MODELING FREE TRADE DEMAND SYSTEM: CASE OF SOUTH KOREAN BEEF MARKET

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This study is intended to seek a theoretical approach for consumer demand analysis under free trade policy of importing country. Free trade demand system was developed through maximizing economic welfare of market participants. In particular, recognizing that non-economic factors like implicit discrimination and misinformation of a particular product might distort consumer preference for the product, this study induced market demand equations with respect to consumer preference to identify the marginal effect of change in consumer preference on market demand.

Key words: beef, consumer preference, free trade demand system, and market demand.

Neoclassical endowment models show that price differences between importing and exporting regions provide opportunities to increase economic welfare through trade (Samuelson 1948; Bhagwati 1964). In importing parties, most trade benefits come from consumers. Local consumers have increased choices with trade. In contrast, Local producers face a more competitive market with a lower price than before trade. According to the equalization of factor prices, prices between importing and exporting regions will gradually converge to one price with increases in market access where the economic welfare of both parties will be maximized.

However, price differences between local products and imported products exist in open markets. For example, price differences between locally produced beef and imported beef currently exist and are even continuing to grow after South Korea opened the beef market to the world economy in 2001. This continuity of price differences in the open market may reflect a consumer preference for locally produced beef due to well established eating habits. However, the increasing trend of price differences seems unreasonable in the light of rational consumer behavior and enforced price competition derived from trade.

In fact, it is true that consumer preferences can be distorted by non-economic factors such as imperfect information and/or implicit discrimination like “buy national product” campaigns. Once tastes have been established, consumers persist in making unreasonable purchasing decision

following the established preference and require a long time to recover from these distorted preferences. Therefore, these non-economic factors can contribute to the reason why large price differences exist between locally produced beef and imported beef and continue to increase following the liberalization of South Korean beef market. In 2005, the price of imported beef was $4.68 per kilogram in the South Korean beef market while the consumer price of locally produced beef was $36.11 per kilogram (exchange rate is 1034 Korean Won/$1, 2005), exhibiting a 770% price difference in 2005 while it was only 190% in 2001. Furthermore, concerns exist as to imperfect information related to food safety. Even though remedial treatment was implemented immediately, the occurrence of mad cow disease in the United State in 2003 caused South Korea to discontinue U.S. beef imports until 2007 when U.S. and South Korea inaugurated Free Trade Agreement (FTA).

Following the establishment of a FTA between the United States and South Korea, agricultural economists and policy makers predict a rosy prospect for U.S. beef producers because the FTA will eventually eliminate the high tariffs for U.S. beef, enabling U.S. beef producer to be more price competitive in the South Korean beef market relative to other beef suppliers. However, even though the South Korean beef market has been open since 2001, U.S. beef producers have not benefited from increased market access. In contrast, the scare resulting from mad cow disease restricted U.S. beef from the South Korean market. It is rational to think that price advantage of U.S. beef resulted from a FTA will result in increased competition in the South Korean beef market. However, the consumption behavior of the South Korean beef consumer is not totally dependent upon economic factors.

Even though the South Korean beef consumer preference can be distorted by non-economic factors, beef suppliers, including importers and local producers, consider existing consumer preference because not only price but also the established preference will affect the market behavior of South Korean beef consumers. Beef importers and local producers supply beef into the market to maximize their economic benefit. Furthermore, both foreign and domestic beef

suppliers recognize that local beef consumers seek to maximize their utility in consuming beef and consumer utility is affected by established preference as well as by price. Jung, et. al. (2002) showed that South Korean beef consumers prefer locally produced beef, Hanwoo, to that of lower priced imported beef.

This study is intended to develop an open economic model for analyzing consumer behavior in the South Korean beef market given existing consumer preference. Furthermore, this study will illustrate price and quantity effects of consumer preference. In order to achieve this goal, this study proceeds as follows: In the next section, a free trade demand system (*FTDS*) will be developed from an economic welfare function. After developing *FTDS*, the role of consumer preference will be discussed in the third section. In section four a conclusion and brief discussion of the limitation of *FTDS* model will be provided.

Free Trade Demand System

Economic Welfare Function

We suppose that there are five major source-differentiated beef in the South Korean beef market such as South Korean (SK), United State (US), Australian (AU), Canadian (CA), and New Zealand (NZ) beef. As Sarris and Freebairn (1983) illustrated in a political preference function (PPF) approach under non-free trade policy of importing country, a free trade demand system simply begins with the linear demand equation as follows:

(1) $$q_i = A_i - B_i p_i, \quad i = 1,2,3,4,5,$$

where we assume that A_i and B_i are unconditional coefficients which can be reverted to inverse market price equation - see Houck (1965 and 1966), Huang (1994 and 1996), and Eales (1996) for more information regarding elasticities and flexibilities - as follows:.

(2) $$p_i = a_i - b_i q_i, \quad i = 1,2,3,4,5,$$

where $a_i = \frac{A_i}{B_i}$ and $b_i = \frac{1}{B_i}$. Later, the study will test this unconditional assumption with empirical data. Given inverse market price, the welfare gain of South Korean beef consumer equates to the following:

(3) $$CS = \sum_i \left(\frac{a_i}{b_i} p_i - \frac{1}{2b_i} p_i^2 \right).$$

Similarly, the sum of welfare gain of each supplier equates to the following:

(4) $$PS = \sum_i (p_i - c_i) q_i ,$$

where c_i is the average unit cost of beef *i* including production cost, transportation cost, and tariffs. Since market equilibrium of price and quantity is a result of a market mechanism rather than government intervention under free trade policy, economic welfare of market participants is the summation of the welfare gain of both consumer and supplier and is expressed as:

(5) $$EWF = \sum_i \left(\frac{a_i}{b_i} p_i - \frac{1}{2b_i} p_i^2 \right) + \sum_i (p_i - c_i) q_i .$$

Free Trade Demand System

The economic welfare function defined in (5) can be rewritten to more easily derive a free trade demand system as intended in this study as follows:

(6) $$EWF = \alpha_0 + \sum_i \alpha_{1j} p_i + \sum_i \alpha_{2i} p_i Q + \sum_{ij} \alpha_{3i} p_i p_j + \sum_i p_i q_i - \sum_i c_i q_i ,$$

where $Q = \sum_i q_i$ is the sum of beef supplied to the South Korean market. As implied in (6), the free trade demand system is derived from the maximizing condition of (6). In order to define the maximizing condition of (6), we differentiate *EWF* with respect to the five individual beef prices.

