Import Demand for Shelled Peanuts in the European Union: Impacts of the U.S. Export Promotion Program

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Abstract

The objective of this study is to propose a system of input demand functions consistent with the theory of the firm where promotion is treated as an information input in the production function. The empirical model is applied to the European Union (EU) input demand for shelled peanuts. The information input is measured as Euros spent on the U.S. Foreign Market Development program (FMD) on peanuts by the U.S. in the EU market. We find that the FMD program had a positive effect on the EU demand for U.S. shelled peanuts. This result suggests that the information provided to manufactures through the FMD has helped to increase the demand for shelled U.S. peanuts in the EU markets. The estimated marginal return of U.S. export promotion expenditures on the FMD program is 240 Euros.

Keyword: Input demand, Shelled peanuts, U.S. Foreign Market Development Program

Introduction

Previous studies analyzing the effectiveness of export promotion programs have mainly focused on the effects of these programs on consumer demand in importing countries. Therefore, the theoretical framework used for the analysis is one derived from consumer demand theory. Using this framework, several studies have examined the effect of U.S. export promotion programs on various agricultural commodities in several importing countries. For example, studies have been conducted analyzing the import demand for red meat in Pacific Rim countries (Le, Kaiser, & Tomek, 1997), beef in Japan (Goddard and Conboy, 1993), pecans in the European Union and Asia (Onunkwo and Epperson, 2000), almonds in the Pacific Rim countries (Halliburton and Henneberry, 1995), and apples in Singapore and the United Kingdom (Richards, Van Ispelen, and Kagan, 1997).

Many agricultural goods (e.g., wheat, cotton, shelled peanuts) are demanded not by foreign consumers, but by firms, as intermediate inputs in a production process of final goods (Davis and Jensen, 1994). Hence, the effectiveness of export promotion programs should be analyzed using the theory of the firm. In this study, we propose to use a system of input demand functions consistent with the theory of the firm where promotion is treated as an information input in the production function. We then use this system of input demand to empirically analyze the effectiveness of the U.S. export promotion program on the EU import demand for shelled peanuts.

A small number of studies have looked at promotion at the firm level rather than the consumer (e.g., Ehrlich and Fisher, 1982; Richards and Patterson, 1998). Ehrlich and Fisher (1982) treated promotion as a capital input to the firm. Richards and Patterson (1998) treated export promotion as an input to U.S. producers' export supply decision.In this study, the export promotion program is treated as an information input in the production function of manufacturing companies in the importing country. This information input provides information on product characteristics and product availability of intermediate inputs (imported inputs) for importing manufactures. The manufactures can choose imported inputs from different sources. Then, the decision of the manufactures based on their information is to buy imported inputs from different sources used in the production process.

The empirical model is applied to the European Union (EU) input demand for shelled peanuts. Since the EU countries only produce a trivial amount of peanuts, the EU peanut industry depends mainly on imports from Argentina, China and the U.S.. To promote U.S. exports, the U.S. federal government provides export promotion funding for peanuts through two programs: the Foreign Market Development (FMD) and Market Access Program/Market Promotion Program (MAP/MPP) programs. The MAP/MPP programs are more of brand and generic advertising to consumers whereas FMD activities include trade services, technical assistance and advertising to manufacturing companies in the importing countries. In this sense, the MAP/MPP program differs fundamentally from the FMD program in that the former affects the demand curve for the finished product, while the latter may affect the derived demand curve for the intermediate inputs. Therefore, we focus on the effect of the U.S. FMD program on import demand for shelled peanuts in the EU because shelled peanuts are imported by EU manufacturers or processors used as imported inputs in the production process of final goods (e.g., peanut butter, peanut candy, and peanut snack).

The purpose of the FMD program for peanuts is to promote and assist U.S. peanut exports in the foreign peanut industry. Average annual expenditures for the FMD spending on the export promotion for peanuts in the EU were about $300,658 during the period of 1991 to

2001 and increased to about $383,351 during the period of 2002 to 2005, after the change in the 2002 Farm Bill. The amount of money funding for the FMD program has raised concerns about the effectiveness of the federal promotion programs. Hence, a question that naturally arises is whether these programs are effective.

World and EU Peanut Trade

According to the Production, Supply, and Distribution (PSD online) database, (FAS, USDA), the main suppliers of peanut exports in the world are Argentina, China and the U.S.. These three countries account for 70% of the world's total export quantity. In 2005, the world total quantity of peanut exports was 2,005 thousand metric tons. Within this amount, Argentina exported 400 thousand metric tons, China exported 784 thousand metric tons, and U.S. exported 223 thousand metric tons. The main importers of peanuts are Canada, European Union (EU), Japan and Mexico which account for more than 60% of total import quantities. Canada, Japan and Mexico each account for 7-8% of the world's total import quantities and EU accounts for around 38-39% (about 778 thousand metric tons) of the world's total import quantities in 2005.

