

## Impact of Price and Non-Price Factors on the Iranian Pistachios Market

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### ABSTRACT

Pistachios play a vital role in Iran's agricultural export. Recently, however, Iran has lost considerable amount of its market share in international trade. This study aimed to address the price and non-price factors affecting the pistachio markets of Iran by estimating a structural system of equations. The domestic supply and demand for pistachios in Iran along with its export demand and supply to European Union, East Asia, and West Asia markets were estimated simultaneously, during 1988 to 2015. The results indicate that Research and Development (R&D) has had a positive effect on the pistachio supply and exports. Hence, it is proposed that the allocation of R&D funding in Iran be reconsidered. However, advertising has an insignificant effect on the Iranian's export supply in international market. Hence, reviewing the type of advertisement is a vital issue for future research. European countries are less sensitive to the Iranian's export price of pistachios, while they pay more attention to the quality and taste of the Iranian's pistachio.

**Keywords:** Advertising, Research and Development, Simultaneous equations system, World market.

### INTRODUCTION

In the history of economics development, export programs have been thought of as a key factor in trade policy of any nation. Given that agricultural products play a critical role in the non-oil exports of oil exporting countries such as Iran, investigating this issue is vital. Customarily, pistachios have been one of the fundamental and continuous agricultural export commodities of Iran. In 2016, pistachios represented around 43% of Iranian agricultural exports (about \$650 million, from between \$197 million in 1997 to \$687 million in 2016) (FAO, 2018). Until 2007, Iran controlled 61.1% of the world's export value of pistachios (approximately \$379 million). However, since 2008, Iran's share

of the market dropped to 34.0%, or about \$738 million (World Bank, 2018).

During the period from 1988 to 2017, the share of Iran's pistachios in the European Union market gradually decreased, from 72.5% (around \$151 million) to around 19.4% (about \$213 million). Also, in the East Asian market, Iran's share decreased from 89.3% (\$31 million) to 17.0% (\$157 million). In addition, in the West Asian market, Iran's share in this period increased from 10.7% (\$2.8 million) in 1988 to 89.9% (\$58 million) in 2003, reaching its highest level. It then gradually decreased to 25.8%, which is about \$24 million (World Bank, 2018).

Because non-price factors, such as investing on Research and Development (R&D), can lead to considerable improvement in the quantity and quality of pistachios, Iranian government investing in

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R&D has a pivotal role in the pistachio export strategy of Iran, in order to improve the quality and quantity of pistachios in the world market against its main competitor, United States. Iran's government pays \$186 thousand annually for pistachio R&D through the Pistachio Research Center (Iran, 2015c). This figure was \$273 thousand in 1996, reaching a peak of \$306 thousand in 2009, but declined sharply during 2013 and 2014 to around \$39.5 thousand dollars.

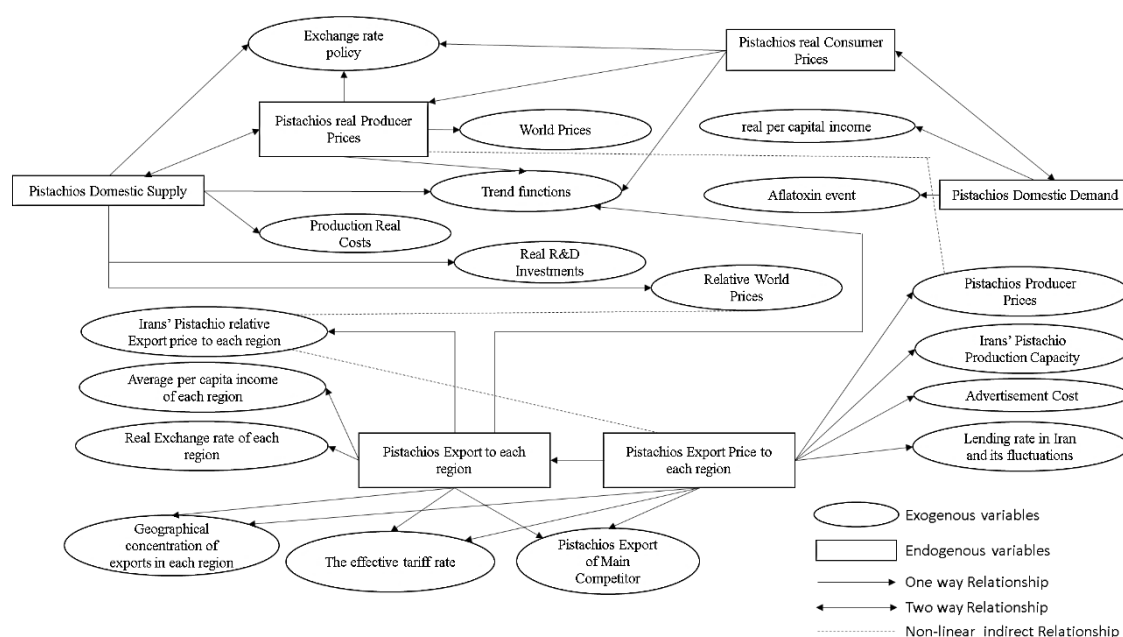
The two private organizations, namely, The Iran Pistachio Association (IPA) and Rafsanjan Pistachio Producers Cooperative (RPPC) are the Iranian pistachio export agents who promote and advertise Iran's pistachios in the world market. RPPC has paid the highest advertising costs in 2008 of about \$600,000. Perhaps this is because aflatoxin was found to be higher than the allowable amount in the Iranian pistachios, which was followed by an increase in Iranian advertising. However, RPPC's advertising cost gradually declined until 2006, and finally reached zero in 2007, raising concerns about the company's export markets. Nevertheless, in 2010, the IPA began a much more organized advertising campaign, although advertising cost level declined gradually during 2010 to 2013, due to the devaluation of the national currency. Another non-price factor affecting export supply is the interest rate on bank lending and its volatility. Since exporters take bank loan for buying pistachio from farmers in order to continue their business activities, the cost of the loan can be a considerable factor to pistachio export agents. Hence, interest rates and its volatility in Iran affects pricing behavior in the world market (Iran, 2015b). Moreover, effective export tariff rate can influence the amount and price of exports to any country, thus it would act as a non-price factor in relation to export supply and demand.