(7) $$\frac{\partial EWF}{\partial p_i} = \alpha_1 + \alpha_2 Q + \sum_j \alpha_3 p_j + q_i = 0 .$$

Then, we obtain *FTDS* which maximizes the economic welfare of participants in the South Korean

beef market as follows:

$$(8) \qquad q_i = \alpha_{1i} + \alpha_{2i} Q + \sum_j \alpha_{3j} p_j, \qquad i, j = 1,2,3,4,5.$$

where α_{2i} represents the marginal effect of market size on the beef comes from country *i* and α_{3j} represents own price effect $(j = i)$ and cross price effect $(j \neq i)$ on the beef *i*. Furthermore, the parameters relationship between (3) and (8) can be defined as following:

$$(9.1) \qquad \alpha_{1i} = \frac{\sum_{j \neq i} b_j a_i}{b_i^2} - \sum_{j \neq i} \left[\frac{\sum_{j \neq i,k} b_j a_k}{b_k b_i} \right],$$

$$(9.2) \qquad \alpha_{2i} = -\frac{\sum_{j \neq i} b_j}{b_i}, \text{ and}$$

$$(9.3) \qquad \alpha_{3j} = \delta' \sum_{j \neq i} \left[\frac{\sum_{j \neq i,k} b_j}{b_i b_k} \right] - \delta \sum_{j=i} \left[\frac{\sum_{k \neq i} b_k}{b_i^2} \right],$$

where $\delta' = 1$ when $j \neq i$ and otherwise 0 and $\delta = 1$ when $j = i$ and otherwise 0. To be consistent with the maximization hypothesis of *EWF*, the second-order conditions of *EWF* require that the Hessian matrix be negative semidefinite at the optimal conditions. This condition is expressed as $-\sum_{j=i} \left[\frac{\sum_{k \neq i} b_k}{b_i^2} \right]$. Also, the Hessian matrix, $[\alpha_3]$, exhibits symmetry.

Empirical Estimation of FTDS

Market Access and Policies for Beef in South Korea

Under South Korean market access commitment, South Korea phased out non-tariff barriers to beef imports, including state trading and price markups, by January 2001. Before then, imported beef was under a quota, which increased until 2000, the final year. Steep price markups have been

eliminated. Before 2001, an increasing share of the quota was allocated to private "supergroups," representing private buyers such as supermarkets, restaurants, and hotels. Through the Simultaneous-Buy-Sell (SBS) system, supergroups were free to negotiate specific cuts and qualities with foreign exporters. The rest of the quota was administered by the Livestock Products Marketing Organization (LPMO), a state trading enterprise. The LPMO allocated some imported beef to special shops licensed to sell it. As of January 1, 2001, beef became freely importable, at a 41.2 percent tariff. Special treatment of imported beef, such as the requirement that it be retailed in shops that did not also sell domestic beef, was supposed to end. Table 1 shows the scheduled reduction of tariffs under the URAA reached its end in 2004. According to United States and South Korea FTA, South Korea will eliminate the 41.2 percent tariffs through a 15-year straight-line tariff phase out for all U.S. beef products.

Data

Conventional demand system analyses of meat consumption data have generally used aggregate annual, quarterly, or monthly time series data of purchases and prices at the retail level (Kinnucan et al. 1997; Mittelhammer et al. 1996; McGuirk et al. 1995). The data used in this study consist of monthly time series observations from January 1995 to December 2004. This time period was purposefully selected because 1) significant progress of liberalization was made in South Korea, 2) South Korean beef imports were a little different from the scheduled level of import commitment, reflecting economic instability and consumer confidence for consumption of beef during this period, and 3) U.S. beef imports were actually banned after 2005 due to a case of mad cow disease in the United States. Related to liberalization of South Korean beef market, 1) a SBS system commenced at the beginning of 1995 and 2) on January 2001, beef became freely importable, at a 41.2 percent tariff without any markup payments. South Korean beef retail price data are obtained from monthly consumer price index announced by the Korean Statistical Information Service. The study used the December 2004 nominal price as a reference price to transform the index into price. Because retail-level prices for imported beef were not available, imported beef prices were obtained from adding

tariff and markup payments to unit value import prices. The unit value import prices are obtained from the Korean Customs Services. Price data were then converted from South Korean currency, Won, into U.S. dollars using monthly average exchange rates from the Federal Reserve Bank of New York. South Korean beef consumption data were reported at the wholesale level and were obtained from Nonghyup. Data on import quantity were collected from the Korean Customs Services. The summary of sample statistics price and quantity for each source-differentiated beef is presented in Table 2.

System Misspecification Tests

Fisher asserts that to evaluate any theory using econometrics, the theory must be viewed in the context of a valid statistical model. A valid statistical model is one whose underlying assumptions are appropriate for the data being analyzed. If the observed data provide statistical adequacy, the underlying relationships defined in the economic model can be appropriately identified. For this purpose, this study followed the testing strategy proposed by McGuirk, Driscoll, Alwang, and Huang (1995) to test for equation-by-equation misspecification.