According to EUROSTAT database, total quantity of peanuts imported by the EU countries[1] was 557.20 thousand metric tons in 1999, slightly increasing until it reached 713.23 thousand metric tons in 2005. During the 1999 to 2005 period, the EU import quantities of shelled peanuts were, on average, 84% of total EU peanut imports. Total value of peanuts imported by the EU countries was 526.92 million Euros in 2005. Out of this total amount, the EU total value import of shelled peanuts was 439.11 million Euros.

China, U.S., and Argentina are the major shelled peanut exporting countries into the EU. However, their share has been changing over time. The U.S. used to be the world's largest exporter of shelled peanuts into the EU market in the early 1990s but now is the third largest exporter, after China and Argentina. In 2005, the EU imports of shelled peanuts were 137.24 for Chinese shelled peanuts, 192.90 for Argentinean shelled peanuts, and 56.37 for U.S. shelled peanuts.

Input Demand Model Incorporating Information Input

The differential approach for the study of input demand (Latinen and Theil, 1978; Laitinen, 1980) has been used by several researchers (e.g.,Rossi, 1984; Washington and Kilmer, 2002; Livanis and Moss, 2006). Rossi extended Laitinen and Theil's work by including fixed factors of production in the production function and assumed that the production technology is separable in the fixed inputs. Washington and Kilmer compared the Rotterdam consumer demand model to the factor demand derived from the differential production approach. Livanis and Moss generalized the Laitinen and Theil model to account for quasi-fixed inputs with no restrictions on the firm's technology.

Our model follows Laitinen and Theil's work (1978) taking into account the information input. The industry's objective is to minimize the total cost of production $\mathbf{wx}'$ subject to the production constraint, where $\mathbf{x} = (x_1,..., x_n)'$ and $\mathbf{w} = (w_1,..., w_n)'$ are the input quantity and price vectors, respectively. Costs are minimized by varying the input quantities $x_i \in \mathbf{x}$ for a given positive output. The production function incorporating the information input variable is represented by the following equation:

(1) $$h(\mathbf{x}, \mathbf{q}, \mathbf{a}) = 0$$

where **q** is the output vector $\mathbf{q} = (q_1,..., q_r, q_{r+1,} ..., q_m)'$, and $\mathbf{a} = [a_1,..., a_l]$ is a vector of the information input provided by l input suppliers. This model is similar to Livanis and Moss (2006), and therefore we closely follow their method of derivation of the input demand equations. However, rather than interpreting **a** as a vector of quasi-fixed inputs, we interpret it as an information input vector. This is possible because the information vector is exogenous to manufacturers and does not have a price.

The short run problem of the industry is given by the Lagrangean function as:

(2) $$L(q,\rho) = \sum_{i=1}^{n} w_i x_i - \lambda h(\mathbf{x},\mathbf{q},\mathbf{a})$$

Differentiating equation (2) with respect to $\log x_i$, we get a set of *n* first order conditions corresponding to each input $x_i \in \mathbf{x}$ $(w_i x_i - \lambda \, \partial h / \partial \log x_i = 0$ where $i = 1, \ldots, n)$.

The optimum input values can be written as functions of input prices, output quantities, and the information inputs:

(3) $$\mathbf{x}_i = x_i(\mathbf{q},\mathbf{w},\mathbf{a}), \qquad i = 1, \ldots, n.$$

In order to express changes in the inputs in terms of changes in the outputs, input prices, and information inputs, equation (3) is totally differentiated with respect to $\log \mathbf{q}$, $\log \mathbf{w}$, and $\log \mathbf{a}$. Hence, the differential of equation (3) is:

(4) $$d(\log \mathbf{x}) = \frac{\partial \log \mathbf{x}}{\partial \log \mathbf{q}'} d(\log \mathbf{q}) + \frac{\partial \log \mathbf{x}}{\partial \log \mathbf{w}'} d(\log \mathbf{w}) + \frac{\partial \log \mathbf{x}}{\partial \log \mathbf{a}'} d(\log \mathbf{a})$$

The terms $\partial \log \mathbf{x} / \partial \log \mathbf{q}'$, $\partial \log \mathbf{x} / \partial \log \mathbf{w}'$, and $\partial \log \mathbf{x} / \partial \log \mathbf{a}'$ in equation (4) are unknown. For estimation purposes these terms have to be substituted by expressions involving only coefficients and the observable terms. Hence, a multi- step mathematical procedure is necessary. The first step involves totally differentiating the first order conditions of the minimization problem and the production function (equation 1) with respect to $\log q_r$, $\log w_i$, and $\log a_i$. The remaining steps, which will be explain in detailed in the following paragraphs, basically involve solving the total differential equations for $\partial \log \mathbf{x}/\partial \log \mathbf{q}'$, $\partial \log \mathbf{x}/\partial \log \mathbf{w}'$, and $\partial \log \mathbf{x}/\partial \log \mathbf{a}'$ as functions of the observed variables and coefficients.