The basics of supply curve extraction from maximizing profits is essentially the same as that used by Varian (2010) with some modifications. In this way, it is initially assumed that firms have already minimized

their costs and maximized profit in order to obtain the supply function (Kwon and Yamauchi, 1993).

The supply of pistachios in Iran is generally a function of the producer real prices for pistachios, a proxy of the production cost and research and development investments. Last year, a rise in prices for pistachio producers was due to increased expectations of profitability of the industry, therefore, the supply of pistachios increased. Hence, the producer prices for pistachios is expected to have a positive effect on its supply. On the other hand, in this study, the agricultural real wage has been proposed as a proxy to the production cost index, which generally displays a negative effect on pistachio supply. The R&D would move the supply curve to the right due to positive change in production technology. It should be noted that, due to OpenStax (OpenStax, 2016), the official exchange rate has also entered into Iran's pistachio supply with the assumption that an increase in the official exchange rate could ultimately lead to devaluation of the national currency as a result of increased exports, and this will strengthen the expectations of Iran's pistachio producers and, consequently, the supply can be improved. Nevertheless, an increase in the fluctuations of the real exchange rate (obtained by using the Hodrick and Prescott (1997) filter) can raise prices of imported inputs, such as fertilizers and pesticides, and these temporary shocks in the market would push the supply of Iran's pistachio to the left. Furthermore, as Rutten *et al.* (2013) have remarked, an increase in export prices of pistachios relative to world prices could contribute to producer expectations, resulting in an upturn in the supply of pistachios (Figure 1).

The pistachio producer real price is supposed to be endogenous because pistachio producer's price depends on the previous global supply, world prices, and government policies. In other words, it is expected that with an increase in supply or a rise in pistachio world prices, producers



**Figure 1.** Domestic and international model of pistachio markets of Iran.

expect to get higher prices (Doran and International Livestock Research Institute, 1995).

Further, since pistachios do not possess a close substitute, the effect of consuming other foods could be assumed as low. Domestic demand in Iran is a function of pistachio consumer real prices (the price paid by consumers relative to food price index) and per capita income. If the consumer real price of pistachios increases, the quantity of demand would decrease. On the other hand, with an increase in per capita income due to increased purchasing power of consumers and assuming pistachios are a normal good, the pistachio demand is expected to increase.

Khan (1974) and Khan and Goldstein (1978) introduced export supply and export demand functions as simultaneous equations. In their view, the export demand of pistachios is a function of the export price of pistachios in the country of origin. For the destination areas (European Union, East Asia or West Asia markets), the export price has a negative effect on export demand, while the income index of destination areas usually has a positive impact on export

demand. It should also be noted that according to different studies (such as Khalighi and Fadaei, 2017), by increasing the real exchange rate and devaluing exporters' currencies, the demand for pistachios in the destination areas will increase. Furthermore, if the effective tariff increases in target markets, one may expect exports to slow down due to a lower trading volume. In addition, the geographical concentration of exports can play a critical role in export value. For instance, during 1988 to 1998, about 89.1% (around 25.3 million Dollars) of export value of pistachio of Iran to East Asia were imported by Japan with a downward trend, however, this situation changed after 1999, in which approximately 86.8% (about 172.8 million Dollars) of export value of pistachio of Iran to East Asia were imported by Hong Kong with an upward trend. Further, In West Asia, major importing continues of Iranian pistachios are United Arab Emirates (UAE), Lebanon, and Saudi Arabia, however, there were drastic changes in Iran pistachio market structure in West Asia. For example, from 1994 to 2004, Lebanon was the largest importer of Iranian pistachios among West



Asian importers, however, after 2010, the largest importer of Iranian pistachios among West Asian importers is UAE (World Bank, 2018). In other words, the geographical concentration represents the structural change among trading partners within each region. As Ahmad and Kalim (2014) state, geographical concentration will positively influence exports over time if trading partners adopt more favorable policies.

The export supply of pistachios is a function of the ratio of export prices to domestic producer prices and an index of productive capacity. From Khan and Goldstein (1978) point of view, if the relative price of exports increases, the export supply will also rise since exporting would be more profitable. Further, an increase in productive capacity would eventually lead to a production surplus, thereby raising the export supply. In addition, according to a study by Richards and Patterson (1998), advertising can affect the export supply in two respects. First, if it is considered as an investment, it can have a positive impact on export supply. Second, if it is considered as a cost factor, it would have a negative effect on export supply.

In this study, according to IPA and RPPC, the effects of interest rate fluctuations on export supply have been examined. They have claimed that this variable creates barriers to reception and repayment of their facilities, causing them financial problems. According to the principles stated by Aguiar and Gopinath (2006), pistachio exporters need bank financing to buy raw pistachios, and process and transport them. In the short term, the fluctuations of this index could eventually lead to greater risk, thereby generating liquidity problems for exporters, not to mention reducing the bargaining power of exporters in pistachio international markets. However, in the long run, because there is time to plan, there will be no problem for exporters. There may even be benefits to them because they can gain cheaper loans.

Most studies on pistachio markets have been carried out on market structure and the

comparative advantages of trade and production; scarcely any examinations have attended to the issue of research and development efforts and the effects of advertising on pistachio markets (Amirteimoori and Chizari, 2008; Bagherpour Najafabad and Mahesha, 2013; Chizari and Sadafi Abkenar, 2016).

