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An Equilibrium Displacement Approach to Analyzing the Effects of Tariff Reduction on Farmers' Profits: The Korea–Chile FTA's Effects on Korean Grape Producers

Byeong-il Ahn and Jeong-bin Im

Abstract
The present study develops an equilibrium displacement model (EDM) to evaluate the impacts of a free trade agreement (FTA) on the profits of individual farmers. The parameters representing the share of profit within revenue and the elasticity of cost with respect to quantity in the cost function play key roles in assessing the change in individual farmers' profit. The application of the developed EDM to assess the impacts of the Korea–Chile FTA indicates that this FTA has little impact on the Korean grape market and grape producers in Korea.

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Keywords EDM; simulation; tariff reduction; farm profit; cost function

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1. Introduction

Equilibrium displacement models (EDMs), in which equations are expressed as the log of differential forms and the parameters linked with the exogenous and endogenous variables represent elasticities, have been widely applied to evaluate the impacts of exogenous shocks on endogenous variables and social welfare (Davis and Espinoza, 1998; Wohlgenant, 2011). One of the most common objects of exogenous shocks has been change in government policies governing taxes, subsidies, tariffs, and so on. For example, some research investigating the impacts of tariff reductions due to WTO negotiations or FTAs uses EDM approaches (for example, Sumner, 2000; Richard and Sumner, 2008; Ahn, 2011; Ahn et al., 2013; Ferrier and Zhen, 2013). These studies analyzed the influences of tariff reduction on changes in domestic production, domestic prices, and imports.

Many studies associated with EDM applications are found in the agricultural field, in particular, since EDMs provide detailed commodity-specific analytical results and is relatively convenient for implementing policy simulations with no need to estimate supply and demand functions. EDMs require only demand and supply elasticities, which can be acquired from existing studies. Among changes in government policies for agriculture, tariff reduction has been frequently analyzed for its effects on the markets of agricultural products (Sumner and Wohlgenant, 1985; Alston et al., 1997; Davis and Espinoza, 1998; Wohlgenant, 1999; Richard and Sumner, 2008; Ahn and Lee, 2010; Ferrier and Zhen, 2013). However, EDMs have been applied to evaluate changes in market equilibrium, and thus have been used to assess the changes in gross revenues of agricultural producers at the market level, which can be derived from changes in equilibrium production and price. Thus, despite their wide applicability and the relatively convenient nature of their usage, EDMs' usefulness has been limited in evaluating the impacts of exogenous shocks on the individual farmer level, such as the profit of a farmer. In order to fill this gap, this study develops an EDM that assesses the impacts of tariff reduction on farm-level profit.

With prevailing regional trade agreements such as FTAs, the degree of market opening to foreign countries has become greater, and the dependence of a country's whole economy on imports and exports is becoming ever more important. Among the various industries in Korea, agriculture in particular has been recognized as very vulnerable to market opening, because the prices of domestically produced agricultural products are generally higher than those of imported ones. Starting with the FTA with Chile, Korea has made numerous FTAs with 45 nations: Singapore, India, Peru, the United States, the four countries involved in the European Free Trade Association (EFTA), the 10 ASEAN countries, the 27 EU countries, and China. Currently, Korea is very active in pursuing FTA negotiations. Since there has been very strong opposition to the FTAs from the agricultural sector, the Korean government has implemented polices such as income-compensating direct payments and indirect support for reducing production costs to support the agricultural sector.

The grounds for these supporting policies have been ex-ante assessments of loss due to the anticipated FTAs. For example, the Korea–Chile FTA was expected to cause 11 to 45 million dollars of loss for the agricultural sector (Eur et al., 1999; Choi et al., 2002; Choi et al., 2006; Jung, 2006). These assessments are based on gross revenues in the agricultural sector, rather than the net profits of farmer. Thus, the policies that created a budget of 21.3 billion dollars intended to support farmers and compensate for losses due to the Korea–Chile, Korea–United States, and Korea–EU FTAs has faced opposition from non-agricultural sectors, since this budget is expected to be far larger than the aggregated loss of profit of all farmers. Doubts about the size of the budget for loss-compensating payments or other policies to support farmers create a need to evaluate the impacts of FTAs on the profit of farmers. In this context, this paper develops an EDM methodology that can be applied to capture the effects of changes in market equilibrium on individual farmers' profits. The effects of the Korea–Chile FTA are then evaluated via the developed farm profit–capturing EDM model.

This paper is structured is as follows. In the next section, the theoretical model is discussed. The EDM and farmers' profit maximization to yield market-level supply are discussed. The linkage between the changes in equilibrium price, quantity, and farm profit are discussed in this section. An empirical application is performed in section 3. In this section, the parameters required for the application of the developed EDM to evaluate the impacts of the Korea–Chile FTA on the grape market are discussed. To acquire the parameters at the farm level, the cost function of a representative grape producer is estimated in this section. Some background information about the grape industry, which was expected be most influenced by the Korea–Chile FTA, is provided in this section. We simulate the effects of the Korea–Chile FTA under different scenarios and compare the effects on the farm profit. We summarize and conclude in Section 4.