Equation-by-equation tests, as suggested by McGuirk et al., are used here to test for misspecification of each equation in the free trade demand system. Even though single-equation tests do not examine misspecification in the contemporaneous covariance between the residuals of different equations, such tests can be useful in detecting misspecifications and provides methods for model respecification when a single source of misspecification is identified. Normality, functional form, heteroskedasticity, autocorrelation and parameter stability are tested individually and jointly.

In the initial tests with raw price and quantity data, the study met serious violations with respect to the statistical prospective. For example, Mardia's skewness and kurtosis test and Henze-Zirkler test all rejected the null hypothesis that the residuals are normally distributed. The Godfrey Largange multiplier tests for serially correlated residuals for each equation were performed. The null hypothesis of Godfrey's test is that the equation residuals are white noise. However, the equations except for New Zealand beef equation showed autoregressive errors. The modified

Breusch-Pagan tests for homoskedasticity showed violations of the regression assumption that the variance of the errors is constant across observations. The RESET2 test did not show the validity of functional form.

The initial test results suggested a need for model respecification because the misspecification shown in the initial tests could lead to biased and inconsistent estimators and consequently inappropriate inferences and policy recommendations. In order to solve the problems of biased and inconsistent estimators in the presence of misspecification errors and maintain economic consistency of free trade demand system, respecification regimes are followed as 1) extreme outliers were eliminated, 2) the data were resorted arbitrarily, and 3) weighted regression was used. Following the recommendations, the study conducted each of the individual and joint tests. The test results showed how a comprehensive set of misspecification can be reduced. Table 3 shows the individual test results both before and after model respecification. Since misspecification is not the direct objective of this study, we will not go any further beyond showing the statistical validity of the free trade demand system.

In addition, as this study mentioned, this study allowed for the unconditional assumption in equation (1) and (2). In order to do this, the study estimated price elasticity coefficients, $\hat{A}_i$ and $\hat{B}_i$, of the five source-differentiated beef and price flexibility coefficients, $\hat{a}_i$ and $\hat{b}_i$, of the five source-differentiated beef. If expected variances of equation (1) and (2) are zero, then the unconditional assumption of coefficients will be satisfied. However, the null hypothesis tests were rejected.

Estimation

In estimating the parameters of *FTDS* model, the model was also imposed with homogeneity and symmetry. Since the free trade demand system composed of quantity share equations for the five source-differentiated beef would be singular, one equation was dropped. The coefficients of the dropped equation were then calculated from the adding-up restriction. Dummy variables reflecting

seasonality in beef demand were included in the pretest estimation. Although some variables were significant, they were not included in the final version of the model because of small sample size and the subsequent degrees of freedom problem.

The *FTDS* model identifies the effects of own and cross price and market size on market demand of each source-differentiated beef at the point of maximizing economic welfare for market participants. Table 4 shows the marginal coefficients of variables of price and market size. Among 20 variables, 17 are significant at least at conventional level of significance. System measure of fit reported below the table. Negativity was satisfied. For easy interpretation, this study converts marginal values into elasticities.

[Place Table 1 Approximately Here]

Table 5 presents the estimated elasticities at the mean of respective variables. Table 5 shows own price elasticity, cross price elasticity, and market size elasticity. As expected, all own price elasticities are negative. New Zealand beef is most sensitive to own price, while South Korean and Australian beef are insensitive to own price. For South Korean and New Zealand beef, four source-differentiated beef are shown to be substitutes. For US beef, South Korean and New Zealand beef are substitutes, while Australian and Canadian beef are complementary goods. In particular, U.S. beef is shown to be strongly substitutable for South Korean beef. For Australian beef, South Korean and New Zealand beef are substitutes, while U.S and Canadian beef are complements. For Canadian beef, South Korean and New Zealand beef are substitutes, while U.S. and Australian beef are complements. Related to growing market size, this study shows that for a 1% increase in South Korean beef market size, South Korean beef consumption increases by 0.468%, US beef 1.319%, Australian beef 0.568%, Canadian beef 1.688%, and New Zealand beef 1.276% increased, respectively. This study also shows that if U.S. beef price decreases as a result of the free trade agreement between the U.S. and South Korea (eliminating high tariffs on U.S. beef), the U.S. and South Korea free trade agreement will bring positive expectations for U.S., Australian, and Canadian beef exports, while South Korean and New Zealand beef supplies are shown to be

reduced.

[Place Table 2 Approximately Here]

Role of Consumer Preference in the Free Trade Demand System

According to microeconomic theory, consumer preference is one of the shifting factors of the demand curve. If South Korean beef consumers have different preferences for each source-differentiated beef, these different preferences will affect market demand for each source - differentiated beef. In order to examine the role of preference in a free trade demand system, the study simply follows the same route as defined in the previous section. Whether preference is distorted or not, the inverse demand price as defined in (2) is weighted by the preference recognized by the South Korean beef consumer as follows:

$$\pi_i = \gamma_i p_i = \gamma_i (a_i - b_i q_i), \tag{10}$$

where γ_i represents a preference for each source-differentiated beef *i* and π_i represents actual market price weighted by the preference. In brief, to visually review preference weighted inverse price, see three different cases of preferences exhibited Figure 1. If the preference is one, then the actual market price, π_i, is equal to the true price, p_i. If the preference is less (greater) than one, implying that the preference is underestimated (overestimated), then market demand will decrease (increase) from q_i to q_i^u (q_i^o) at a constant actual market price, π_i.