Cosar (2002) used panel data analysis to calculate the price, foreign income, and real exchange rate elasticities of aggregate export demand. He concluded that exchange rate policies have a limited effect on turkey exports. In 2002, a gathering of California pistachio cultivators pushed for establishment of a federal marketing order that would mandate quality standards and an inspection program to guarantee consistency in the quality of California pistachios, thereby expanding consumer trust and, therefore, demand in the product, enhancing producer returns. Gray *et al.* (2005) developed a simulation model of supply and demand for California pistachios to illustrate the effect of the proposed federal marketing order for California pistachios. In their view, an aflatoxin event could impose serious costs on the California pistachio industry. Zheng *et al.* (2012) evaluated the US role in the world production and trade of pistachios and distinguished product safety as the main consideration influencing export demand for US pistachios. As far as they are concerned, US pistachio producers should exploit this innovation and their focus on higher food safety standards to enhance their international place in the world market. In addition, Roberts and Schlenker (2013) presented a framework to identify demand and supply elasticities of agricultural commodities in the United States employing yield shock. They predicted an annual 30% increase in world food prices followed by an annual \$155 billion decrease in the global consumer surplus from food consumption. In an earlier study, Mousavi (2015) estimated export demand and supply functions of The Dutch Rose of Fars province in the region of the Persian Gulf in order to calculate the elasticities of the

considered functions and provide export policies for Iran. In another study, Khalighi and Fadaei (2017) applied an Ordinary Least Squares (OLS) method to assess the effects of the exchange rate and outsourcing of foreign policy on Iranian's date exports value.

This study attempted to dissect the non-price factors affecting the pistachio markets of Iran by estimating a structural system of equations, in order to provide a foundation for more compelling domestic and foreign policies regarding the pistachio trade.

## MATERIALS AND METHODS

This study draws attention to pistachio exports of Iran, which export primarily to three different regions (The European Union, East Asia, and West Asia). It should be noted that domestic supply and demand functions of Iran was estimated simultaneously along with export supply and export demand in each region. Producer and consumer real prices were also determined endogenously. In other words, one can find out about the modeling in this study according to Figure 1.

### Empirical Model

The domestic supply of Iran at time  $t$  ( $Q^s$ ) is a function of Domestic Producer Prices of Iran at time  $t$  (PDP) relative to the agricultural producer paid Price Index of Iran at time  $t$  (PCI) and the ratio of the agricultural Wage Index (FWI) to agricultural producer received price index (SAI), which acts as a proxy of production cost of Iran. This proxy was used because of the lack of time series data on horticultural products, specially for pistachios (see Kwon and Yamauchi, 1993). Real research and development investment of Iran at time  $t$  would positively influence the domestic supply as a strategic variable. In addition, since Iran is one of the main pistachio exporters, the ratio of its Export Prices

( $PX_{ir,w}$ ) to World Prices ( $PX_{w,w}$ ) can positively influence its domestic supply (Rutten *et al.*, 2013). Moreover, Real Exchange Rate fluctuations ( $^dRER_{ir,us}$ ) and the official Exchange Rate (Rial per Dollar) ( $^fER_{ir,us}$ ) were considered as the factors affecting the pistachio supply as proxy for the exchange rate policy in Iran. Therefore, the pistachio supply of Iran can be described by Equation (1).

Here, the Gross Domestic product Price deflator (GDPd) is used to adjust research and development investment. Furthermore, a Trend variable (Trend) entered the model to represent the change in technology. In addition,  $D_{irr}$  is a Dummy variable indicating the exchange rate unification event in year 2000, thus it is considered as zero (0) before the year 2000 and one (1) after that (There is usually more than one price for foreign exchange rates in Iran, one official and the other the free market rate. However, Iran's government decided to put an end to the dual foreign exchange regime, in an attempt to control the bullish foreign exchange and gold markets and promote safety of foreign investments.).

In order to evaluate the pricing behavior of Iranian pistachio producers, their price equations were formalized (Kwon and Yamauchi, 1993). Equation (2) is defined by assuming that producers are free of any money illusions. They consider the previous year's supply and global prices as well as expectations of technological progress on supplies.

Domestic demand of Iran at time  $t$  ( $Q^d$ ) is a function of the Domestic Consumption Price of Iran at time  $t$  (CDP) relative to the Consumer Food Price Index of Iran at time  $t$  ( $CPI^F$ ) and real per capita income of Iran at time  $t$  ( $GNI^I/POP$ ), therefore, the domestic demand function of Iran can be written as Equation (3).

$D_{ire}$  is a Dummy variable indicating the effect of aflatoxin on Iranian pistachios during the period 1997 to 2000 that led to the return of their sales because of being



$$\ln(Q^S)_t = f \left( \ln \left( \frac{PDP^{rial}}{PCI} \right)_{t-1}, \ln \left( \frac{FWI}{SAI} \right)_t, \ln \left( \frac{R \& D^{rial}}{GDPd} \right)_t, \ln \left( \frac{PX_{ir,w}}{PX_{w,w}} \right)_t, \ln(RER_{ir,us}^{dt})_t, \ln(ER_{ir,us}^{of})_t, Trend, D_{irr} \right) \quad (1)$$

$$\ln \left( \frac{PDP^{rial}}{PCI} \right)_t = f \left( \ln(Q^S)_{t-1}, \ln(PX_{w,w})_t, D_{irr}, Trend \right) \quad (2)$$

$$\ln(Q^D)_t = f \left( \ln \left( \frac{CDP^{rial}}{CPI^F} \right)_t, \ln \left( \frac{GNI^r}{POP} \right)_t, D_{ire} \right) \quad (3)$$

defective goods. This variable is expected to have a positive impact on domestic consumption, however, on total income levels, a negative effect is possible because low quality pistachios were returned to Iran.

In order to determine the pricing behavior of Iranian pistachio consumers, their price equations are estimated based on the assumption that consumers will try to bargain the price down based on consumption quantity. In other words, by increasing consumption, the consumer expects to pay a lower price (Kwon and Yamauchi, 1993). It is also known that the costs of production can increase consumer prices (Rutten *et al.*, 2013). Therefore, consumer price equation would be written as Equation (4).

The demand and supply equations of Iranian and American pistachio exports to different regions are estimated according to the principles established by Khan and Goldstein (1978). Some adjustments were performed in order to add strategic variables. In addition, other studies were under consideration, such as Khan (1974), Sarwar

and Anderson (1990), Muscatelli *et al.* (1992), and Shigeyuki and Yoichi (2009), to name but a few.