2. Model

Assuming domestic and imported products are not homogeneous, demand for and supply of a specific agricultural product can be expressed as in equations (1) and (2). If we employ a small country assumption, which is very reasonable from the perspective of Korea's imports, considering the market shares of the commodities (including grapes, the target of analysis in this study) imported by Korea within the total traded volume in the international markets, the price of the imported product competing with a domestic one is the international price multiplied by the exchange rate and the tariff rate, as in equation (3).

$$Q = f_d(P, P_w, H_d) \tag{1}$$

$$Q = f_s(P, H_s) \tag{2}$$

$$P_w = P_a e(1 + R), \tag{3}$$

where P is the country's own price, P_w is the price of the imported product, H_d comprises demand shifters, H_s denotes supply shifters, P_a is the international price, e is the exchange rate, and R is the tariff rate. By taking the total differentiation of equations (1) to (3), we have following log-differential forms.

$$\frac{dQ}{Q} = \frac{\partial f_d(.)}{\partial P}\frac{P}{Q}\frac{dP}{P} + \frac{\partial f_d(.)}{\partial P_w}\frac{P_w}{Q}\frac{dP_w}{P_w} + \frac{\partial f_d(.)}{\partial H_d}\frac{H_d}{Q}\frac{dH_d}{H_d} \tag{4}$$

$$\frac{dQ}{Q} = \frac{\partial f_s(.)}{\partial P}\frac{P}{Q}\frac{dP}{P} + \frac{\partial f_s(.)}{\partial H_s}\frac{H_s}{Q}\frac{dH_s}{H_s} \tag{5}$$

$$\frac{dP_w}{P_w} = \frac{dP_a e(1+R)}{P_a e(1+R)} + \frac{P_a de(1+R)}{P_a e(1+R)} + \frac{P_a dR}{P_a e(1+R)}. \tag{6}$$

Since the percentage changes in quantity and price are the endogenous variables, the solutions to the above simultaneous equation system are derived as equations (7) and (8).

$$EP = \frac{1}{\eta - \varepsilon}\left[-\varepsilon\eta_w\left(EP_a + Ee + \frac{dR}{1+R}\right) - \varepsilon\eta_h EH_d + \eta\varepsilon_h EH_s\right] \tag{7}$$

$$EQ = \frac{1}{\eta - \varepsilon}\left[-\eta_w\left(EP_a + Ee + \frac{dR}{1+R}\right) - \eta_h EH_d + \varepsilon_h EH_s\right], \quad (8)$$

where EQ, EP, EP_w, EH_d, EH_s, EP_a, and Ee indicate dQ/Q, dP/P, dP_w/P_w, dH_d/H_d, dH_s/H_s, dP_a/P_a, and de/e, respectively. The parameters η, η_w, η_h, ε, and ε_h are own price elasticity of demand, cross elasticity of demand with respect to the price of the imported product, elasticity of demand with respect to the demand shifters, own price elasticity of supply, and elasticity of supply with respect to supply shifters, respectively.

Next, we discuss the profit for the producers of an agricultural product. Under a competitive market, the profit of a representative producer can be expressed as $\pi_i = Pq_i - C_i(q_i, w_1, w_2, \ldots, w_k)$, where q_i is the quantity supplied by individual producer i, $C_i(q_i, w_1, w_2, \ldots, w_k)$ is the cost for individual producer i to produce output q_i, and w_k is the price of input k. When input prices are influenced by changes in output price, total differentiation of the profit function yields the following log-differential form of the profit.[1]

$$E\pi_i = \frac{1}{\rho_i}EP - \frac{1}{\rho_i}Eq_i - \delta_i\left(\frac{1}{\rho_i} - 1\right)Eq_i - \sum_{j=1}^{k}\varphi_{ij}\gamma_j\left(\frac{1}{\rho_i} - 1\right)EP$$

$$= \left[\frac{1}{\rho_i} - \sum_{j=1}^{k}\varphi_{ij}\gamma_j\left(\frac{1}{\rho_i} - 1\right)\right]EP + \left[\frac{1-\delta_i}{\rho_i} + \delta_i\right]Eq_i, \quad (9)$$

where $E\pi_i$ is the proportional change in the individual farmer's profit, Eq_i is the proportional change in the quantity supplied by individual farmer i, ρ_i is the share of profit within revenue ($\frac{\pi_i}{Pq_i}$), δ_i is the elasticity of cost with respect to quantity ($\frac{\partial C_i(.)}{\partial q_i}\frac{q_i}{C_i(.)}$), φ_{ij} is the elasticity of cost with respect to input price w_j ($\frac{\partial C_i(.)}{\partial W_j}\frac{W_j}{C_i(.)}$), and

[1] Detailed derivation is as follows. $\frac{d\pi_i}{\pi_i} = \frac{dP}{P}\frac{Pq_i}{\pi_i} + \frac{dq_i}{q_i}\frac{Pq_i}{\pi_i} - \frac{\partial C_i(.)}{\partial q_i}\frac{q_i}{C_i(.)}\frac{dq_i}{q_i}\frac{C_i(.)}{\pi_i} - \sum_{j=1}^{k}\frac{\partial C_i(.)}{\partial W_j}\frac{W_j}{C_i(.)}\frac{\partial W_j}{\partial P}\frac{P}{W_j}\frac{dP}{P}\frac{C_i(.)}{\pi_i}$

γ_j is the elasticity of input price w_j with respect to the output price ($\frac{\partial W_j}{\partial P}\frac{P}{W_j}$). When the demand of inputs for the specific output of interest is a very small portion of total input demand, and the input market is competitive, then, essentially, γ_j is close to zero. Thus, in this case, equation (9) is simplified to the form of $\frac{1}{\rho_i}EP + [\frac{1-\delta_i}{\rho_i} + \delta_i]Eq_i$. In calculating this final form of profit change, the proportional changes in price and quantity (i.e., *EP* and *EQ*) derived in equation (7) and (8) are used.

