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STRUCTURAL APPROACH TO ANALYZE THE EFFECTS OF EXHCHANGE RATE ON IMPORT DEMAND

YOUNGJAE LEE

Department of Agricultural Economics and Agribusiness
Louisiana State University AgCenter
101 Agricultural Administration Building
Baton Rouge LA 70803-5606

Phone: 225-578-2754
Fax: 225-578-2716
E-Mail: YLee@agcenter.lsu.edu

P. LYNN KENNEDY

Department of Agricultural Economics and Agribusiness
Louisiana State University AgCenter
101 Agricultural Administration Building
Baton Rouge LA 70803-5606

Phone: 225-578-2726
Fax: 225-578-2716
E-Mail: Lkennedy@agcenter.lsu.edu

BRIAN M. HILBUN

Department of Agricultural Economics and Agribusiness
Louisiana State University AgCenter
101 Agricultural Administration Building
Baton Rouge LA 70803-5606

Phone: 225-578-0345
Fax: 225-578-2716
E-Mail: BHilbun@agcenter.lsu.edu

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STRUCTURAL APPROACH TO ANALYZE THE EFFECTS OF EXHCHANGE RATE ON IMPORT DEMAND

YOUNGJAE LEE, P. LYNN KENNEDY, and BRIAN HILBUN

The effect exchange rates have on local prices may induce a change in relative prices and import demand. This study shows that substitutability, endogeneity of foreign price, elasticity of substitution, and degree of returns to scale influence the impacts exchange rates have on relative prices and import demand. In an empirical examination of the Korean beef market, this study found a decrease in relative prices and an increase in import demand when the U.S. dollar depreciates, and an increase in relative prices and a decrease in import demand when the U.S. dollar appreciates. However, the effect on relative prices is greater than the effect on import demand, implying that the foreign price elasticity of import demand is less than one.

The study of the exchange rate in international commodity trade has been developed on the theoretical basis of the Marshall-Lerner (LM) condition and *J*-curve phenomenon.[1] In particular, studies related to the *J*-curve phenomenon detect the effects of currency-contracts, exchange rate pass-through, and quantity adjustments by which a country's trade balance will worsen immediately after the occurrence of a currency depreciation and begin to improve only some time later.[2] International trade economists, therefore, have examined the long-run and short-run effects of the exchange rate on the trade balance (Devereux and Engel, 2002; Coughlin, 2006; and Bahmani-Oskooee and Ratha, 2008). The seminal work on exchange rate impacts in U.S. agriculture was by Schuh (1974, 1976). He illustrates that the consequence of U.S. dollar over-valuation is to raise the price of the U.S. products with respect to foreign currency, which reduces the quantity demanded in foreign countries. Many agricultural economists have sufficiently examined the empirical effect of exchange rates on U.S. agricultural trade flows, focusing on U.S. agricultural exports (Konandreas, Bushnell, and Green, 1978; Chamber and Just, 1981; Carter and Pick, 1989; Pick, 1990; Cho, Sheldon, and McCorriston, 2002; and

Kandilov, 2008). Most of the literature on this issue concentrates on the empirical impacts exchange rate fluctuations have on U.S. agricultural exports.

The purpose of this study is to determine the impact the exchange rate has on local prices and import demand. However, it is not the specific intention of this work to *estimate* an empirical coefficient of the exchange rate variable in an econometric framework. This implies that a more systematic, as opposed to solely an econometric, approach has been adopted. The reason for the exchange rate affecting import demand is because the exchange rate affects the local price. Furthermore, it may be the case that changes in the exchange rate not only affect foreign prices of U.S. products carried into a foreign country, but also the home prices of products produced by foreign countries. This may accrue because of substitutability between the U.S. and home products in the foreign country. The price effect in substitutability could be accounted for in the well developed economic structure of consumer utility and production of the foreign country.