[Place Figure 1 Approximately Here]

With different consumer preferences for each source-differentiated beef, welfare gains to both consumer and supplier and of the gains in economic welfare of market participants are redefined as followings:

$$CS^p = \sum_i \left(\frac{a_i}{b_i} \pi_i - \frac{1}{2 b_i \gamma_i} \pi_i^2 \right), \tag{11}$$

(12) $PS^{p} = \sum_{i}(\pi_i - c_i)q_i$,

(13) $EWF^{p} = \sum_{i}\left(\frac{a_i}{b_i}\pi_i - \frac{1}{2b_i\gamma_i}\pi_i^2\right) + \sum_{i}(\pi_i - c_i)q_i$,

where CS^{p}, PS^{p}, and EWF^{p} are defined in terms of actual market price, π_i, rather than true price, p_i. Finally, the preference weighted free trade demand system and parameters are redefined as followings:

(14) $q_i = \beta_{1i} + \beta_{2i}Q + \sum_{j}\beta_{3j}\pi_j, \qquad i, j = 1,2,3,4,5,$

(15) $\beta_{1i} = \frac{\sum_{j\neq i} b_j\gamma_j a_i}{b_i^2\gamma_i} - \sum_{j\neq i}\left[\frac{\sum_{j\neq i,k} b_j\gamma_j a_k}{b_k b_i\gamma_i}\right],$

(16) $\beta_{2i} = -\frac{\sum_{j\neq i} b_j\gamma_j}{b_i\gamma_i}$, and

(17) $\beta_{3j} = \delta'\sum_{j\neq i}\left[\frac{\sum_{j\neq i,k} b_j\gamma_j}{b_i\gamma_i b_k\gamma_k}\right] - \delta\sum_{j=i}\left[\frac{\sum_{k\neq i} b_k\gamma_k}{b_i^2\gamma_i^2}\right],$

where the Hessian matrix, $[\beta_3]$, also shows symmetry and negativity.

Preference Effects on Market Demand

Before developing this section, let us review two cases of the relationship between preference and market demand. Figure 2 shows that an increase in own preference, γ_i, increases market demand of own good from q_i^0 to q_i^1 under given π_i, π_j, q_j, and γ_j. Figure 3 shows that the impact of cross preference, an increase in cross preference, γ_j, decreases market demand of q_i from q_i^1 to q_i^0 given π_i and π_j.

[Place Figure 2 Approximately Here]

[Place Figure 3 Approximately Here]

Now, to measure quantitatively these own and cross preference impacts on market demand, equation (14) can be differentiated with respect to γ_i and γ_j. Then, own preference and cross preference differential equations are defined as follows:

$$(18) \qquad \frac{\partial q_i}{\partial \gamma_i} = A + \frac{\sum_{j \neq i} b_j \gamma_j}{b_i \gamma_i^2} Q + \frac{\sum_{j \neq i} b_j \gamma_j}{b_i^2 \gamma_i^3} \pi_i - \sum_{j \neq i} \frac{\sum_{k \neq i,j} b_k \gamma_k}{b_i \gamma_i^2 b_j \gamma_j} \pi_j ,$$

$$(19) \qquad \frac{\partial q_i}{\partial \gamma_j} = B - \frac{b_j}{b_i \gamma_i} Q - \frac{b_j}{b_i^2 \gamma_i^2} \pi_i - \frac{\sum_{k \neq i,j} b_k \gamma_k}{b_i \gamma_i b_j \gamma_j^2} \pi_j + \frac{b_j}{b_i \gamma_i b_k \gamma_k} \pi_k .$$

where $A = -\frac{a_i \sum_{j \neq i} b_j \gamma_j}{b_i^2 \gamma_i^2} + \sum_j \frac{a_j \sum_{k \neq i,j} b_k \gamma_k}{b_i \gamma_i^2 (b_j)}$ and $B = \frac{b_j}{b_i^2 \gamma_i^2} - \sum_{k \neq i,j} \frac{b_j a_k}{b_k b_i \gamma_i^2}$.

To be consistent with preference theory, own (cross) preference first derivative should be greater (less) than zero. However, both (18) and (19) are ambiguous as to determine the empirical sign of first derivative of γ_i and γ_j because if one of the preferences is extremely low own (cross) preference effect will be negative (positive). Even though both (18) and (19) can not globally show the clear impact of preference on market demand, both equations can be used to locally determine the empirical impact of preference on market demand by normalizing preference and by using parameters estimated by econometric method, $\hat{a}_i$ and $\hat{b}_i$. Since we know actual market price and quantity of market consumption for each source-differentiated beef, we can determine the sign of own preference and cross preference in those equations with $\hat{a}_i$ and $\hat{b}_i$. Equation (18) and (19) can also be used to compare preference impacts on market demand in a variety of market sizes and market prices with equation (14).

Simulation Results

In order to simulate the South Korean beef model, this study estimated parameters, $\hat{a}_i$ and $\hat{b}_i$,

using the same data set used in the previous section. Table 6 shows the statistical information of $\hat{a}_i$ and $\hat{b}_i$ all of which are statistically significant at the 1% level. The statistics show that the sign of beef prices of South Korea, U.S., Canada, and New Zealand are negative as we expected while the beef price of Australia is positive. After parameter estimation, this study replaced $\hat{a}_i$ and $\hat{b}_i$ for a_i and b_i in (18) and (19) to confirm empirical sign of change in consumer preference.