Based on equation (9), we can assess the proportional changes in the farmer's profit on two levels: the impact on the aggregated farm profit and the impact on the profit of the individual farmer. First, under the assumption of symmetric parameters $\rho_i = \rho$, $\delta_i = \delta$, and $\varphi_{ij} = \varphi_j$, we can calculate the quantity share-weighted average of proportional changes in the profit of the individual farmer as equation (10). Thus, the proportional changes in price and quantity at the market level (i.e., *EQ* and *EP*) are directly used to calculate the proportional change in aggregated farm profits in equation (10).

$$E\pi^T = \sum_{i=1}^{n} \frac{q_i}{Q} E\pi_i = \left[\frac{1}{\rho} - \delta\left(\frac{1}{\rho} - 1\right)\right] EQ + [\frac{1}{\rho} - \sum_{j=1}^{k} \varphi_j \gamma_j (\frac{1}{\rho_i} - 1)]EP. \quad (10)$$ [2]

Second, if we denote the elasticity of supply with respect to the price of output at the individual farmer level as ε_i, then the proportional change in quantity supplied (Eq_i) for individual farmer *i* is calculated as $\varepsilon_i EP$. Thus, equation (9) can be converted into this form:

[2] The proportional change in total equilibrium quantity is the quantity-share weighted average of the proportional changes in the quantities supplied by individual farmers as indicated by following equation.

$EQ = \frac{1}{Q}\sum dq_i = \sum \frac{dq_i}{q_i}\frac{q_i}{Q} = \sum \frac{q_i}{Q} Eq_i$.

$$E\pi_i = [\frac{\varepsilon_i(1-\delta_i)+1}{\rho_i} + \delta_i\varepsilon_i - \sum_{j=1}^{k}\varphi_{ij}\gamma_j(\frac{1}{\rho_i} - 1)]EP. \quad (11)$$

In applying equation (11), however, information about the parameters ε_i, δ_i, ρ_i, and φ_{ij} at individual farmer level is very hard to acquire; thus, in this study, we employ equation (10) for the empirical assessments. With the assumption of competitive input markets, which implies γ_j is zero, equation (10) is turned into a more tractable form of equation (12). Considering the share of gross revenue for grape famers, whose profit is the target of the empirical assessment of the current study, within total farm revenue (2 percent for the last five years), it is reasonable to say that there is little possibility that the change in grape price influences the prices of the inputs for grape farming. Thus, zero γ_j is an acceptable assumption.

$$E\pi^T = \sum_{i=1}^{n}\frac{q_i}{Q}E\pi_i = \left[\frac{1}{\rho} - \delta\left(\frac{1}{\rho} - 1\right)\right]EQ + \frac{1}{\rho}EP \quad (12)$$

From equation (12), we can elicit several implications. Under constant return to scale (δ = 1), equation (12) becomes $E\pi^T = EQ + \frac{1}{\rho}EP$. Thus, when the changes in price and quantity (i.e., EP and EQ) are caused by shifts (down or up) in demand, the signs of EP and EQ coincide, resulting in the same sign of $E\pi^T$. However, if the changes in price and quantity are caused by shifts in supply, the sign of EP is different from that of EQ. In this case, the parameter ratio η/ρ plays a role. For the detailed investigation, we can set exogenous shocks other than EH_s as equal to zero in equations (7) and (8). Then, by substituting the simplified equations (7) and (8) into equation (12), we have the form of $E\pi^T = \varepsilon_h EH_s + \frac{\eta}{\rho}\varepsilon_h EH_s$. This equation suggests that the sign of $E\pi^T$ follows the sign of EQ (i.e., $\varepsilon_h EH_s$) when $\rho > -\eta$, and follows the sign of EP (i.e., $\frac{\eta}{\rho}\varepsilon_h EH_s$) when $\rho < -\eta$.

Under increasing return to scale ($0 < \delta < 1$), the term $\left[\frac{1}{\rho} - \delta\left(\frac{1}{\rho} - 1\right)\right]$ is always positive. Thus, when the changes in price and quantity (i.e., EP and EQ) are caused by shifts (down or up) in demand, the signs of EP and EQ coincide, and therefore the sign of $E\pi^T$ follows that of EP or EQ, as in the case of constant return to sale. However, the sign of EP is different from that of EQ when the changes in price and quantity are caused by shifts in supply. For deeper investigation of this case, we can simplify equation (12) as $E\pi^T = \varepsilon_h\left[\frac{1}{\rho} - \delta\left(\frac{1}{\rho} - 1\right)\right] EH_s + \frac{\eta}{\rho}\varepsilon_h EH_s$ with the assumption that exogenous shocks other than EH_s are zero in equations (7) and (8). Therefore, the sign of $E\pi^T$ follows the sign of EQ when $(1 - \delta + \delta\rho) > -\eta$ and follows the sign of EP when $(1 - \delta + \delta\rho) < -\eta$.