In general, export demand refers to the amount of foreign demand for goods produced by the country of origin. The export demand equation of pistachios from Iran to region  $j$  is given as Equation (5):

Where,  $EX_{ir,j}^D$  represents the Export Demand quantity from Iran to region  $j$ ,  $PX_{ir,j}$  stands for the export Price from Iran to region  $j$ ,  $YPG_{ir,j}$  marks the weighted average of income of trading Partners of Iran in the region  $j$ ,  $POP_{ir,j}^m$  is the Population Of trading Partners of Iran in the region  $j$ , and  $Z_{ir,j}$  represents a vector of other variables affecting the export demand of the country of Iran related to the destination region ( $j$ ) including export rivals in the region, which are expected to have a negative effect on the export demand for Iran. The Real Exchange Rate ( $RER_{ir,j}$ ) is expected to have a positive impact on exports. The effective Tariff Rate ( $TR_{jr,i}$ ) of the region  $j$  against the pistachio exports of Iran is expected to have a negative impact on the export demand of the

$$\ln \left( \frac{CDP^{rial}}{CPI^F} \right)_t = f \left( \ln(Q^D)_t, \ln \left( \frac{PDP^{rial}}{PCI} \right)_{t-1}, D_{irr}, Trend \right) \quad (4)$$

$$\ln(EX_{ir,j}^D)_t = a_0 + a_1 \ln \left( \frac{PX_{ir,j}}{PX_{ir,w}} \right)_t + a_2 \ln \left( \frac{YPG_{ir,j}}{POP_{ir,j}^m} \right)_t + a_3 \ln(Z_{ir,j})_t \quad (5)$$

destination country and the geographical concentration of exports ( $SD_{ir,j}^{EX}$ ) of Iran to region  $j$ .

Since Equation (5) has a log-linear form,  $a_1$  and  $a_2$  represent the relative price elasticity and the real per capita income elasticity of the export demand, respectively. Therefore,  $a_1$  and  $a_2$  are expected to be negative and positive, respectively.

Generally, the degree of response of the internal factors of exports to the export quantity is called export supply. Export supply is specified as a log-linear function of the relative price of exports (the ratio of export prices to domestic prices) and an indicator of the production capacity of the exporting country:

In Equations (1) to (6), it is assumed that the export price rises with increasing domestic prices (here, the producer price is in dollars per ton). Since the export price increases, production will be more profitable and could eventually lead to an increase in export supply. In addition, assuming *ceteris paribus*, exports are posited to improve when the production capacity of the country expands. Hence, both  $\beta_1$  and  $\beta_2$  are expected to be positive. Furthermore, the variable  $M_{ir,j}$  is a vector of variables that affect the supply of exports, including the cost of Advertising in exporting Iran ( $AD_{ir,j}$ ), which would have a positive impact on the country's export supply if it is effective; the effective tariff rate of region  $j$  against Iran, which is expected to have a negative effect on export supply; the Lending Rate in Iran ( $LR_{ir}$ ) which, according to the export agents, would have a negative effect on exports (This variable along with its fluctuations ( $VLR_i$ ) affects the lending facilities received by export agents of Iran.); and the amount of competitor exports to the joint trading zone, which is expected to have a negative impact

on the supply of exports. Equation (7) can be obtained as a function of the export price form Equation (6).

Where,  $b_0 = -\beta_0/\beta_1$ ,  $b_1 = 1/\beta_1$ ,  $b_2 = -\beta_2/\beta_1$ ,  $b_3 = \beta_3/\beta_1$  and  $b_4 = -\beta_4/\beta_1$ . Since  $\beta_1$  and  $\beta_2$  are positive, it is expected that  $b_1 > 0$ ,  $b_2 < 0$  and  $b_3 > 0$ ;  $b_4$  should possess a sign opposite to the expected signs of variables in vector  $M_{ir,j}$ . The parameter  $\beta_1$ , which is the price elasticity of the export supply, can be calculated by inverting  $b_1$ . As  $b_1$  tends to zero,  $\beta_1$  will tend toward infinity (Khan and Goldstein, 1978).

Hence, the domestic supply and demand equations of Iran, along with the price behavioral equations of its producers and consumers as well as the equations of export supply and demand of Iran to the three regions of the European Union, East Asia, and West Asia would be estimated as a system of simultaneous equations.

Data on the pistachio production of Iran over the period 1988 to 2015 was received from the Food and Agriculture Organization of The United Nations (FAO). Data on the volume of stocks at the beginning and the end of each year, domestic consumption, and the distribution quantity were obtained from the US Department of Agriculture's Foreign Service on Production, Supply, and Distribution (PSD) (United States Department of Agriculture, 2015).

The prices of Iranian producers were received in units of rials per ton and dollars per ton from the Food and Agriculture Organization of The United Nations (FAO). The consumer prices of pistachios in Iran were measured in rials per ton and obtained from the Central Bank of the Islamic Republic of Iran and the Department of the

$$\ln(EX_{ir,j}^S)_t = \beta_0 + \beta_1 \ln\left(\frac{PX_{ir,j}}{PDP}\right)_t + \beta_2 \ln(Y_{ir}^*)_t + \beta_3 \ln(M_{ir,j})_t \quad (6)$$

$$\ln(PX_{ir,j})_t = b_0 + b_1 \ln(EX_{ir,j}^S)_t + b_2 \ln(Y_{ir}^*)_t + b_3 \ln(PDP)_t + b_4 \ln(M_{ir,j})_t \quad (7)$$



General Directorate of Economic Statistics.

The indices of the prices paid to and received by Iranian farmers were calculated using the national accounts data published by the Central Bank of the Islamic Republic of Iran using the division of current values to fixed values. Then, its base year was changed to 2011.

The food price index in Iran was received from the Central Bureau of Statistics of the Central Bank of the Islamic Republic of Iran (2015a).

Information about the research and development investment of Iran are gathered from the Pistachio Research Center of Iran. Iran's pistachio advertising costs were obtained from the IPA as well as the pistachio producers in RPPC balance sheets, which included the cost of foreign business tours and participation in international exhibitions.

