an aflatoxin event in the context of food safety concerns (Brunke et al. 2004).

As stated above, a dummy variable is created to investigate the effect of food safety concerns, in which "1" indicates that there were one or more food safety shocks in the U.S. in the corresponding year, while "0" indicates no evidence of food safety concerns.
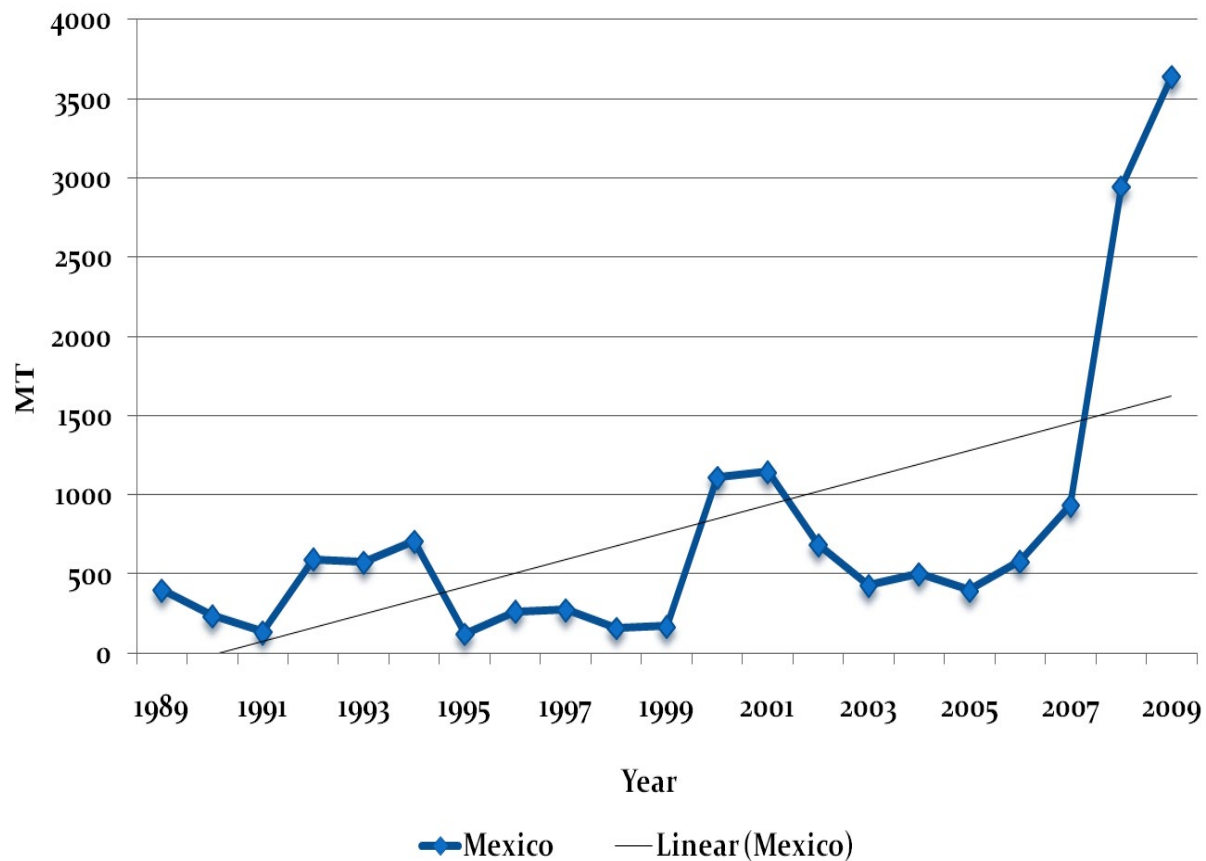
Figure 3. U.S. Pistachios Export Trend to Mexico, 1989–2009.

Estimation Results

The results from the estimation of Equation 1 are presented in Tables 1 and 2. The models are estimated using OLS (Ordinary Least Squares). Variables are included in natural logarithmic form.

In Table 1, results are generated by OLS with an $\bar{R}^2$ of 96.08 percent, and all the variables except real exchange rate between U.S. and Canadian dollars have signs as expected in the model specification. Of those coefficients having the expected signs, Canadian GDP and walnut export price are statistically significant at the one percent level. Food safety shocks is statistically significant at the five percent level. Canadian GDP, U.S. walnut export prices, and food safety concerns explain the majority of

pistachio import demand variation in Canada.