For decreasing return to scale ($\delta > 1$), the sign of the term $\left[\frac{1}{\rho} - \delta\left(\frac{1}{\rho} - 1\right)\right]$ depends on the relative magnitudes of δ and ρ. Thus, even in the case of a shift in demand, the signs of $E\pi^T$ can differ from those of EP and EQ.

Across the three different cases of return to scale, we can derive the implication that with higher value of profit share (ρ), we have more possibility that $(1 - \delta + \delta\rho)$ will become greater than $-\eta$, which suggest that at the higher profit share, the sign of $E\pi^T$ tends to depend on EQ. In other words, increase in the equilibrium quantity would result in an increase in profit, if the profit share is high enough. The other implication is that $E\pi^T$ tends to depend on EQ at the higher degree of return to scale (i.e., at the lower value of δ). This can be clearly illustrated by checking the relationship of $\frac{\partial(1-\delta+\delta\rho)}{\partial\delta} = (\rho - 1) < 0$ from equation (12).

3. Application to evaluate the impacts of the Korea–Chile FTA on grape producers in Korea

3.1 Cost function estimation and parameter specification

In this section, we discuss the parameters needed to apply the developed EDM to ex-post assessments of the Korea-Chile FTA. Of the parameters in equations (7), (8), and (10), own price elasticity of demand (η), cross elasticity of demand with respect to the price of the imported product (η_w), and own price elasticity of supply (ε) in the grape industry can be acquired from previous studies (we assume the parameters η_h and ε_h to be zero since we evaluate only the impacts of the FTA). The value of parameter ρ is provided by the Korea Research Development Administration. However, the elasticity of cost with respect to quantity (δ) requires empirical estimation. This section first presents the econometric model used to estimate elasticity in the cost function and then describes the data for the empirical estimation as well as the estimation results. The elasticities of demand and supply that were used in the simulations are also discussed in this section.

(1) Cost function estimation

The applied model for estimating the elasticities in cost is the Cobb-Douglas function in the form of $C(q, w_1, w_2, \ldots, w_k) = Aq^{\delta} w_1^{\varphi_1} w_2^{\varphi_2} \ldots w_k^{\varphi_k}$, where δ is the elasticity of cost with respect to quantity and φ_k is the elasticity of cost with respect to input price w_k.[3] The Korea Rural Development Administration provides the average cost of

[3] We may depend on more flexible functional forms such as the trans-log cost function. In this case, the elasticity of cost with respect to quantity depends on the level of production, which requires us to choose a specific level of production to derive the value of δ; thus, the simulation results for the FTA's impact differ by level of production. The Cobb-Douglas cost function precludes δ from depending on production level. However, the choice of the relatively simpler form of Cobb-Douglas is not superior for estimating a more accurate value of elasticity. Therefore, in order

producing major agricultural products including grapes. In order to use these data, the Cobb-Douglas cost function was transformed into average cost by dividing the presumed cost function by the quantity produced. The empirical model for the estimation was acquired by taking the log and including the trend as well as regional dummies as in equation (13).

$$lnAC_{it} = lnA + (\delta - 1)lnq_{it} + \varphi_1 ln \quad {}_{1t} + \varphi_2 ln \quad {}_{2t} + \alpha T + \sum_{i=1}^{4} \alpha_{di} D_i + \varepsilon_{it}, \quad (13)$$

where AC_{ti} is the representative producer's average cost of producing 1 kilogram of grapes in region i at time t, q_{it} is the quantity produced by the representative producer in region i at time t, w_{1t} is the price of purchased variable inputs at time t, w_{2t} is the farm wage at time t, T is the trend, and D_i is the dummy variable that indicates the major producing regions (D_0 is Gyeong-gi province, D_1 is Gyegon-buk province, D_2 is Gyeong-nam province, D_3 is Chung-buk province, and D_4 is Chung-nam province).

The panel data set for the period from 1995 to 2008 in five grape-producing regions was constructed for the empirical implementation. The average cost data were acquired from the Farm Profit Statistics Yearbook issued by the Korea Rural Development Administration. Quantities produced in each major producing region were obtained from the website of the Korean Statistical Information Service (http://kosis.kr/). The price of purchased variable inputs was calculated by averaging the price indices of farm inputs from the Korean Statistical Information Service. Farm wage was calculated by dividing the total expenditure for labor by the total hours of labor employed, using the Farm Profit Statistics Yearbook. All price and cost

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to investigate the influence δ on the simulation results, we perform sensitivity analysis in section 3.

variables were deflated by the GDP deflator. Table 1 reports the summary statistics of the data.

Table 2 presents the estimation results of the average cost function for grapes. All estimated coefficients except those of lnW_{It} and D_3 are significant at 90 percent or higher. The coefficient of lnq_{it} is estimated be -0.1141, which implies a negative relationship between quantity produced and average production cost. This estimation result further suggests that increasing the production scale would generate larger profits for farmers, which indicates the existence of economies of scale in grape farming. The empirical parameter δ (elasticity of cost with respect to quantity) needed to apply the EDM developed above is calculated as 0.8859 from the coefficient of lnq_{it}. The coefficients on the price of purchased variable input and farm wage are estimated to be statistically significant. These are very reasonable results that show the positive relationships between input prices and production cost.