[Place Table 3 Approximately Here]

Table 7 shows the impacts of changes in consumer preferences with and without changes in market size and actual market prices. The sign of equation (18), which represents own preference effect in empirical analysis, is shown to be positive for beef of South Korea, U.S., and New Zealand while the empirical sign of (18) is shown to be negative for Australian and Canadian beef. Related to cross preference effect, the empirical sign of equation (19) is shown to be different depending on which preference is changed. Increases in preference for South Korean beef have a negative impact on U.S. and New Zealand beef demand. Increases in preference for U.S, Canadian, and New Zealand beef decrease South Korean beef demand, while increases in preference for Australian beef simultaneously increase South Korean and U.S. beef demand. Table 7 also shows that the effect of change in consumer preference on market demand with changes in market size and actual market prices. When we compare Case 1 and Case 2, Canadian beef market demand is changed from a negative relationship with changes in South Korean beef consumer preference for U.S. beef and New Zealand beef to a positive relationship. When we compare Case 1 and Case 3, changes in actual market prices of imported beef produced different results from independent effect of change in consumer preference. In case 3, an increase in South Korean beef consumer preference for U.S. beef will change market demand for Canadian beef from negative to positive. An increase in preference for Australian beef will change own preference effect for Australian beef from negative to positive. Also, an increase in preference for Canadian beef will change market demand for South Korean beef from negative to positive and market demand for Australian and New Zealand beef

from positive to negative. In case 4, an increase in preference for U.S. beef will change market demand for Canadian beef from negative to positive. An increase in preference for Australian beef will change market demand for own beef from negative to positive. Finally, an increase in preference for Canadian beef will change market demand for South Korean beef from negative to positive and market demand for New Zealand beef from positive to negative. If consumer preference for imported beef and market volume increases, market demand for not only imported beef but also locally produced beef increases. Market demand for South Korean beef with an increase in market volume and preference for imported beef is increased more than without increase in market volume and preference for imported beef. In particular, the decreasing rate of market demand for Australian and Canadian beef is reduced with an increase in market volume. If prices of imported beef increase, market demand for South Korean beef is increased more than without an increase in prices of imported beef and market demand for U.S. and New Zealand beef is increased less than without an increase in prices of imported beef. With an increase in prices of imported beef, market demand for Australian beef is increased even though an increase in preference for Australian beef without an increase in prices of imported beef decreases market demand for Australian beef. Market demand for Canadian beef with an increase in prices of imported beef is shown to decrease at a decreasing rate. The impact of decrease in price of South Korean beef shows little impact on market demand for imported beef.

[Place Table 4 Approximately Here]

Conclusion

Recognizing the possibility of distortion for consumer preference for foreign sourced beef in the South Korean market, this study developed a free trade demand model to analyze South Korean beef consumer behavior. This research goal was achieved by two different steps. In the first step, this study identified the maximum condition of the economic welfare function in which market participants maximize their economic benefit from trade and derived free trade demand system

without considering existing South Korean beef consumer preference. In the second step, this study analyzed preference effects on market demand of each source differentiated beef using the free trade demand model weighted with consumer preference.

In doing these efforts, this study met serious statistical problems in performing empirical estimation under the *FTDS* frame. In order to solve the problems of biased and inconsistent estimators in the presence of misspecification errors and maintain economic consistency of *FTDS*, this study respecified the model following as 1) extreme outliers were eliminated, 2) the data were resorted arbitrarily, and 3) weighted regression was used. Following these recommendations shows statistical validity of *FTDS* model.

The empirical results of *FTDS* model showed that South Korean beef consumers are shown to be negative but not sensitive to change in own price of each source-differentiated beef except for New Zealand beef. For South Korean beef, all four foreign sourced beef are shown to be substitutes. In particular, U.S, beef is shown to be the strongest substitutable good for South Korean beef. With increasing market size, Canadian beef and U.S. beef can easily extend their South Korean market share relative to other foreign sources for beef.

Related to the role of consumer preference, the results showed that U.S. beef can extend their market share with increasing South Korean beef consumer preference for U.S. beef. In particular, this result might reflect the decrease of U.S. beef consumption after 2003 when mad cow disease was reported in the U.S. The most interesting finding related to preference analysis is that an increase in the prices of foreign sourced beef does not negatively affect market demand for this foreign sourced beef if preference for foreign sourced beef and/or market size increases and a decrease in South Korean beef price is shown not to affect market demand for foreign sourced beef.

As a result, this study suggests that marketing strategy should be focused on increasing consumer preference for the U.S. beef by providing correct information about the product and on reducing distortion of preference in order to fully succeed in the South Korean beef market.

Table 1. Liberalization Schedule for South Korean Beef Market

Year	Quota 1/	Tariff	Markup	Tariff + Markup	SBS
		Percent			
1995	123000	43.6	70	113.6	30
1996	147000	43.2	60	103.2	40
1997	167000	42.8	40	82.8	50
1998	187000	42.4	20	62.4	60
1999	206000	41.6	10	51.6	70
2000	225000	41.2	0	41.2	70
2001	Abolition	40.8	Abolition	40.8	Abolition
2002	Abolition	40.4	Abolition	40.4	Abolition
2003	Abolition	40.0	Abolition	40.0	Abolition
2004	Abolition	40.0	Abolition	40.0	Abolition
2005	Abolition	40.0	Abolition	40.0	Abolition
2006	Abolition	40.0	Abolition	40.0	Abolition
2007	Abolition	40.0	Abolition	40.0	Abolition

Source: USDA (United States Department of Agriculture), 2007
1. Unit: 1000kg

Table 2. Summary Statistics for Price and Quantity of Each Source Differentiated Beef, 1995-2004

	Mean	SD	Minimum	Maximum
SKBQ	38318	12318	13088	74196
USBQ	8514	5680	90	23912
AUBQ	5588	2328	785	12372
CABQ	647	641	1	3012
NZBQ	1969	3527	128	38570
SKBP	21.87	7.28	13.08	34.12
USBP	5.92	1.66	3.13	10.88
AUBP	3.68	0.90	2.56	5.74
CABP	5.28	2.33	2.94	13.86
NZBP	3.76	0.71	2.66	5.70