In Table 2, results are generated by OLS with an $\bar{R}^2$ of 72.3 percent. Iranian pistachio export prices, real exchange rate between the U.S. dollar and Mexican peso, and U.S. pecan export price are statistically significant. This means that these three variables are important factors in determining pistachio import demand in Mexico. However, the food safety shock variable has an unexpected positive sign.

As the model is in logarithmic functional form, we can interpret the coefficients as elasticties. For each one percent increase in Canadian GDP, holding other factors constant, pistachio import demand in Canada will increase by 1.86 percent. In Mexico, every one percent increase in U.S. pecan export

Table 1. Estimation Results for Canada.

Variables	Expected signs	Coefficients
Constant	n.a.	7.938
Export price	−	−0.50966
Iranian export price	+	0.0365
Canadian GDP	+	1.85728***
Real exchange rate	−	0.89603
Walnut export price	+	1.46726***
Pecan export price	+	0.06492
Food safety shocks	−	−0.20899**

*Adj. R^2 = 0.9608, DW = 2.819.

Table 2. Estimation Results for Mexico.

Variables	Expected signs	Coefficients
Constant	n.a.	6.4101
Export price	−	0.07005
Iranian export price	+	1.50366**
Mexican GDP	+	0.70338
Real exchange rate	−	−2.6001*
Walnut export price	+	−1.99712
Pecan export price	+	1.57396**
Food safety shocks	−	0.30118

*Adj. R^2 = 0.723, DW = 1.731.

price will increase pistachio import demand by 1.57 percent, ceteris paribus.

Conclusions

This paper investigates the factors influencing U.S. pistachio export demand in North America and the impact of food safety shocks. According to the OLS results we conclude that Canadian GDP, U.S. walnut export prices, and food safety concerns explain the majority of pistachio import demand variation in Canada. Iranian pistachio export prices, real exchange rate between the Mexican peso and the U.S. dollar, and U.S. pecan export prices explain the majority of Mexican pistachio import demand variation.

Food safety issues are becoming an increasingly important topic in food industry and are statistically significant in Canada. Regarding globalization in today's market, this study shows that food safety issues that happen in one part of the world could potentially affect the import demand in other parts

of the world. To remain competitive in the world trade market, the U.S. has to find solutions to current food safety problems. This can be achieved through product quality improvement and developing stricter regulations for safe food production to meet the international demands.

There are several possible reasons for FS not having the expected sign in Mexico. First of all, there are limitations in the data. The dummy variable created in the model provides weak information. For example, it does not show exactly how many food safety shocks actually happened in each year and how important those events are. This could lead to potential specification error. Second, Mexico has a lower GDP than does Canada and Mexican consumers have a smaller per capita pistachio consumption than do Canadian consumers. Third, according to the data, Mexico imports a much smaller volume of pistachios than does Canada, which would result in a much smaller chance of encountering aflatoxin contamination. Last, there could be different standards of food safety regulation in these two countries and we would expect higher consumer confidence in the country that has less strict regulation.

References

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* D:1052.

Buchanan, J. R., N. F. Sommer, and R. J. Fortlage. 1975. "Aspergillus flavus infection and aflatoxin production in fig fruits." *Application Microbiology* 30:238–241.

Chizari, A. H., and A. Somaieh, 2007. "The USA and Iran's Pistachio Export: A Comparative Advantage and Specialization Approach." Department of Agricultural Economics, Tarbiat Modares University.

De Lloyd, D. 2000. Aflatoxins and Toxicity. http://delloyd.50megs.com/hazard/aflatoxins_poison.html, Accessed May 15, 2010.

Food and Agriculture Organization (FAO). No date. FAOSTAT Database. http://faostat.fao.org/site/535/default.aspx#ancor. Accessed on February 5, 2010.

USDA-ERS. 2010a. Exchange Rate Data. http://www.ers.usda.gov/Data/ExchangeRates/. Accessed February 5, 2010.

USDA-ERS. 2010b. GDP Data. http://www.ers.usda.gov/Data/Macroeconomics/. Accessed February 5, 2010.

USDA-FAS. 2010. General Agreement on Trade in Services Statistics Database. http://www.fas.usda.gov/gats/default.aspx. Accessed February 5, 2010.