(2) Parameter specification

Several previous studies include the own price elasticity of demand (η) of the grape. Moon and Hong (2003) and Song et al. (2009) estimated its value as -0.59 and -0.51, respectively, while -0.75 and -0.37 were used as the price elasticity of demand for grapes in the outlook models developed by the Korea Rural Economic Institute (KREI-ASMO, 2007; KASMO, 2008). In the KASMO model developed by KREI, 0.49 was used as own price elasticity demand for domestic grapes (KREI, 2012). For the own price elasticity of supply (ε) of grapes, we found three previous studies: Song (2009) used 0.62, KREI-ASMO (2007) used 0.11, and KASMO (2012) used 0.77.

Only two studies have estimated the cross elasticity of grape demand with respect to the price of imported grapes (η_w): it was estimated as 0.06 in KASMO

(2008) and 0.18 in KASMO (2012). In order to reflect more cases of cross elasticity, we considered other information that can be drawn from equation (7) as well as existing demand and supply elasticities. If we intend to estimate equation (7) by regarding it as a reduced from, we may express the empirical form as $lnP_t = \beta_0 + \beta_1 lnP_{w,t} + \beta_d lnH_{d,t} + \beta_s lnH_{s,t} + \varepsilon_t$, where P_t is the price of domestic grapes, $P_{w,t}$ is the price of imported grapes, $H_{d,t}$ is the factors influencing the demand for domestic grapes, and $H_{s,t}$ is the factors influencing the supply of domestic grapes. Under this form of empirical equation, the estimated coefficient $\widehat{\beta_1}$, which is called a coefficient of price transmission from the imported product to the domestic one, is interpreted as $-\eta_w/(\eta - \varepsilon)$, in comparison with equation (7), and thus contains the information of cross price elasticity. We found studies that the estimated price transmission coefficient for grapes: Lee and Kim (2007) estimated it as 0.170 and 0.142, and Song (2009) estimated it as 0.18. Using these estimates and the information regarding η and ε in the previous studies, we derived the values of η_w in the form of $-\hat{\beta}_1(\eta - \varepsilon)$. The derived values are between 0.1462 and 0.0528.

The different estimates or uses for the elasticities in the previous studies make it difficult to select the right values for the simulations this study is aiming for. Therefore, we choose a range of elasticities from the previous studies instead of selecting a single parameter value. Table 3 shows the selected ranges for each elasticity. For the Monte Carlo simulations, we generate 1,000 random combinations of the elasticities and ρ assuming uniform distribution for each parameter. Thus, we are able to get 1,000 different simulation results. As discussed, for the elasticity of cost with respect to quantity (δ), we used the estimated value of 0.8859 in the simulations. In the Farm Profit Statistics Yearbook issued by the Rural Development Administration in Korea, the share of profit within the gross revenue of grape producers (ρ) is 0.497 to 0.6525 during last 10 years. We used these reported values in the simulations.

3.2 Korea's grape imports from Chile and simulation scenarios

Since grapes are mainly produced in the summer in Korea, Korea and Chile agreed to apply a seasonal tariff during the negotiation of the FTA. Thus, according the Korea–Chile FTA, which was implemented in 2004, the tariff on Chilean grapes was reduced from 45 percent in 2003 to 0 percent in 2013. However, this tariff reduction schedule has only applied to imports from November to April; the tariff on Chilean grape imports during the summer and fall seasons has been maintained at 45 percent.

Before the FTA (2000 to 2003, as in figure 1), Korea's annual average grape imports from Chile were 6,824 tons and 10.23 billion dollars. In the first year of FTA implementation (2004), Korea imported 8,317 tons and 13.13 billion dollars of Chilean grapes. During the 10 years of FTA implementation, Korea's grape imports from Chile have increased by 5.2 times in quantity and 10.56 times in value. In 2013, the tenth year of FTA implementation, when the zero percent tariff on Chilean grapes was reached, Korea imported 47,412 tons and 144.32 billion dollars of Chilean grapes. Figure 1 well shows these rapid increases in grape imports from Chile. Currently, Chilean grapes comprise than 85 percent of Korea's total grape imports; thus, the most important substitute for the domestic grape is grapes imported from Chile.

Although most of the grapes are produced and consumed during summer in Korea, a significant portion of grape production occurs in the winter and spring seasons. Currently, about 10 percent of grapes are produced in the spring and winter, which means many grape producers are directly exposed to competition from the Chilean grape. Table 4 exhibits the tariff rates under the Korea–Chile FTA and the import prices of Chilean grapes. Although the tariff rate has declined continuously during the last 10 years, the imported cost, insurance, and freight (CIF) price has fluctuated but increased significantly. As a result, the tariff-embedded CIF price converted into Korean currency in 2013 was 3,328.8 won/kg, which is 1.3 times higher than that in 2003.

In order to evaluate the influences of the Korea–Chile FTA on Korean grape producers, we choose the winter and spring season grapes produced in greenhouses as the target market in Korea. Two simulation scenarios are used. The first scenario is to assess the sole effects of tariff reduction under the schedule of the Korea–Chile FTA. In this scenario, only the changes in tariff rate are considered, and thus the exogenous shocks EP_a, Ee, EH_d, and EH_s are set to zero in equations (7) and (8). The second scenario is introduced in order to derive more insights about the impacts of the changes in import prices. In this scenario, we allow changes in exchange rate and international price (i.e., $EP_a \neq 0$, $Ee \neq 0$) in addition to the tariff reductions incurred from the FTA ($\frac{dR}{1+R} \neq 0$).[4] For the simulations, the year 2003, when the tariff reduction due to the FTA had not been implemented is set as the base year, and 2013, when the tariff reduction was completed, is set as the target year for assessing the impacts.