The statistics on the quantity and value of exports and imports of pistachios, along with information on tariff effective rates, were derived from the trade matrices provided by World Integrated Trade Solution (WITS) (2018). Export prices were obtained by calculating the ratio of export values to export quantities (i.e., the unit value). Thus, the export price to each region is equal to the weighted average of export prices to all the countries of the region. In addition, in order to evaluate geographical concentration of exports to each region, the standard deviation of countries within each region were calculated demonstrating the export variation across countries in each region (Gervais and Jensen, 2014). The real exchange rate of each trading partner was calculated by obtaining data from the World Bank on the exchange rate and the consumer price index of Iran using Equation (8).

$$RER_{ir,j} = ER_{ir,j} \frac{CPI_j}{CPI_{ir}} \quad (8)$$

Where,  $ER_{ir,j}$  is the Iran's Exchange Rate for the region  $j$ ,  $CPI_{ir}$  marks the Consumer Price Index for Iran and  $CPI_j$  represents the Consumer Price Index for the destination area ( $j$ ). It is worth bearing in mind that to

assess the Exchange Rate index of Rials for East Asian ( $ER_{ir,ea}$ ) and West Asian ( $ER_{ir,wa}$ ) regions, a weighted geometric mean has been used, weighted by the export value share of Iranian pistachios to countries within each region (see Loretan, 2005). It should be noted that the lending rate of the Iranian banks was obtained from the Central Bank of Iran.

The information on the gross national income and the population of all regions was gathered from the World Bank and the Food and Agriculture Organization of The United Nations (FAO), respectively. Income indicators were constructed using a weighted average, which is also weighted by the export value share of Iranian pistachios to countries within considered regions.

## RESULTS AND DISCUSSION

With the intention of estimating the domestic demand and supply equations, the domestic price equations, and the export demand and supply equations of Iran to three different markets (European Union, East Asian, and West Asian), a system of equations was designed, consisting of ten equations.

In this article, several methods have been estimated in order to analyze simultaneous equations in annual time series, including Ordinary Least Squares (OLS), Weighted Least Squares (WLS), Indirect Least Squares (ILS), Seemingly Unrelated Regression (SUR), Instrumental Variable (IV), two-Stage Least Squares (2SLS), Weighted two-Stage Least Squares (W2SLS), three-Stage Least Squares (3SLS), Generalized Method of Moments (GMM), and Full-Information Maximum Likelihood (FIML), to name but a few. In this study, the Wu-Hausman test was applied to determine the best estimation method (Baum *et al.*, 2003) and the W2SLS method was chosen. In addition, Jarque and Bera (1980) statistics were used to test the normality of error terms (Srivastava, 1984). Further, 'the System Residual Portmanteau



Tests for Autocorrelations' or 'The Box-Pierce/Ljung-Box Q-statistics' were adapted with the aim of examining the autocorrelation of error terms (Lutkepohl, 2005). Moreover, the Pagan and Hall (1983) test was employed with the purpose of analyzing heteroscedasticity of error terms. In addition to the R-squared statistics of each equation, the R-squared statistic proposed by Dhrymes (1974) was calculated to determine the goodness of fit of the system. Assuming that error terms are homoscedastic in this study, the Sargan statistic (1958), Basmann's F statistic (1960)

and the C statistic were utilized to test over-identifying restrictions (Baum *et al.*, 2003). the R-squared statistic proposed by Dhrymes (1974) for the system of equations was also calculated at 0.92 and it was significant at a 1% level. On the other hand, the lags of the Q statistics were statistically insignificant. As a result, the equations and their system were not autocorrelated.

The equations in Tables 1, 2, and 3 are estimated simultaneously using W2SLS method. The numbers in parentheses represent standard errors. It can be said that most of the estimated coefficients are

**Table 1.** Domestic supply and demand for pistachios in Iran along with endogenous price equations.

Variable	Coef	Variable	Coef	Variable	Coef	Variable	Coef
$\ln(Q_{ir}^S)_t$	Indep <sup>a</sup>	$\ln\left(\frac{PDP^{rial}}{PCI}\right)_t$	Indep.	$\ln(Q^D)_t$	Indep.	$\ln\left(\frac{CDP^{rial}}{CPI^F}\right)_t$	Indep.
$\ln\left(\frac{PDP^{rial}}{PCI}\right)_{t-1}$	0.149* (0.08) <sup>b</sup>	$\ln(Q_{ir}^S)_{t-1}$	0.893*** (0.134)	Intercept	2.925 (11.192)	Intercept	14.95*** (1.752)
$\ln\left(\frac{FWI}{SAI}\right)_t$	-1.059** (0.428)	$\ln(PX_{w,w})_t$	0.943*** (0.198)	$\ln\left(\frac{CDP^{rial}}{CPI^F}\right)_t$	-0.494 (0.44)	$\ln(Q^D)_t$	-0.076** (0.037)
$\ln\left(\frac{R \& D}{GDP^d}\right)_t$	0.69*** (0.117)	$D_{irr}$	0.453** (0.176)	$\ln\left(\frac{GNI^r}{POP}\right)_t$	2.135*** (0.745)	$\ln\left(\frac{PDP^{rial}}{PCI}\right)_{t-1}$	0.263*** (0.093)
$\ln\left(\frac{PX_{ir,w}}{PX_{w,w}}\right)_t$	1.179** (0.51)	Trend	-0.109** (0.044)	$D_{ire}$	635.54*** (81.181)	$D_{irr}$	-0.237*** (0.085)
$\ln(ER_{ir,us}^{of})_t$	0.448*** (0.093)	Trend <sup>2</sup>	0.002 (0.002)	$D_{ire}$	-75.33*** (9.617)	Trend	0.299** (0.116)
$\ln(ER_{ir,us}^d)_t$	-0.321** (0.151)			$\times \ln\left(\frac{GNI^r}{POP}\right)_t$			
$D_{irr}$	-0.64*** (0.127)			$\ln(Q^D)_{t-1}$	0.482** (0.204)	Trend <sup>2</sup>	-0.062* (0.033)
Trend	0.045* (0.024)						
$R^2$	0.68	$R^2$	0.39	$R^2$	0.76	$R^2$	0.66
DW	2.20	DW	1.70	DW	2.00	DW	1.94
F	5.15 [0.003] <sup>c</sup>	F	3.25 [0.035]	F	18.91 [0.000]	F	7.42 [0.000]
$Q_1^d$	0.30 [0.763]	$Q_1$	0.32 [0.839]	$Q_1$	0.09 [0.319]	$Q_1$	0.01 [0.334]
$Q_2^e$	0.58 [0.251]	$Q_2$	0.57 [0.675]	$Q_2$	0.76 [0.853]	$Q_2$	0.114 [1.000]

<sup>a</sup> Independent variable of the respective equation; <sup>b</sup> Numbers in parentheses represent standard error of the coefficients; <sup>c</sup> Numbers in brackets represent portability of the test statistics, <sup>d</sup> and <sup>e</sup> Represent the Box-Pierce/Ljung-Box Q-statistics of orders 1 and 2, respectively. \*, \*\* and \*\*\*: Denote statistical significance at the 10, 5 and 1% levels, respectively.