The total differentiation of the first order conditions and equation (1) with respect to $\log q_r$, $\log w_i$, and $\log a_i$ in matrix form is:

$$\text{(5)} \qquad \begin{bmatrix} \mathbf{F}^{-1}(\mathbf{F}-\gamma\mathbf{H}_1)\mathbf{F}^{-1} & \boldsymbol{\iota}_n \\ \boldsymbol{\iota}_n' & \mathbf{0} \end{bmatrix} \begin{bmatrix} \mathbf{F}\dfrac{\partial \log \mathbf{x}}{\partial \log \mathbf{q}'} & \mathbf{F}\dfrac{\partial \log \mathbf{x}}{\partial \log \mathbf{w}'} & \mathbf{F}\dfrac{\partial \log \mathbf{x}}{\partial \log \mathbf{a}'} \\ -\dfrac{\partial \log \boldsymbol{\lambda}}{\partial \log \mathbf{q}'} & -\dfrac{\partial \log \boldsymbol{\lambda}}{\partial \log \mathbf{w}'} & -\dfrac{\partial \log \boldsymbol{\lambda}}{\partial \log \mathbf{a}'} \end{bmatrix} = \begin{bmatrix} \gamma\mathbf{F}^{-1}\mathbf{H}_2 - \mathbf{I} & \gamma\mathbf{F}^{-1}\mathbf{H}_3 \\ \gamma\mathbf{g}' & \mathbf{0} & \gamma\boldsymbol{\pi}' \end{bmatrix}$$

where $\mathbf{F} = \text{diag}(f_1, f_2,..., f_n)$, $\mathbf{g}' = (g_1,..., g_r,..., g_m)'$, $\boldsymbol{\pi}' = (\pi_1,...,\pi_k,...,\pi_l)'$, $\boldsymbol{\iota}_\mathbf{n}$ is an $n \times 1$ unit vector, $f_i = w_i x_i \big/ \sum_{i=1}^{n} w_i x_i$, $g_r = -\partial h(\cdot)/\partial \log z_r$, $\pi_\text{k} = -\partial h(\cdot)/\partial \log a_k$, $\gamma = \lambda \big/ \sum_{i=1}^{n} w_i x_i$, and

$$\mathbf{H}_1 = \left[\frac{\partial^2 h}{\partial \log x_i \partial \log x_j}\right]_{n\times n}, \ \mathbf{H}_2 = \left[\frac{\partial^2 h}{\partial \log x_i \partial \log q_r}\right]_{n\times m}, \ \mathbf{H}_3 = \left[\frac{\partial^2 h}{\partial \log x_i \partial \log a_k}\right]_{n\times l}.$$

Next, define $\boldsymbol{\Theta} = [\theta_{ij}] = (1/\psi)\mathbf{F}(\mathbf{F}-\gamma\mathbf{H}_1)^{-1}\mathbf{F}$, a symmetric positive definite $n \times n$ matrix, where ψ is a positive scalar defined by $\psi = \boldsymbol{\iota}_\mathbf{n}'\mathbf{F}(\mathbf{F}-\gamma\mathbf{H}_1)^{-1}\mathbf{F}\boldsymbol{\iota}_\mathbf{n}$. Define also $\boldsymbol{\theta} = \boldsymbol{\Theta}\boldsymbol{\iota}_\mathbf{n}$ which is a four element vector obtained from the row sum of $\boldsymbol{\Theta}$. Hence, equation (5) can be rearranged:

$$\text{(6)} \qquad \begin{bmatrix} \mathbf{F}\dfrac{\partial \log \mathbf{x}}{\partial \log \mathbf{q}'} & \mathbf{F}\dfrac{\partial \log \mathbf{x}}{\partial \log \mathbf{w}'} & \mathbf{F}\dfrac{\partial \log \mathbf{x}}{\partial \log a} \\ -\dfrac{\partial \log \boldsymbol{\lambda}}{\partial \log \mathbf{q}'} & -\dfrac{\partial \log \boldsymbol{\lambda}}{\partial \log \mathbf{w}'} & -\dfrac{\partial \log \boldsymbol{\lambda}}{\partial \log a} \end{bmatrix} = \begin{bmatrix} \boldsymbol{\psi}(\boldsymbol{\Theta}-\boldsymbol{\theta}\boldsymbol{\theta}') & \boldsymbol{\theta} \\ \boldsymbol{\theta}' & -1/\psi \end{bmatrix} \begin{bmatrix} \gamma\mathbf{F}^{-1}\mathbf{H}_2 - \mathbf{I} & \gamma\mathbf{F}^{-1}\mathbf{H}_3 \\ \gamma\mathbf{g}' & \mathbf{0} & \gamma\boldsymbol{\pi}' \end{bmatrix}$$