For the grape market, the change in the price of grapes imported from Chile has not been the only exogenous shock that has influenced the equilibrium price and quantity of domestic greenhouse-grown grapes. Rather there have been changes in factors that have resulted in shifts in demand and supply. For example, taste changes for the imported grape and greenhouse-grown grape and increases in the production costs for farming greenhouse grapes are other exogenous shocks. In this study,

[4] However, EH_d and EH_s are set to zero in equations (7) and (8).

however, these other exogenous shocks are not considered in the analyses, since the main purpose is to assess the impacts of the Korea–Chile FTA.

3.3. Simulation results and discussion

Figure 2 shows the simulated impacts of the Korea–Chile FTA. Each of the four diagrams in figure 1 is a distribution of the percentage change in the price of domestic grapes (E_price), quantity of domestic grapes (E_quantity), gross revenue for grape producers (E_revenue), and profit of grape producers (E_profit) in the market of greenhouse-grown grapes, generated from 1,000 different random combinations of elasticities, as discussed.

As illustrated, the Korea–Chile FTA is simulated to have relatively little impact on the Korean grape market. If there had been no exogenous shocks other than tariff reduction due to the Korea–Chile FTA, the price of domestic grapes in the winter and spring seasons would have decreased by 1.54 percent compared to the price in 2003. The mean of the percentage change in domestic grapes in the winter and spring seasons is simulated to be -3.87 percent. The gross revenue of the farmers that produce grapes in winter and spring would have decreased by 5.4 percent if the tariff on Chilean grapes had been removed, ceteris paribus. The profit of the individual producer is simulated to have decreased by 6.9 percent on average due to the Korea–Chile FTA, ceteris paribus.

Figure 3 shows the simulated impacts of the changes in the price of Chilean grapes on the Korean grape market. Although the reduction of the tariff rate leads to the decline of the import price in Korea, this effect is offset by the rise in the international price of Chilean grapes, which results in more demand for domestic grapes that are competing with Chilean grapes. Thus, the diagrams in figure 3 all show positive influences on the Korean grape market.

If there had been no exogenous shocks other than the changes in the price of Chilean grapes, which includes the effects of tariff reduction due to the Korea–Chile FTA, the price of domestic grapes in the winter and spring seasons would have increased by 3.22 percent compared to the price in 2003. As a result, domestic grape production in the winter and spring seasons is simulated to increase by 8.08 percent. The gross revenue of the grape growers would have increased by 11.3 percent if there had been only the changes in the price of Chilean grapes, ceteris paribus. The profit of the grape grower is simulated to increase by 14.41 percent on average owing to the rise of the price of Chilean grapes, ceteris paribus.

Comparison of the results in figures 2 and 3 indicates that the impacts of the changes in international price and exchange rate are larger than those from the reductions of tariff rate. Table 5 reports the imputed effects of the changes in international price and exchange rate. If we do not consider the other exogenous shock in supply and demand, changes in international price and exchange rate would have increased the price of domestic grapes by 4.76 percent, the quantity of domestic grapes by 11.95 percent, the gross revenue of grape producers by 16.7 percent, and the profit for individual grape farmers by 21.31 percent, effects much larger than those from the tariff reduction only, as discussed.

Increases in the imported price of Chilean grapes would have resulted in a decrease in the demand for (import of) Chilean grapes if there had been no other exogenous shocks. However, as indicated in figure 1, the import of Chilean grapes has rapidly increased despite the increase in the price. This suggests that other demand shocks for the Chilean grape shifted up the demand curve. The most plausible candidate for this shock is the hange in taste of consumers in Korea. Currently, grapes are easily purchased in supermarkets, grocery stores, and elsewhere throughout the year. This strongly suggests that consumers demand more grapes in winter and spring than they did 10 years ago. Thus, we can conclude that more consumption of not only the Chilean grape but also the domestic grape is a reasonable phenomenon.

3.4. Sensitivity of simulation results according to different cost parameters

Parameter δ (elasticity of cost with respect to quantity produced) does not play a role in determining change in quantity, price, and revenue. However, as discussed, it influences the change in farmer's profit. The above simulation results are based on the estimated value δ at the fixed level of 0.8859. In this section, we investigate the influences δ on the change in farmer's profit due to tariff reduction and changes in the import price of Chilean grapes.

Various cases of increasing, constant, and decreasing returns to scale are considered for the sensitivity analyses. Under the assumption that the cost function for producing grapes has the property of constant return to scale ($\delta = 1$), the change in farmer's profit incurred by tariff reduction due to the Korea–Chile FTA is simulated to be -7.14% on average. In this case, the change in import price (in which tariff reduction, changes in exchange rate, and international price are included) is simulated to increase farmer's profit by 4.57%. For the cases of increasing return to scale ($\delta < 1$), the decrease in farmer's profit is simulated to be greater than that for the constant return to scale case, while the increasing return to scale scenario shows less of a decrease in farmer's profit compared with the constant to return to scale case.

The detailed sensitivity analysis in table 5 indicates that the magnitude of change in farmer's profit becomes smaller as δ increases. Table 6 suggests that a 1 percent rise in δ results in about a 0.33 percent rise in the change in farmer's profit due to the Korea–Chile FTA, which implies the elasticity of cost with respect to quantity produced has some significant effect on the farmer's profit.