**Table 2.** Iran export demand of pistachios to European Union, East Asia, and West Asia.

Variable	Coef	Variable	Coef	Variable	Coef
$\ln(EX_{ir,eu})_t$	Indep <sup>a</sup>	$\ln(EX_{ir,ea})_t$	Indep	$\ln(EX_{ir,wa})_t$	Indep
<i>Intercept</i>	20.145*** (0.964) <sup>b</sup>				
$\ln\left(\frac{PX_{ir,eu}}{PX_{ir,w}}\right)_t$	-0.151 (0.23)	$\ln\left(\frac{PX_{ir,ea}}{PX_{ir,w}}\right)_{t-1}$	-1.572*** (0.371)	$\ln\left(\frac{PX_{ir,wa}}{PX_{ir,w}}\right)_{t-1}$	-0.654 (0.549)
$\ln\left(\frac{YPG_{ir,eu}}{POP_{ir,eu}^M}\right)_t$	0.12* (0.066)	$\ln\left(\frac{YPG_{ir,ea}}{POP_{ir,ea}^M}\right)_t$	0.406*** (0.045)	$\ln\left(\frac{YPG_{ir,wa}}{POP_{ir,wa}^M}\right)_t$	0.788*** (0.072)
$\ln(EX_{us,eu})_t$	-0.195*** (0.059)	$\ln(EX_{us,ea})_t$	0.055 (0.119)	$\ln(EX_{us,wa})_t$	-0.098** (0.042)
$\ln(RER_{ir,eu})_t$	0.167*** (0.05)	$\ln(RER_{ir,ea})_t$	0.122** (0.059)	$\ln(RER_{ir,wa})_t$	0.041 (0.028)
$\ln(TR_{eu,ir})_t$	0.006 (0.006)	$\ln(TR_{ea,ir})_t$	-0.046 (0.045)	$\ln(TR_{wa,ir})_t$	-0.066 (0.063)
<i>Trend</i>	-1.19*** (0.144)	$\ln(SD_{ir,ea}^{EX})_t$	0.832*** (0.182)	$\ln(SD_{ir,wa}^{EX})_t$	0.482*** (0.058)
$R^2$	0.88	$R^2$	0.93	$R^2$	0.96
$DW$	2.01	$DW$	1.33	$DW$	2.06
$F$	21.51[0.000] <sup>c</sup>	$F$	54.13 [0.000]	$F$	89.06[0.000]
$Q_1^d$	0.12 [0.122]	$Q_1$	2.11 [0.561]	$Q_1$	3.444 [0.24]
$Q_2^e$	0.73 [0.941]	$Q_2$	0.15 [0.278]	$Q_2$	0.62 [0.179]

<sup>a</sup> Independent variable of the respective equation; <sup>b</sup> Numbers in parentheses represent standard error of the coefficients; <sup>c</sup> Numbers in brackets represent portability of the test statistics, <sup>d</sup> and <sup>e</sup> Represent the Box-Pierce/Ljung-Box Q-statistics of orders 1 and 2, respectively. \*, \*\* and \*\*\*: Denote statistical significance at the 10, 5 and 1% levels, respectively.

significant. In addition, due to the logarithmic-linear form of the equations, the estimated coefficients represent the elasticities.

Table 1 represents the pistachios Demand and Supply of Iran. The supply elasticity calculated at 0.15 is positive and significant at 10% level. Moreover, the real price index of agricultural wages was estimated at -1.06,

which has a significant negative effect at 1% level(see: Silberberg and Suen, 2001). The government investment in R&D was computed at 0.69, thus, it plays a vital role in the agricultural supplies of Iran, having a positive and significant effect. As expected, the exchange rate had positive and significant effect on Iran's domestic supply, which was measured at 0.45 and means that

**Table 3.** Iran Inverse Export Supply of Pistachios to European Union, East Asia, and West Asia.

Variable	Coef	Variable	Coef	Variable	Coef
$\ln(PX_{ir,eu})_t$	Indep <sup>a</sup>	$\ln(PX_{ir,ea})_t$	Indep	$\ln(PX_{ir,wa})_t$	Indep
				<i>Intercept</i>	8.339*** (1.954)
$\ln(EX_{ir,eu})_{t-1}$	0.754*** (0.163) <sup>b</sup>	$\ln(EX_{ir,ea})_{t-1}$	0.215** (0.098)	$\ln(EX_{ir,wa})_{t-1}$	0.129* (0.067)
$\ln(Q_{ir}^Q)_t$	-0.760 (1.470)	$\ln(Q_{ir}^Q)_t$	-1.152 (1.06)	$\ln(Q_{ir}^Q)_t$	-0.536 (0.818)
$\ln(PDP_{ir})_{t-1}$	0.781*** (0.124)	$\ln(PDP_{ir})_{t-1}$	0.808*** (0.265)	$\ln(PDP_{ir})_{t-1}$	0.429 (0.295)
$\ln(AD_{ir,eu})_t$	-0.001 (0.007)	$\ln(AD_{ir,ea})_t$	-0.013*** (0.005)	$\ln(AD_{ir,wa})_t$	0.002 (0.004)
$\ln(LR_{ir})_t$	-2.475*** (0.654)	$\ln(LR_{ir})_t$	-0.415 (0.272)	$\ln(LR_{ir})_t$	-1.872*** (0.458)
$\ln(VLR_{ir})_t$	1.111 (2.005)	$\ln(VLR_{ir})_t$	0.860 (1.352)	$\ln(VLR_{ir})_t$	3.419*** (1.276)
$\ln(TR_{eu,ir})_t$	0.001 (0.015)	$\ln(TR_{ea,ir})_t$	0.081 (0.057)	$\ln(TR_{wa,ir})_t$	0.022 (0.192)
$\ln(EX_{us,eu})_t$	0.052 (0.067)	$\ln(EX_{us,ea})_t$	0.078 (0.171)	$\ln(EX_{us,wa})_t$	0.033 (0.092)
		$\ln(SD_{ir,ea}^{EX})_t$	-0.292*** (0.103)		
$R^2$	0.68	$R^2$	0.56	$R^2$	0.89
$DW$	2.20	$DW$	1.77	$DW$	1.27
$F$	5.18 [0.003] <sup>c</sup>	$F$	2.55 [0.072]	$F$	16.46 [0.000]
$Q_1^d$	0.57 [0.846]	$Q_1$	0.08 [0.296]	$Q_1$	2.83 [0.224]
$Q_2^e$	0.45 [0.655]	$Q_2$	0.78 [0.117]	$Q_2$	0.09 [0.199]