Next, premultiply equation (4) by $\mathbf{F}$ and then substitute the expressions for $\mathbf{F}\partial \log \mathbf{x}/\partial \log \mathbf{q}'$, $\mathbf{F}\partial \log \mathbf{x}/\partial \log \mathbf{w}'$, and $\mathbf{F}\partial \log \mathbf{x}/\partial \log \mathbf{a}'$ obtained from equation (6) back in equation (4). The conditional input demand equations are then:

$$\text{(7)} \qquad \mathbf{F}d(\log \mathbf{x}) = (\gamma\boldsymbol{\theta}\mathbf{g}' + \gamma\psi(\boldsymbol{\Theta}-\boldsymbol{\theta}\boldsymbol{\theta}')\mathbf{F}^{-1}\mathbf{H}_2)d(\log \mathbf{q}) - \psi(\boldsymbol{\Theta}-\boldsymbol{\theta}\boldsymbol{\theta}')d(\log \mathbf{w})$$

$$+ \ (\gamma\boldsymbol{\theta}\boldsymbol{\pi}' + \gamma\psi(\boldsymbol{\Theta}-\boldsymbol{\theta}\boldsymbol{\theta}')\mathbf{F}^{-1}\mathbf{H}_3)d(\log \mathbf{a})$$

Let $\mathbf{g}' = \boldsymbol{\iota}'_m \mathbf{G}$ with $\mathbf{G} = \text{diag}(g_1,...,g_m)$, $\boldsymbol{\pi}' = \boldsymbol{\iota}'_l \mathbf{A}$ with $\mathbf{A} = \text{diag}(\pi_1,...,\pi_l)$. Also, let $\theta_i^r = (\partial w_i x_i / \partial q_r)/(\partial C/\partial q_r)$ be the share of the ith input in the marginal cost of the rth product, and $\xi_i^k = (\partial w_i x_i / \partial a_k)/(\partial C/\partial a_k)$ the share of the ith input in the shadow price of information input kth. Then, the coefficients of $d\log q$ and $d\log a$ in equation (7) are equal to $\gamma[\theta_i^r]\mathbf{G}$ and $\gamma[\xi_i^k]\mathbf{A}$, respectively. Hence, equation (7) becomes:

(8) $$\mathbf{F}d(\log \mathbf{x}) = \gamma[\theta_i^r]\mathbf{G}d(\log \mathbf{q}) - \psi(\boldsymbol{\Theta} - \boldsymbol{\theta}\boldsymbol{\theta}')d(\log \mathbf{w}) + \gamma[\xi_i^k]\mathbf{A}d(\log \mathbf{a})$$

The ith element of equation (8) which corresponds to the input $x_i \in \mathbf{x}$ takes the form:

(9) $$f_i d(\log x_i) = \gamma \sum_{r=1}^{m} \theta_i^r g_r d(\log q_r) - \psi \sum_{j=1}^{n} (\theta_{ij} - \theta_i \theta_j) d(\log w_j) + \gamma \sum_{k=1}^{l} \xi_i^k \pi_k d(\log a)$$

Equation (9) is the ith differential input demand equation which describes the change in the demand for the ith input $d(\log x_i)$ in terms of output changes $(\log q_r)$, input price changes $d(\log w_j)$, and information input changes $d(\log a)$. It is important to point out that in this model the information input **a** does not change the total amount of input $(\sum_{i=1}^{n} x_i)$ but the information input changes the proportion of each input (x_i) used in the production process.

Empirical Model: Application to EU Imported Demand for Shelled Peanuts

The EU peanut industry requires several inputs in the production process of peanut processed products (e.g., peanut butter, peanut snack, and peanut candy). Variable inputs include shelled peanuts, labor, energy, and other materials. Hence, the input demand equations should include the prices of all these inputs and the quantities of all the products manufactured by the industry. However, data limitations preclude us to include all of these variables in the empirical model. Our empirical model uses two simplifying assumptions. We first assume that labor, energy and other material are separable from shelled peanut inputs, and second we assume that the peanut industry has the input-output separable forms.

Input demand equations for the other inputs (energy and labor) could also be included, but the quantity data necessary to estimate these equations are not available. Furthermore, the price and quantity data for other materials used in the production process of peanut processed products are not available. Therefore, these inputs are excluded from our model.

The input-output separable form implies that the changes in input demands are independent of the changes in individual outputs. As a result, changes in output play no role in the total input decision. This assumption, which we acknowledge is very strong, it is necessary given the unavailability of data on quantities and prices of all processed products manufactured in the EU using shelled peanuts.