4. Summary and conclusions

The EDM is a very efficient tool for analyzing policy effects or the results of exogenous shocks on markets. Therefore, many empirical studies have followed the EDM approach. However, the EDM has been generally applied to evaluate changes in market equilibrium and thus has been used only to assess changes in gross revenues of agricultural producers at the market level. In order to expand its usage, the present study develops an EDM that allows the evaluation of the change in profit of individual farmers. The parameters that represent the share of profit within revenue and the elasticity of cost with respect to quantity in the cost function play key roles in this expansion. The application of the developed EDM to the assessment of the impacts of the Korea–Chile FTA indicates that this FTA has little impact on the Korean grape market and grape producers in Korea.

The EDM developed in the present paper is useful and easily applicable in that the additional information relative to the traditional approaches, which require the elasticities in the supply and demand sides, is only the profit share and elasticity of cost with respect to quantity. However, the application of the EDM developed in this paper also has a limitation. It does not reflect the adjustment process to the shocks by market participants. Therefore, there is room for developing an EDM that is more general and better captures the dynamic aspects of the market, which will be pursued in future research.

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Table 1. Summary statistics of the data

Variable	Mean	Standard deviation
AC (average cost, kwon/kg)	1,204	343
q_{it} (quantity produced, kg/farm)	9,359	1,164
w_{1t} (price index of purchased variable input, 2005 = 100)	91	17
w_{2t} (price index of farm wage, 2005 = 100)	85	17

Table 2. Estimation results for average cost function of grapes

Variable	Estimated coefficient	Standard error	P-value
lnq_{it}	-.1141	.0670	0.089
lnw_{1t}	.0312	.1897	0.869
lnw_{2t}	.4161	.1877	0.027
T	.0278	.0100	0.006
D_1 *(Gyeong-buk)*	-.2415	.0903	0.007
D_2 *(Gyeong-nam)*	-.3150	.1136	0.006
D_3 *(Chung-buk)*	-.0866	.0682	0.204
D_4 *(Chung-nam)*	-.2087	.0477	0.000
Constant	-50.9754	18.5869	0.006

Adjusted $R^2 = 0.8480$

Table 3. Parameters used in the simulations

Parameter	Values
Own price elasticity of demand (η)	-0.37–-0.75
Own price elasticity of supply (ε)	0.11–0.77
Cross elasticity of grape demand with respect to the price of imported grapes (η_w)	0.0528–0.18
Elasticity of cost with respect to quantity produced (δ)	0.8859
Share of profit within revenue (ρ)	0.497–0.6525

Table 4. Tariff rates and import prices of Chilean grapes

	Tariff rate for Chilean grapes (November to April)	International CIF price (dollars/kg)	Exchange rate (won/dollar)	Tariff-embedded CIF price in Korean currency (won/kg)
2003	45.0	1.49	1,192.6	2576.6
2004	40.5	1.58	1,035.1	2297.8
2005	36.0	1.71	1,011.6	2352.6
2006	31.5	1.83	929.8	2237.5
2007	27.0	2.02	936.1	2401.5
2008	22.5	2.18	1,259.5	3363.5
2009	18.0	1.98	1,164.5	2720.7
2010	13.5	2.35	1,156.9	3085.7
2011	9.0	2.54	1,108.3	3068.4
2012	4.5	2.54	1,126.5	2990.1
2013	0.0	3.04	1,095.0	3328.8

Table 5. Imputed effects of the changes in international price and exchange rate

	Change in the price of domestic grapes	Change in the quantity of domestic grapes	Change in gross revenue of grape producers	Change in profit for individual grape farmers
Simulation results under				
Tariff reduction only	-1.54%	-3.87%	-5.4%	-6.9%
Change in imported price	3.22%	8.08%	11.3%	14.41%
Imputed effects of the changes in international price and exchange rate				
	4.76%	11.95%	16.70%	21.31%

Table 6. Sensitivity of the changes in grape producers' profit according to the level of elasticity of cost with respect to quantity produced (δ)

Elasticity of cost with respect to quantity produced (δ)	Effect of tariff reduction		Effect of change in import price	
	Mean	S.D.	Mean	S.D.
0.5	-7.96%	2.90%	16.64%	6.05%
0.6	-7.66%	2.64%	16.02%	5.52%
0.7	-7.37%	2.51%	15.40%	5.25%
0.8	-7.14%	2.45%	14.93%	5.11%
0.9	-6.80%	2.39%	14.22%	4.99%
1	-6.52%	2.19%	13.63%	4.57%
1.1	-6.18%	2.16%	12.92%	4.52%
1.2	-5.95%	2.02%	12.43%	4.22%

Note: The mean and standard deviation are calculated from the 1,000 simulation results based on 1,000 random combinations of the parameters within the ranges presented in table 3.