<sup>a</sup> Independent variable of the respective equation; <sup>b</sup> Numbers in parentheses represent standard error of the coefficients; <sup>c</sup> Numbers in brackets represent portability of the test statistics, <sup>d</sup> and <sup>e</sup> Represent the Box-Pierce/Ljung-Box Q-statistics of orders 1 and 2, respectively. \*, \*\* and \*\*\*: Denote statistical significance at the 10, 5 and 1% levels, respectively.

the increasing exchange rate in the long-term motivates pistachio farmers to produce more. However, real exchange rate fluctuations have a negative effect on domestic supply, which reckoned at -0.32, as it escalates the risk of production by increasing the price of inputs in the short term. It should be noted that the exchange rate unification policy of Iran ( $D_{irr}$ ) has had a negative effect on Iran's pistachio supply, as seen through Table 1. However, it had a positive impact on the real producer price of pistachios in Iran, as this would increase the

price of imported inputs such as pesticides and chemical fertilizers, causing the supply curve to shift to the left. Hence, after the exchange rate unification, the pistachios supply would be 47.3% lower than before, while the real producer price of pistachios would be 56.8% higher than before.

The demand elasticity was -0.49, hence, Iran's domestic demand curve was more elastic than its supply curve, because pistachios are not considered essential snacks by Iranian consumers, and they are not expected to have a significant impact on



consumer demand. An important point about the demand for pistachios is the high-income elasticity in demand for this product, which is estimated at 2.13. Iranian pistachios were exports to European markets returned to Iran due to aflatoxin contamination and were supplied to domestic markets. As a results income elasticity of pistachios in the Iranian domestic market has been negative (Table 1).

The real price of pistachios for consumers in Iran is also calculated in Table 1. It can be shown that the effect of all factors studied is as expected. Further, the most important variable in the real prices for consumers in Iran is the real price for pistachio producers. These findings show that, in Iran, pistachio consumer prices are more affected by the bargaining power of producers, calculated at 0.26. It is also essential to note that unification of the exchange rate in 2000 has had a negative effect on the real prices for Iranian consumers. In other words, with the stability of other factors, before the unification policy, the real consumer's price in Iran was about 29 million Rials per ton. However, after the unification policy, it dropped about 457,000 Rials per ton under the aforementioned conditions.

The price elasticities of export demand are calculated in Table 2 for the regions European Union, East Asia and West Asia at -0.15, -1.57, and -0.65, respectively. These results indicate that price elasticity of pistachio export demand of Iran to East Asia, unlike European Union and West Asia, is statistically significant. Furthermore, the absolute elasticity is more than 1, therefore, pistachio export demand of Iran to East Asia is elastic with respect to export price. Hence, price strategies in East Asia are more effective than other regions. The income elasticities of export demand are also calculated in the previously mentioned equations for European Union, East Asia, and West Asia at 0.12, 0.41, and 0.79, respectively. Results show that income elasticity of export demand to every region is significant.

In the pistachio world market, the United States is the main competitor of Iran, thus

the export quantity of the United States is considered as an independent variable in export demand equations of Iran (Table 2). The results demonstrate that the pistachio export of the United States to European Union and West Asia negatively and significantly influence export demand of Iran to these regions, which were roughly calculated at -0.20 and -0.10, respectively. However, in East Asia, the pistachio export of the United States has a positive impact on export demand of Iran, however, this parameter is insignificant. Moreover, regarding the results of the real exchange rate significance, it can be said that this variable generally has a positive effect on the demand for Iranian pistachio exports to different regions. The impacts of exchange rate on export demand were estimated at 0.17, 0.12, and 0.04 for European Union, East Asia, and West Asia, respectively, and were significant for European Union and East Asia.

The estimated results of Iran's export prices to European Union, East Asia, and West Asia markets are shown in Table 3, and all the signs are as expected. The interest rates for exporters have a negative effect on the export prices for Iranian exporters. In other words, the impact of interest rate measured at -2.47, -0.41, and -1.87 in export price equations of Iran in European Union, East Asia, and West Asia, respectively, is only significant in the European Union and West Asia. In order to repay the bank loan or decrease the cost of the loan, the pistachio exporters are forced to sell their pistachios at a lower price than the world price in order to repay their loans and to get loans for the next pistachio harvest time. However, in the long run, the export agents have the opportunity to plan and sell at the right prices at the right time. Thus, the volatility of interest rates has a negative effect on export supply of Iran to the European Union, East Asia, and West Asia markets, as shown in Table 4, and it was computed at -1.61, -4.29 and -26.32, respectively. It is worth noting that this result is only significant in West Asia.