Mathematically the input-output assumption implies that $\theta_i d(\log X) = \gamma \sum_{r=1}^{m} \theta_i^r g_r (\log q_r)$ [2] where $\sum_{r=1}^{m} g_r \theta_i^r = \theta_i$, $i = 1,...,\ n$ which means that the marginal shares of each input are the same across outputs. Also, this assumption implies that $d(\log X) \approx \gamma d(\log Q)$ which in words means the total input decision of the industry, expressing the Divisia volume index of the inputs as proportional to the corresponding index of the outputs. Hence, the *ith* differential input demand equation of the EU peanut industry in equation (9) can be written as:

(10)
$$f_i d(\log x_i) = \theta_i d(\log X) - \sum_{j=1}^{n} \theta_{ij} d(\log w_j) + \sum_{k=1}^{l} \mu_{ik} d(\log a_k),$$

where $f_i = p_i q_i / C$ is the share of the *ith* input as the proportion of total cost C, $d(\log X) = \sum_{i=1}^{n} f_i d(\log x_i)$ is the Divisia volume index of the inputs.

The input demand in equation (10)[3] (the change in input demand for ith input) involves three terms: 1) the Divisia volume index of inputs $d(\log X)$, 2) the changes in input price $d(\log w_j)$, and 3) the changes in information input $d(\log a_k)$. To be consistent with economic theory, the system of input demand must satisfy the following input demand restrictions. Adding up implies the following restrictions in the parameters ($\sum_{s=1}^{n}\theta_s = 1;\ \sum_{s=1}^{n}\theta_{sj} = 0;\ \sum_{s=1}^{n}\mu_{sk} = 0$), homogeneity implies ($\sum_{s=1}^{n}\theta_{sj} = 0$), and symmetry implies ($\theta_{ij} = \theta_{ji}$). The restriction ($\sum_{s=1}^{n}\mu_{sk} = 0$) implies that only the proportion of shelled peanuts from different sources can change but not the total their total amount.

As mentioned previously, the EU peanut industry depends on imports of shelled peanuts from Argentina, China, the U.S., and the rest of the world. Since there is some evidence that shelled peanuts from different sources have different quality, it is important to differentiate the sources when analyzing the EU peanut import demand. Therefore, we estimate a system of EU input demand equations for shelled peanuts incorporating the information input. This information input is measured as Euros spent on FMD by the U.S. in the EU market. The U.S. is the only country that is funding an export promotion program in Europe. The other export counties do not have any types of export promotion for peanuts in Europe. The additional explanatory variables for the conditional input demand in equation (10) are seasonal dummy variables and a dummy variable to capture the effect of farm bill 2002 (2002:4-2005:4). Hence, the empirical model of the conditional input demand system used for estimation in study is:

$$\bar{f}_{it} d(\log x_{it}) = \theta_i d(\log X_t) - \sum_{j=1}^{4}\theta_{ij} d(\log w_{jt}) + \mu_{us} d(\log a_{ust}) \tag{11}$$

$$+\sum_{v=1}^{3} d_v D_{vt} + d_f FB_t + \varepsilon_{it},$$

where $\bar{f}_{it} = (f_{it} + f_{it-1})/2,$ t indexes time (1991:1-2005:4), a_{us} is Euros spent on FMD by U.S. in the EU market, D_v is the seasonal dummy variable, FB is the farm bill dummy variable, and ε_i is the error term.

The conditional input demand system of imported shelled peanuts represented by equation (11) contains four equations (i = Argentina, China, U.S., and ROW). The ROW equation for shelled peanuts is dropped to avoid singularity problems since the input shares in the conditional input demand system sums to one. The parameters of the conditional input demand system after imposing homogeneity and symmetry were estimated by iterated seemingly unrelated regression method (ITSUR).

Elasticities

The conditional own price and cross price elasticities of the input source differentiated demand model are $\varepsilon_{ij} = \theta_{ij} / f_i$ when $i = j$ for the own price elasticities and $i \neq j$ for the cross price elasticities. The own price elasticities are expected to be negative. For the cross price elasticities, if θ_{ij} is negative (positive), *ith* and *jth* import inputs are specific complements (substitutes).

The Divisia index elasticity is $\eta_i = \theta_i / f_i$. When η_i is greater one, the industry's use of the *ith* import input increases more rapidly than the industry's average import input. Similarly, when η_i is between zero and one, the industry's use of the *ith* import input increases when average import input does, but not so quickly. In general, the Divisia import elasticity shows the percentage change in a country's exports that are imported into another country given a one percent change in the importing country's total imports.

The information input elasticities (export promotion elasticities) (ρ_{ij}) are μ_{ik} / f_i. When μ_{ik} has positive value, it implies that the export promotion program has positive effect on the ith import input from source *i*. On the other hand, when μ_{ik} has negative value, it implied that the export promotion program has negative effect on ith import input from source *i*.

Data

The data used to estimate the model are quarterly time series data from 1991 to 2005. The sources of peanuts considered are Argentina, China, U.S., and the rest of the world. The quantity of imports from each source is measured in 100 kilogram (kg), and the value of imports is measured in Euros. Import price data is not available to obtain so unit prices[4] are used as a proxy for import prices. The data were obtained from several sources published by EUROSTAT. The U.S. dollar export promotion expenditures on the FMD program for peanuts in the EU are from the American Peanut Council[5] (APC).