Figure 1. Korea's Chilean grape imports

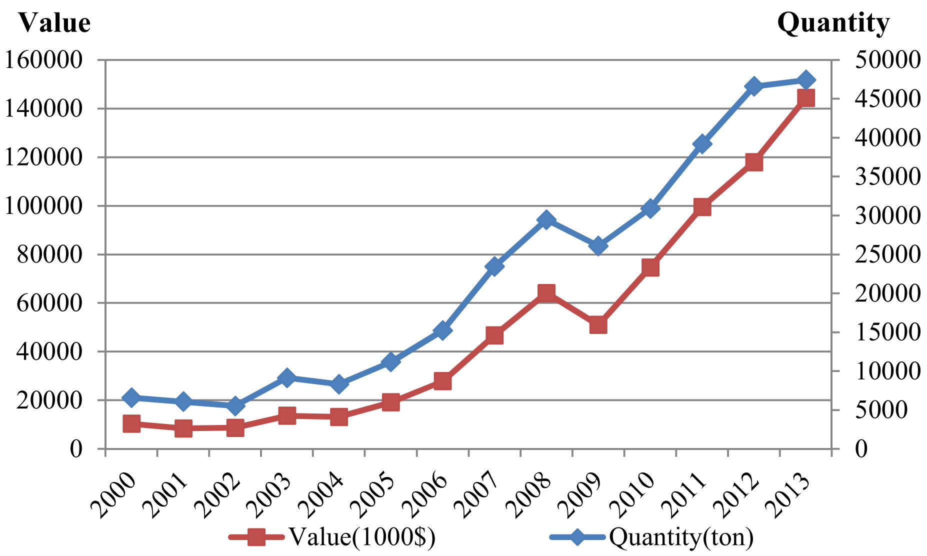

Figure 2. Effects of Korea–Chile FTA on the Korean grape market

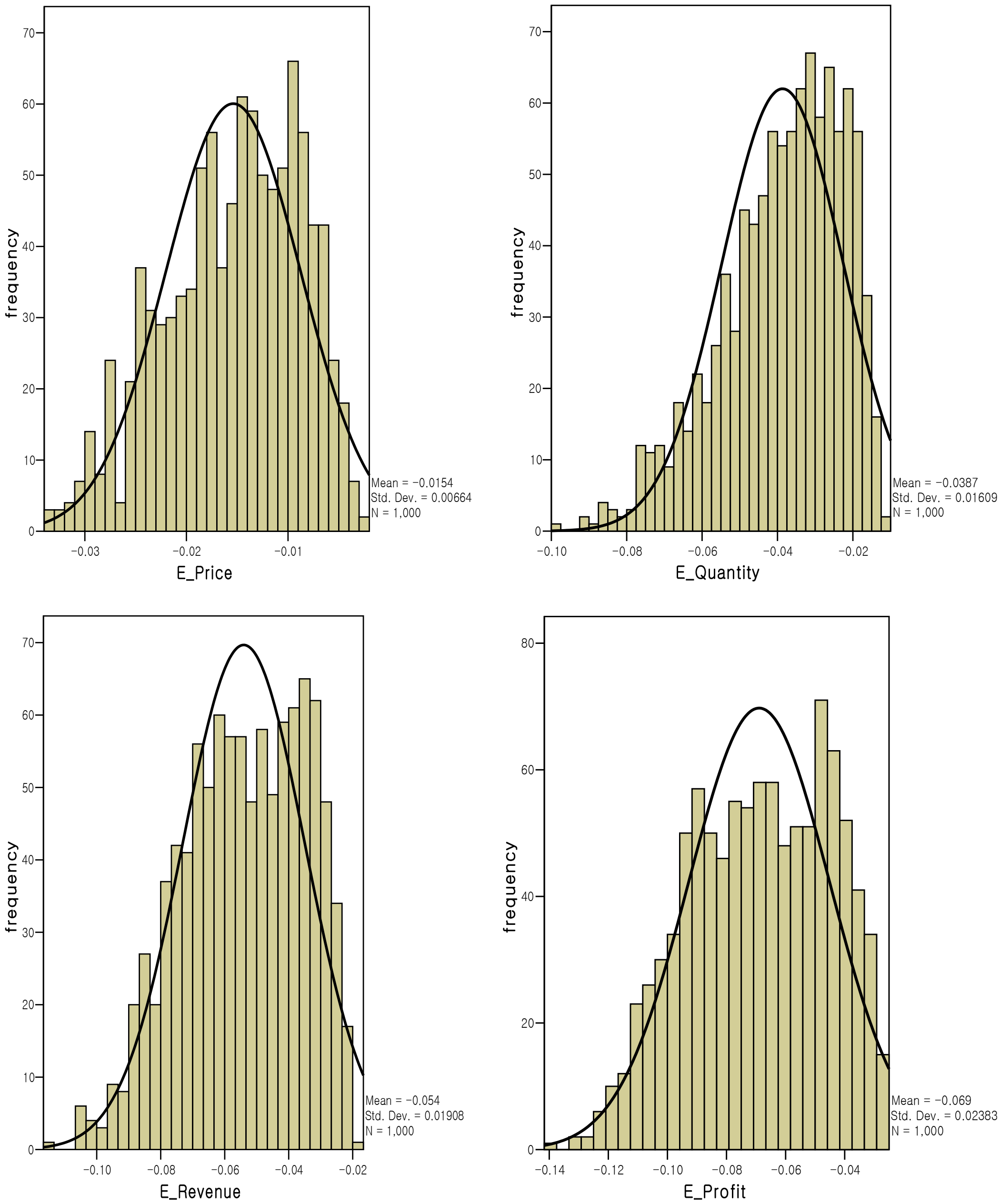

Figure 3. Effects of changes in the price of Chilean grapes on the Korean grape market