In fact, this study found, in examining the economic behaviors of foreign consumers and producers, that the previous models did not account for 1) the true exogeneity of the exchange rate variable in econometric models; 2) the importance of elasticity of substitution and degree of returns to scale of foreign consumers and producers in explaining the effect of exchange rate on import demand; 3) the indirect effect of the exchange rate on the home price in the foreign country; and 4) the differences between the short-run and long-run effects on local prices and import demand. One common denominator of previous studies is that the econometric model is constructed using either volume or value of trade as the dependent variable and either the exchange rate or exchange rate variability as the explanatory variable. This approach, however, cannot provide adequate understanding concerning how the exchange rate affects local prices

and import demand. In seeking to provide this type of explanation, this study provides an empirical examination of Korean imported beef demand.

This paper proceeds as follows: In the next section, a theoretical model is outlined to show the effects the exchange rate has on both local prices and import demand. In order to do this, this study uses a constant-elasticity-of-substitution (CES) utility function of the Dixit-Stiglitz type and a cost function representing a degree of returns to scale. Section three provides an empirical example of the Korean beef import market. In this section, we determine empirical parameters for 1) the market share of imported beef, 2) the elasticity of substitution for the Korean beef consumer, and 3) the degree of returns to scale for the Korean beef producer. Section four simulates the depreciation and appreciation of the U.S. dollar in order to examine the impact of the exchange rate on local prices and import demand, given the parameters of the Korean beef consumer and producer. In the final section, conclusions and issues for future research are presented.

Direct and Indirect Exchange Rate Effects

It should be noted that the nominal exchange rate, e_{ij}, between country *i* and *j* is determined through the foreign exchange market. Therefore, in most cases the exchange rate will not be affected by a change in either the home or foreign price.[3] Also, this study uses the assumptions of no barriers to trade, no transportation costs, and no other distance related impediments.[4]

Due to the utility of different currencies in country *i* and country *j*, the foreign price of the product of country *i* (*j*) is expressed by both the home price of the product of country *i* (*j*) and the exchange rate between country *i* and *j* as follows:

(1) $p_{ij} = e_{ij} p_{ii}$ (or $p_{ji} = e_{ji} p_{jj}$),

where p_{ij} (p_{ji}) represents the foreign price of the product of country *i* (*j*), p_{ii} (p_{jj}) is the home price of the product of country *i* (*j*), e_{ij} (e_{ji}) is the exchange rate when the currency of country *i* (*j*) is exchanged for the currency of country *j* (*i*).

Therefore, the relationship between e_{ij} and e_{ji} is an inverse relationship which can be expressed as follows:

(2) $$e_{ji} = e_{ij}^{-1}.$$

So, e_{ji} decreases (increases) simultaneously when e_{ij} increases (decreases).

In (1), it should be recognized that home prices would not be directly affected by a change in the exchange rate while the foreign prices directly changed as follows:

(3.1) $$\frac{\partial p_{ii}}{\partial e_{ij}} = \frac{\partial p_{jj}}{\partial e_{ij}} = 0,$$

(3.2) $$\frac{\partial p_{ij}}{\partial e_{ij}} = p_{ii} \text{ and } \frac{\partial p_{ji}}{\partial e_{ij}} = \frac{-p_{jj}}{e_{ij}^2}.$$

Equation (3.2) shows that a one unit decrease in the value of country *i*'s currency decreases the foreign price of country *i* by p_{ii} while simultaneously increasing the foreign price of country *j* by $\frac{p_{jj}}{e_{ij}^2}$. However, equation (3.1) shows that a devaluation of country *i*'s currency will not affect the home prices of either country *i* or country *j*. In addition, foreign price, p_{ij} (p_{ji}), would be affected not only by a change in the exchange rate, e_{ij}, but also by a change in the home price, p_{ii} (p_{jj}) as follows:

(4.1) $$\frac{\partial p_{ij}}{\partial p_{ii}} = e_{ij},$$

(4.2) $$\frac{\partial p_{ji}}{\partial p_{jj}} = e_{ij}^{-1}.$$

Since it is the foreign price of the exporting country rather than the home price of exporting country that induces import demand, it is important to determine if a change in the foreign price originates from a change in the exchange rate or from a change in home price. For illustrative purposes, it is useful to examine the Korean beef imports market. The foreign prices of beef imported into the Korean beef market have increased since 2000 with an increase in the home prices of the exporting countries rather than a decrease in the value of the Korean currency (Won) against the U.S. dollar.[5] In fact, the exchange rate of the Korean Won against the U.S. dollar decreased during this period of time (see Figure 1). To avoid this problem, previous studies used the real exchange rate in their empirical econometric models. However, the real exchange rate is calculated on the basis of a comprehensive price level rather than a specific commodity's price level. Furthermore, even if the real commodity exchange rate were calculated on the basis of the specific commodity price, the effect of a change in the exchange rate on the foreign price should be separable from the effect of a change in home price.