The U.S. dollar export promotion expenditures on the EU were converted to the Euros by using the real exchange rate between U.S. and the EU (U.S. dollars to one Euro). The real exchange rate was obtained by multiplying the nominal exchange rate times the ratio of the U.S. to Netherlands Consumer Price Index for food. The Netherlands Consumer Price Index for food was used as proxy for EU Consumer Price Index because the Netherlands is the main importer of peanuts in the EU and data for the nominal exchange rate and EU Consumer Price Index for food are only available after 1998. The nominal exchange rate between the U.S. and the EU was obtained by multiplying the nominal exchange rate between the U.S. and the UK by the nominal exchange rate between the UK and the EU. Exchange rate between the U.S. and the UK (U.S. dollars to one British pound) is from the Federal Reserve Bank of St. Louis and is available online. Nominal exchange rate between UK and the EU (British pound to one Euro) is from the EUROSTAT database. U.S. and Netherlands Consumer Price Indexes for food are from SourceOECD Main Economic Indicators.

An interpolation method was utilized to produce quarterly time series of the Euro export promotion expenditures from the available annual time series. Interpolation methods allow producing a time series at a higher frequency that is actually available; for example, a quarterly series from yearly data.

Peanut production in the EU is not included since the EU produces only a trivial amount of peanuts, and peanut processors depend on peanut import from different sources. Hence, domestic production can be ignored in this study because their peanut production is very small relative to the amount of their peanut imports[6].

Results

A description and simple statistics for the variables based on quarterly basis (quantities, values, and US export expenditures on the FMD program) are presented in table 1. The mean quantities of EU imports are 29.86 thousand metric tons for Argentinean shelled peanuts, 28.27 thousand metric tons for Chinese shelled peanuts, and 26.32 thousand metric tons for U.S. shelled peanuts. In addition, the mean values of EU imports are 22.03 million Euros for Argentinean shelled peanuts, 20.11 million Euros for Chinese shelled peanuts and 21.73 million Euros for U.S. shelled peanuts. Furthermore, the mean expenditure of U.S. FMD program is 71.64 thousand Euros.

Given the fact that the system of input demand equations is estimated using time series data, a test of autocorrelation is conducted. Specifically, we use the Breush-Godfrey (BG) systemwise test (Shukur, 2002) for autocorrelation. The test is done using multivariate an F-test proposed by Rao. Results of BG systemwise test indicate that there is no presence of autocorrelation in the system of equations (P value equals 0.71). This might be due to the fact that the DFAM uses the first difference of the log of variables. Homogeneity and symmetry are also tested using a likelihood ratio (LR) test. The null hypothesis that homogeneity is satisfied is rejected (P-value = 0.005) but we can not reject the null hypothesis that symmetry is satisfied (P-value = 0.33).

Parameter estimates

Conditional differentiated input demand parameter estimates for EU imports of shelled peanuts are shown in table 2. All the own-price parameter estimates are negative, as expected. The estimates of the marginal factor shares are statistically significant for all equations and positive. The positive sign indicates that as total imports increase, imports from each source country also increase as well.

Most of the cross price coefficients are statistically significant except for the cross price coefficient between Argentina and U.S. in the input demand equation for Argentinean shelled peanuts. The cross price coefficients indicate that imported shelled peanuts from U.S., China, and Argentina are substitutes in the EU markets. Only imported shelled peanuts from China and the rest of the world are complements in the EU markets.

The dummy variable included to capture the 2002 Farm bill which eliminated the marketing quota system for peanuts is found to have a negative effect on import input demand for U.S. shelled peanuts but the coefficient is not statistically different from zero.

Results in table 2 also indicate the export promotion (U.S. FMD expenditure) has a statistically significant positive effect on the import input demand for U.S. shelled peanuts and statistically significant negative effect on the import input demand for Argentina shelled peanuts. This suggests that U.S. export promotion expenditures on the FMD program would help to increase EU import demand for U.S. shelled peanuts and to decrease EU import demand for Argentinean shelled peanuts. The results also indicate a positive effect of the FMD program on the import input demand for Chinese shelled peanuts but it is not statistically significant. Therefore the results suggest that the information provided to manufacturers through the FMD has helped to maintain the import input demand for U.S. shelled peanuts in the EU market.

Elasticities

Divisia index and price elasticities evaluated at the factor mean are presented in table 3. The Divisia index elasticities are 0.55, 1.04, 1.56, and 0.69 for Argentina, China, U.S., and rest of the world, respectively. With the exception of the rest of the world, all of the Divisia index elasticities are significant at the 5% level. This indicates that if total shelled peanuts imported into EU increase by 1.0%, shelled peanuts export to EU from these countries will increase by 0.55%, 1.04%, 1.56%, and 0.69%, respectively. Therefore, the biggest beneficiary when total shelled peanuts imports increase into EU markets is the U.S., followed by China, the rest of the world, and Argentina.