Sources: KCS, KOSIS, and Nonghyup
SKBQ: South Korean Beef Consumption
USBQ: U.S. Beef Consumption
AUBQ: Australian Beef Consumption
CABQ: Canadian Beef Consumption
NZBQ: New Zealand Beef Consumption
SKBP: South Korean Beef Price
USBP: U.S. Beef Price
AUBP: Australian Beef Price
CABP: Canadian Beef Price
NZBP: New Zealand Beef Price

Table 3. Free Trade Demand System: *p*-values for Equation-by-Equation Misspecification Tests

	q_{sk}	q_{us}	q_{au}	q_{ca}	q_{nz}
	Before Model Respecification				
Normality	0.0001	0.2168	0.0279	<.0001	<.0001
Functional Form	0.201	<.0001	0.4513	0.0001	<.0001
Heteroskedasticity	<.0001	<.0001	0.0109	0.0815	<.0001
Autocorrelation	<.0001	<.0001	0.0324	<.0001	0.8743
Parameter Stability	<.0001	<.0001	0.0671	<.0001	0.0148
	After Model Respecification				
Normality	0.7048	0.2596	0.2398	0.1768	0.6094
Functional Form	0.0616	<.0001	0.3049	0.0029	0.1034
Heteroskedasticity	0.3114	0.0338	0.5450	0.2073	0.1901
Autocorrelation	0.6493	0.8679	0.3896	0.7471	0.7764
Parameter Stability	0.0073	0.0001	0.9951	0.1812	0.2819

q_i is a single equation for beef *i* sourced from country *i*.

$_{SK}$: South Korea, $_{US}$: United States, $_{AU}$: Australia, $_{CA}$: Canada, and $_{NZ}$: New Zealand.

Table 4. Estimated Marginal Coefficients of Prices in Free Trade Demand System

	$\hat{\alpha}_{3sk}$	$\hat{\alpha}_{3us}$	$\hat{\alpha}_{3au}$	$\hat{\alpha}_{3ca}$	$\hat{\alpha}_{3nz}$	$\hat{Q}$
q_{sk}	-697***	353***	127***	13	204***	0.582***
q_{us}		-1574***	-626**	-91	1938***	0.250***
q_{au}			-462	-396***	1356***	0.042**
q_{ca}				-98*	571***	0.027***
q_{nz}					-4070***	0.099***

* indicates significance at 1% level
** indicates significance at 5% level
*** indicates significance at 10% level
System Weighted R^2=0.99
$\hat{\alpha}_{3i}$ is an estimated marginal coefficient of price of beef *i* sourced from country *i*.
$\hat{Q}$ is an estimated marginal coefficient of total quantity supplied into South Korean beef market.

Table 5. Price and Quantity Elasticities at Mean Values

	p_{sk}	p_{us}	p_{au}	p_{ca}	p_{nz}	Q
q_{sk}	-0.3673	0.0300	0.0091	0.0008	0.0101	0.4683
q_{us}	0.8114	-0.7217	-0.1107	-0.0302	0.5104	1.3196
q_{au}	0.5900	-0.2660	-0.2836	-0.2285	0.5648	0.5677
q_{ca}	0.3472	-0.4629	-1.4553	-0.4071	2.0326	1.6883
q_{nz}	1.8423	3.4433	1.5852	0.8958	-4.6754	1.2758

p_i is price of beef *i* sourced from country *i*.

Q is total quantity of beef supplied into South Korean beef market.

Table 6. Statistical Information of Estimated Parameters, $\hat{a}$ and $\hat{b}$.

	$\hat{a}_i$	S.E.	t-value	$\hat{b}_i$	S.E.	t-value
q_{sk}	34.96206*	1.75002	19.98	-0.00034*	0.00004	-7.86
q_{us}	4.05512*	0.09721	41.72	-0.00005*	0.00001	-5.14
q_{au}	1.72164*	0.12643	13.62	0.00011*	0.00002	5.01
q_{ca}	3.35810*	0.12916	26.00	-0.00036*	0.00014	-2.52
q_{nz}	2.38724*	0.04387	54.41	-0.00003*	0.00001	-2.55

In order to estimate parameters, this study used system equation model because error terms are simultaneously correlated at time *t*.

* represents statistical significance at 1% level.

Table 7. Impacts of changes in consumer preference with/without changes in market size and market prices

Case 1: Independent Effect of Consumer Preference

	$\hat{\gamma}_{sk}$	$\hat{\gamma}_{us}$	$\hat{\gamma}_{au}$	$\hat{\gamma}_{ca}$	$\hat{\gamma}_{nz}$
q_{sk}	+	-	+	-	-
q_{us}	-	+	+	-	-
q_{au}	+	+	-	+	+
q_{ca}	+	-	-	-	-
q_{nz}	-	-	+	+	+

Case 2: Joint Effect of Consumer Preference with an Increase in Market Size

	$\hat{\gamma}_{sk}$	$\hat{\gamma}_{us}$	$\hat{\gamma}_{au}$	$\hat{\gamma}_{ca}$	$\hat{\gamma}_{nz}$
q_{sk}	+	-	+	-	-
q_{us}	-	+	+	-	-
q_{au}	+	+	-	+	+
q_{ca}	+	+	-	-	+
q_{nz}	-	-	+	+	+

Case 3: Joint Effect of Consumer Preference with an Increase in Market Size and Prices

	$\hat{\gamma}_{sk}$	$\hat{\gamma}_{us}$	$\hat{\gamma}_{au}$	$\hat{\gamma}_{ca}$	$\hat{\gamma}_{nz}$
q_{sk}	+	-	+	+	-
q_{us}	-	+	+	-	-
q_{au}	+	+	+	-	+
q_{ca}	+	+	-	-	-
q_{nz}	-	-	+	-	+

Case 4: Join Effect of Consumer Preference with an Increase in Market Size and Prices of Imported Beef and a Decrease in South Korean Beef Price

	$\hat{\gamma}_{sk}$	$\hat{\gamma}_{us}$	$\hat{\gamma}_{au}$	$\hat{\gamma}_{ca}$	$\hat{\gamma}_{nz}$
q_{sk}	+	-	+	+	-
q_{us}	-	+	+	-	-
q_{au}	+	+	+	+	+
q_{ca}	+	+	-	-	-
q_{nz}	-	-	+	-	+

$\hat{\gamma}_i$ is consumer preference for beef *i* sourced from country *i*.