**Table 4.** Iran export supply of pistachios to European Union, East Asia, and West Asia.

Variable	Coef <sup>a</sup>	Variable	Coef	Variable	Coef
$\ln(EX_{ir,eu})_{t-1}$	Indep	$\ln(EX_{ir,ea})_{t-1}$	Indep	$\ln(EX_{ir,wa})_{t-1}$	Indep
				<i>Intercept</i>	-64.60
$\ln(PX_{ir,eu})_t$	1.34	$\ln(PX_{ir,ea})_t$	4.39	$\ln(PX_{ir,wa})_t$	7.77
$\ln(Q_{ir}^Q)_t$	1.00	$\ln(Q_{ir}^Q)_t$	5.24	$\ln(Q_{ir}^Q)_t$	4.16
$\ln(PDP_{ir})_{t-1}$	-1.04	$\ln(PDP_{ir})_{t-1}$	-3.43	$\ln(PDP_{ir})_{t-1}$	-3.38
$\ln(AD_{ir,eu})_t$	0.002	$\ln(AD_{ir,ea})_t$	0.06	$\ln(AD_{ir,wa})_t$	-0.01
$\ln(LR_{ir})_t$	3.28	$\ln(LR_{ir})_t$	1.85	$\ln(LR_{ir})_t$	14.57
$\ln(VLR_{ir})_t$	-1.61	$\ln(VLR_{ir})_t$	-4.29	$\ln(VLR_{ir})_t$	-26.32
$\ln(TR_{eu,ir})_t$	-0.001	$\ln(TR_{ea,ir})_t$	-0.34	$\ln(TR_{wa,ir})_t$	-0.21
$\ln(EX_{us,eu})_t$	-0.07	$\ln(EX_{us,ea})_t$	-0.38	$\ln(EX_{us,wa})_t$	-0.23
		$\ln(SD_{ir,ea}^{EX})_t$	1.23		

<sup>a</sup> These coefficients were calculated by solving the inverse supply equations for export quantities.

The cost of advertising has a small effect on Iran's export supply and the hypothetical test of its positive and significant effect on export supply is only correct for Iran's exports to East Asia market, which was estimated at 0.06 in Table 4. Among other equations, the only positive but not significant effect of advertising is on Iran's export supply to the European Union, which was calculated at 0.002, and in West Asia it has been negligible and even negative, but not significant. This indicates that because of inefficiency in some markets, the advertising activities can be seen more as an expenditure.

Tariff effects are rarely calculated in various studies. Nevertheless, in this study, by obtaining relevant data from the WITS database, the effect of this variable on the pistachios trade in the export demand and supply side of Iran has been assessed. It is noteworthy that this variable had an insignificant effect on the main trade variables, that is, the export price and quantity. However, the only significant evidence is the negative impact of this variable on Iran's export demand in West

Asia, which was calculated at 0.02 in Table 3.

## CONCLUSIONS

This study was designed to explore the relationships in the global market of pistachios and the domestic markets of Iran. A system of simultaneous equations was estimated to answer some of the questions of Iranian export agents in relation to the role of R&D, advertising, and interest rates in pistachio markets. It has been revealed that R&D has a considerable and positive effect on the pistachio supply, while advertising has an insignificant effect on the export supply. On the other hand, the volatility of banking interest rates has a negative effect on Iran's export supply.

Although R&D programs are more effective in Iran's pistachio supply, Iran's real R&D investment is declining. It is suggested that the allocation of R&D funding in Iran be reconsidered. Moreover, regarding the negative effect of exchange rate fluctuations on supply, one of the policy



recommendations of this study is to maintain stability in the exchange rate. Furthermore, since East Asian export tariffs have a negative and significant impact on Iran's export demand, it is recommended that further research should be undertaken using panel data to investigate East Asian countries tariffs affecting Iran's export demand. Therefore, bilateral negotiations to reduce the tariffs for pistachios in accordance with the rules of world trade are encouraged. In addition, the results show that Iran's type of advertising in the global market, which is limited to international exhibitions and advertising in the virtual network, has had a negligible effect on the expansion of the Iranian export market. Hence, studying the suitable types of advertising is a vital issue for future research. Further, given that Iranian exporters need banks' loan to purchase, process, and package pistachio for export markets, short-term fluctuations in the lending rate have a negative effect on their export supply; nevertheless, its long-term interest rate on bank loan stability does have a positive effect on export supply. Thus, the best policy in the interface with this fundamental variable is to maintain its stability through a stable monetary policy by Central Bank of Iran. Also, with regard to export demand elasticities, it can be shown that Iran has market power in the European Union market. In other words, European countries are less responsive to the Iranian's export price of pistachios, and they pay more attention to their quality and taste, which can be considered in Iranian advertising programs in the European Union.

This study has found that generally US pistachio is the main competitor of Iran pistachios in European Union and West Asia markets. However, due to the decline of R&D investment in Iran, which is an essential factor in increasing the quantity and quality of pistachio production, Iran is losing its market share to United States. Moreover, the study has gone some way towards enhancing our understanding of the

effect of financial variables like interest rate on export supply, and provides empirical results on the subject.

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## اثر عوامل قیمتی و غیرقیمتی بر بازارهای پسته ایران

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### چکیده

پسته نقش مهمی در صادرات محصولات کشاورزی ایران ایفا می‌کند. این در حالی است که ایران سهم بزرگی از صادرات بین‌المللی این محصول را از دست داده است. هدف این مقاله بررسی اثر عوامل قیمتی و غیرقیمتی در بازارهای ایران با استفاده از سیستم معادلات ساختاری می‌باشد. به این ترتیب، عرضه و تقاضای داخلی پسته ایران به همراه عرضه و تقاضای صادراتی آن به سه منطقه اتحادیه اروپا، شرق آسیا و غرب آسیا طی دوره ۱۹۸۸ تا ۲۰۱۵ به صورت همزمان برآورد شدند. نتایج حاکی از اثر مثبت سرمایه‌گذاری در پژوهش و تحقیقات (R&D) بر عرضه و صادرات ایران می‌باشد. بنابراین پیشنهاد می‌شود تا در تأمین مالی پژوهش و تحقیقات تجدید نظر شود. اما برای تبلیغات اثر معنی‌داری بر عرضه صادراتی ایران در بازار مشاهده نشد. بنابراین، پیشنهاد می‌شود تا در مسأله نوع تبلیغات به عنوان یک عامل اساسی در مطالعات آینده بیشتر تمرکز شود. همچنین کشورهای اروپایی کمتر به قیمت صادراتی ایران حساس هستند و بیشتری به کیفیت و طعم پسته ایرانی توجه می‌کنند.