The own-price elasticities for shelled peanuts from different sources are negative corresponding to the law of demand. The own price elasticities of demand for Argentina shelled peanuts are -1.97, for Chinese shelled peanuts -2.19, for U.S. shelled peanuts -2.03, and for the rest of the world -1.32. They are all elastic and significant. These results imply that shelled peanuts from China, Argentina and U.S. imported into the EU are more sensitive to a price change than shelled peanuts from rest of the world. Hence, China, Argentina and U.S. exporters may have an incentive to decrease price to raise total sales.

The cross-price elasticities indicate that shelled peanuts from Argentina, China, and U.S. are substitutes. Furthermore, the cross price elasticities between Argentina and China have a high degree of substitutability as well as the cross price elasticities between China and U.S.. The cross price elasticities of U.S./China and Argentina/China are significant and their values are 1.34 and 1.07, respectively. These results indicate that if the price of China shelled peanuts increase by 1 percent, the quantity demanded for U.S. shelled peanuts into the EU will increase by 1.34%, and the quantity demanded for Argentina shelled peanuts exported into the EU will increase by 1.07%. This suggests that U.S. gains a little bit more than Argentina when China price for shelled peanuts increases. In addition, the cross price elasticities of Argentina/U.S. and China/U.S. are 0.27 and 1.48, respectively. These results suggest that China gains more than Argentina when U.S. price for shelled peanuts increases. The cross price elasticities of China/Argentina and U.S./Argentina are 1.16 and 0.27, respectively. These results suggest that China will gain more than U.S. when Argentina price for shelled peanuts increases.

All export promotion elasticities are calculated at the input mean showed in table 3. The export promotion elasticities for Chinese and rest of the world shelled peanuts are found to be insignificant. This implies that U.S. export promotion expenditures on the FMD program do not have an impact on input demand for Chinese and the rest of the world shelled peanuts. The export promotion elasticities of EU import demand for U.S. shelled peanuts have a positive effect while the export promotion elasticities for Argentinean shelled peanuts have a negative effect. The export promotion elasticities for U.S. and Argentinean shelled peanuts are found to be significant.

Using the export promotion elasticities in table 3, the marginal return to promotion expenditures can be obtained by multiplying promotion elasticity by the ratio of mean imported peanut expenditures to mean promotion expenditures in that country (Halliburton and Henneberry, 1995; Richards, Van Ispelen and Kagan, 1997). Thus, the marginal return per Euros of U.S. export promotion expenditures on the FMD program is 240 EURO dollars for U.S. shelled peanuts. The high rate of return for U.S. shelled peanuts is due to the fact that U.S. export promotion expenditure on the FMD program is only 0.42 percent of the total imported value of U.S. shelled peanuts during years 1991-2005.

Summary and Conclusions

This paper analyzes the effect of input suppliers' promotion on the manufacturers demand for the inputs. It is shown that a system of input demand functions consistent with the theory of the firm, where promotion is treated as an information input in the production function, can be used for empirical applications.

The empirical application examines the effect of the U.S. FMD program on EU import input demand for shelled peanuts. A system of input demands is estimated for imported shelled peanuts from Argentina, China, and the U.S. using the quarterly data from 1991 to 2005. The results of Divisia index elasticities for imported shelled peanuts show that, U.S. is the biggest beneficiary of export shelled peanuts to the EU markets when EU's total imports of shelled peanuts increases. A high value of Divisia index elasticity is associated with high quality of peanuts because the Divisia elasticity indicates a similar relationship as the conditional expenditure elasticity in the Rotterdam model.

Conditional own-price elasticities indicate that imported shelled peanuts from Argentina and China are more sensitive to a price change than shelled peanuts from U.S.. Conditional cross-price elasticities indicate that Argentinean and Chinese shelled peanuts are substitutes with U.S. shelled peanuts. This indicates that U.S., Argentina and China are competing exporters to the EU shelled peanut market.

The U.S. shelled peanuts export promotion (U.S. FMD expenditure) was found to have a positive effect on the input demand for U.S. shelled peanuts. This suggests that U.S. export promotion expenditures on the FMD program has achieve its objective of helping to increase EU import demand for U.S. shelled peanuts. The marginal return rate per Euros of U.S. export promotion expenditures on the FMD program is 240 Euros.

The results also indicate that the U.S. would get the most benefit from the growth in EU imports of shelled peanuts. However, since the demand for shelled peanuts in Europe has been steady, maintaining strong export markets is an important priority for the U.S. peanut industry. In that sense, as our results show export promotion programs may be a marketing strategy to help boost the demand for U.S. peanuts. Another marketing strategy that could be used is product differentiation since there is evidence that U.S. peanuts are perceived to have a better quality than peanuts from other sources.