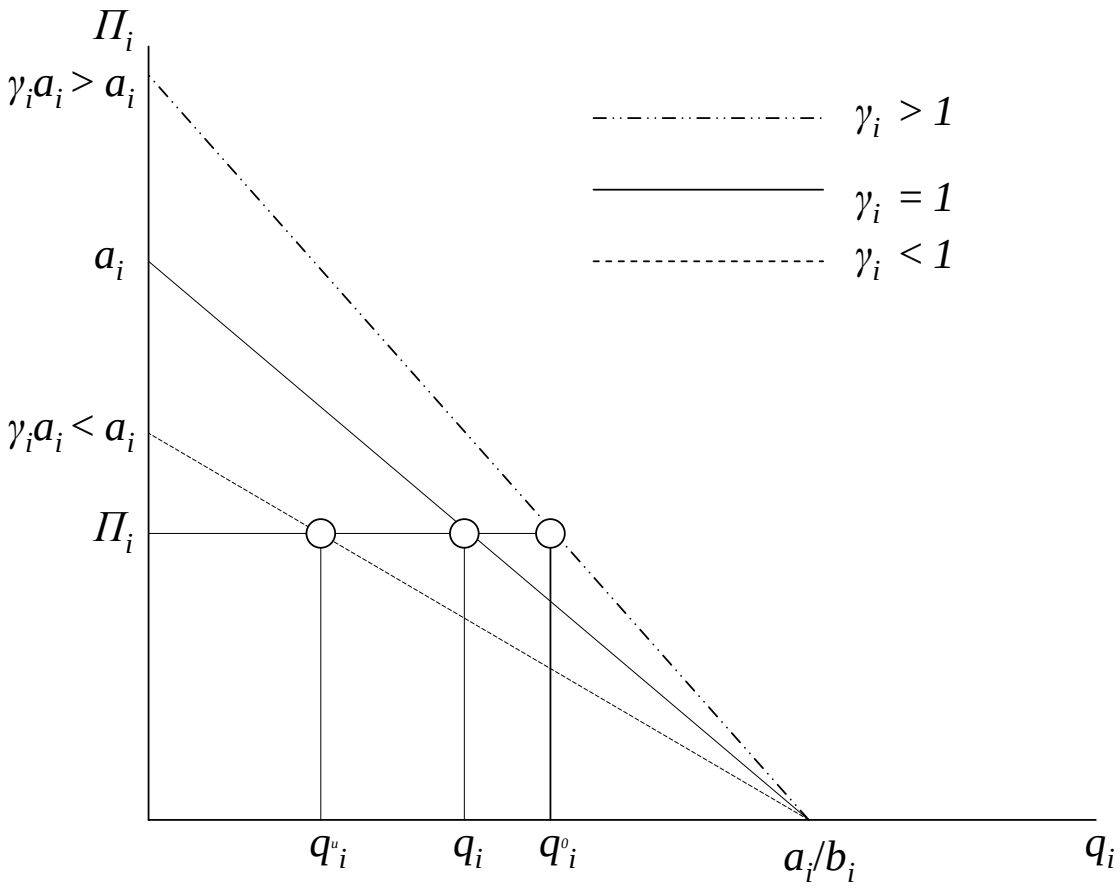

Figure 1. Relationship Between Consumer Preference and Market Demand

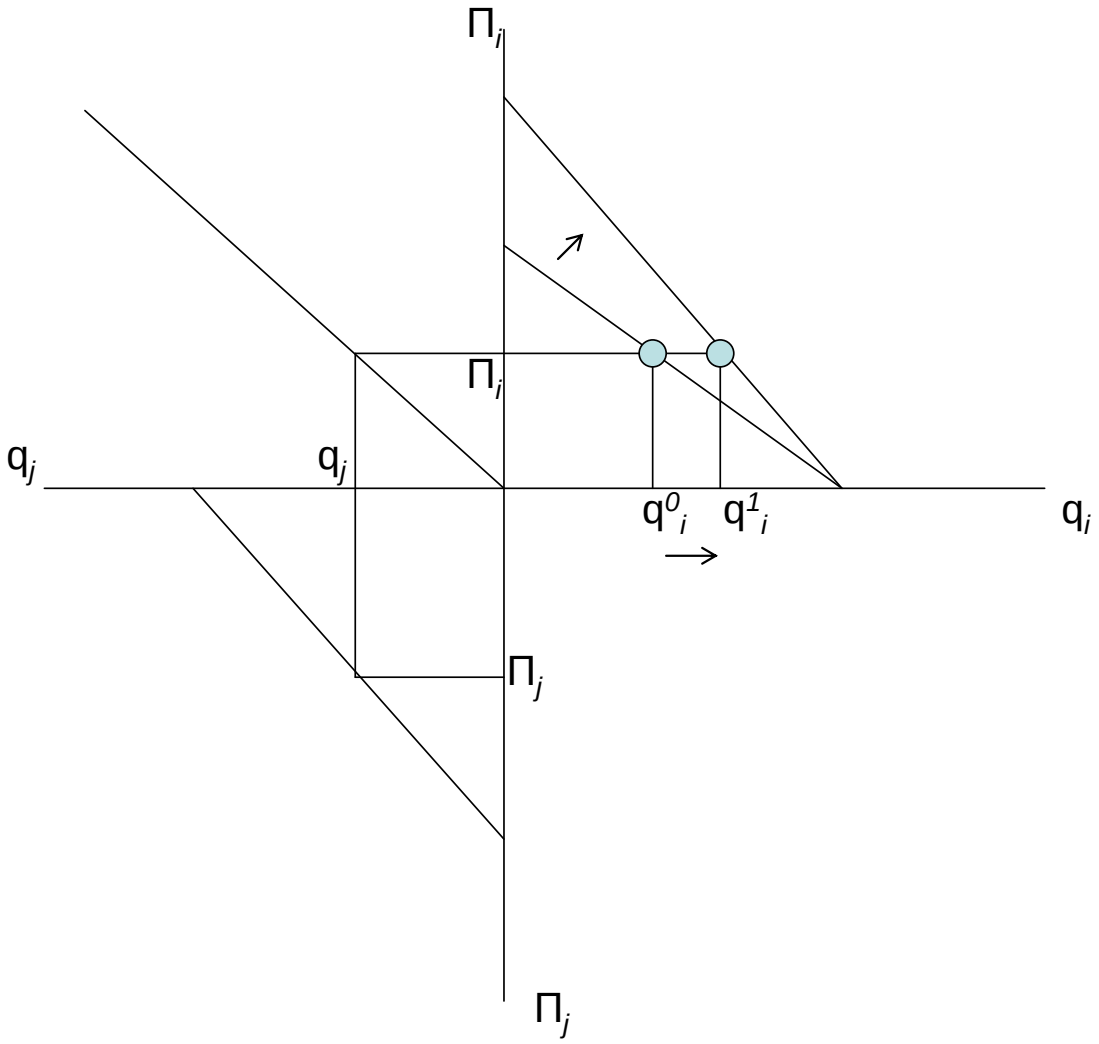

Figure 2. Relationship Between Consumer Preference for Own Good and Market Demand