[1] The EU total quantities of peanut imports are both Extra-EU and Intra-EU imports.

[2] More detail about derivation can be found with Laitinen and Theil (1978), and Laitinen (1980).

[3] The solution in equation (10) is equivalent to the Rotterdam model derived from consumer demand theory under the assumption of input-output separability. Furthermore, Davis and Jensen (1994) showed that the solution of input demand derived from two-stage profit is equivalent to the solution of consumer demand derived from two-stage utility maximization at the optimal point.

[4] Unit prices of imported shelled peanuts from each country are computed by dividing total value by total quantity of imports.

[5] The export promotion data is from personal communication and contract with American Peanut Council in 2007.

[6] The EU production is less than 0.0001 percent of total world production and is less than 0.01 percent of total EU import of peanuts. The data of EU and world peanut production are available at Production, Supply and Distribution (PSD online).

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Table 1. The mean of EU import quantities and values for shelled peanuts from Argentina (AR), China (CN), U.S., and rest of the world (RS) and U.S. FMD expenditures on quarterly basis.

Variables	Mean	Std Dev	Minimum	Maximum
Quantity for AR shelled peanuts (100 kg)	298645	135060	38769	643808
Quantity for CN shelled peanuts (100 kg)	282718	105333	93549	549702
Quantity for US shelled peanuts (100 kg)	263228	110352	71396	595136
Quantity for RS shelled peanuts (100 kg)	167198	85999	25955	507913
Value of AR shelled peanuts (Euro dollars)	22034343	9885678	2526450	41900359
Value of CN shelled peanuts (Euro dollars)	20111691	7859970	7084498	46298800
Value of US shelled peanuts (Euro dollars)	21732635	7633827	7882526	36259150
Value of RS shelled peanuts (Euro dollars)	11166544	5588292	1765500	30969937
U.S. FMD expenditure (Euro dollars)	71637	14385	50364	113599

Source: EUROSTAT database and American Peanut Council (APC).

Table 2. Parameter Estimates of the Restricted Conditional Differentiated Input Demand for EU Imports of Shelled Peanuts (Homogeneity and Symmetry imposed)

Parameter	Argentina	China	United States
Price Coefficients (θ_{ij})			
Argentina	-0.574^{**}		
	(0.149)		
China	0.310^{**}	-0.587^{**}	
	(0.130)	(0.178)	
United States	0.079	0.396^{**}	-0.600^{**}
	(0.121)	(0.136)	(0.177)
Rest of the World	0.186^{**}	-0.119^{*}	0.125^{*}
	(0.064)	(0.066)	(0.074)
Marginal Factor Shares (θ_i)	0.160^{*}	0.279^{**}	0.460^{**}
	(0.081)	(0.080)	(0.095)
Export Promotion (μ_{us})	-0.352^{**}	0.038	0.235^{*}
(U.S. FMD expenditure)	(0.122)	(0.121)	(0.142)
Seasonal Dummy (D_v)			
Quarter1 (January-March)	-0.070^{**}	0.060^{**}	-0.021
	(0.020)	(0.019)	(0.023)
Quarter2 (April-June)	-0.081^{**}	0.054^{**}	0.043^{*}
	(0.019)	(0.019)	(0.022)
Quarter3 (July-September)	0.157^{**}	-0.051^{**}	-0.080^{**}
	(0.020)	(0.020)	(0.023)
Dummy variable Farm Bill 2002	0.020	-0.025	-0.009
	(0.024)	(0.024)	(0.028)
R^2	0.809	0.459	0.576
adj-R^2	0.783	0.385	0.517
DW	2.315	1.991	2.027

Significance levels of 0.05 and 0.10 are indicated by ** and *, respectively.
Values in the parentheses represent the standard errors.

Table 3. Conditional Divisia and Price Elasticities of the Restricted Conditional Differentiated Input Demand for EU imports of Shelled Peanuts

Exporting Country	Divisia Index	Conditional Own-Price Elasticities	Conditional Cross-Price Elasticities				Elasticities of Export Promotion
			Argentina	China	United States	Rest of the World	
Argentina	0.55* (0.28)	-1.97** (0.51)	-	1.07** (0.45)	0.27 (0.41)	0.64** (0.22)	-1.21** (0.42)
China	1.04** (0.30)	-2.19** (0.66)	1.16** (0.49)	-	1.48** (0.51)	-0.44* (0.24)	0.14 (0.45)
United States	1.56** (0.32)	-2.03** (0.60)	0.27 (0.41)	1.34** (0.46)	-	0.42* (0.25)	0.79* (0.48)
Rest of the World	0.69 (0.44)	-1.32** (0.41)	1.28** (0.44)	-0.82* (0.45)	0.86* (0.51)	-	0.54 (0.68)

Significance levels of 0.05 and 0.10 are indicated by ** and *, respectively.
Values in the parentheses represent the standard errors.