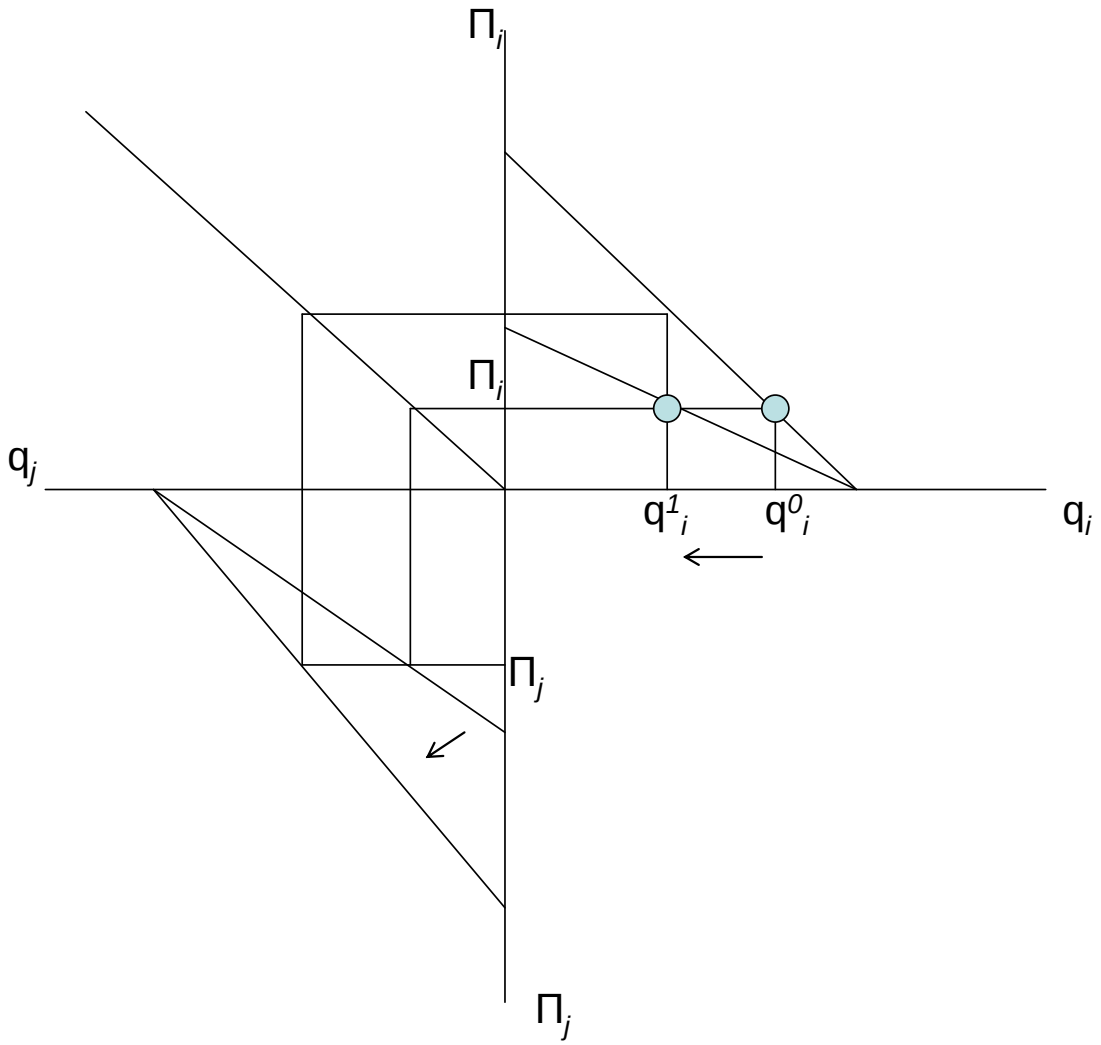

Figure 3. Relationship Between Consumer Preference for Cross Good and Market Demand

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