[Place Figure 1 Approximately Here]

Up to this point, we discussed the endogeneity issue of foreign price depending on the exchange rate and home price. In order to further develop exchange rate impacts on import demand, the issue of substitutability between home and foreign products in the foreign country must be discussed. Typically, import demand is determined as the difference between the quantity demanded by foreign consumers and the quantity supplied by foreign producers. Given the home price of the importing country, a change in the exchange rate directly induces a change in the foreign price of the exporting country as shown in Equation (1). A change in the foreign price of the exporting country is likely to induce substitution between home and foreign

products. This substitution might affect the home price of the importing country, which is the indirect effect of a change in exchange rate on the home price of importing country in this study. A change in the home price of the importing country affects producers' profit in the importing country. Therefore, the effect of a change in the exchange rate on import demand should be examined in the system of demand and supply of the importing country.

As a first step in following this systematic approach, this study uses a constant-elasticity-of-substitution (CES) utility function of the Dixit-Stiglitz type to examine how a change in the exchange rate affects on the demand structure of the foreign consumer. From this theoretical review, the relationship between the exchange rate and both home and foreign prices are identified. In the CES utility function, the importing country *j*'s consumer problem in choosing product, Q_{ij} which is produced in country *i* and sold in country *j* or Q_{jj} which is produced and sold in country *j*, would be summarized as follows:

(5) $$u_j = A_j\left[\alpha Q_{ij}^r + (1-\alpha)Q_{jj}^r\right]^{\frac{1}{r}}, \quad \text{s.t. } p_{ij}Q_{ij} + p_{jj}Q_{jj} = m_j,$$

where A_j is a measure of the demand level of country *j*, α is a share parameter, $r = \frac{\omega - 1}{\omega}$ where ω is the elasticity of substitution, and m_j is the expenditure of country *j* on the products. From (5), we can derive demand equations for Q_{jj} and Q_{ij} of country *j* as follows:

(6.1) $$Q_{jj} = \frac{(\alpha)^{\frac{1}{r-1}}(p_{jj})^{\frac{1}{r-1}} m_j}{(1-\alpha)^{\frac{1}{r-1}}(p_{ij})^{\frac{r}{r-1}} + (\alpha)^{\frac{1}{r-1}}(p_{jj})^{\frac{r}{r-1}}},$$

(6.2) $$Q_{ij} = \frac{(1-\alpha)^{\frac{1}{r-1}}(p_{ij})^{\frac{1}{r-1}} m_j}{(1-\alpha)^{\frac{1}{r-1}}(p_{ij})^{\frac{r}{r-1}} + (\alpha)^{\frac{1}{r-1}}(p_{jj})^{\frac{r}{r-1}}}.$$

As the above domestic and imports demand equations show, the effect of a change in the exchange rate on domestic and import demand would be realized through the endogeneity of the foreign price of the exporting country *i*. Superficially, the domestic and import demand of importing country *j* seem not to be affected by the home price when the exchange rate changes because there is no direct effect of a change in the exchange rate on the home price of importing country *j* when the exchange rate changes. However, it should be noted that the domestic and import demand equations show a relationship between e_{ij} and p_{jj} through price competition between Q_{ij} and Q_{jj} and endogeneity of the foreign price of the exporting country.

In the second step, we show the indirect effect of a change in the exchange rate, e_{ij} ,on the home price, p_{jj} , of the importing country, as mentioned above. To do this, it is necessary to define the profit maximizing condition, regardless of exchange rate changes, for the producers in importing country j. In a perfectly competitive market, price is determined through the interaction of both demand and supply. Each producer would be a price taker and their production strategy would be to maximize profit. Given the home price, how much a foreign producer produces will depend upon the degree of returns to scale of their production technology. This relationship can be summarized as follows:

(7.1) $\pi_j = p_{jj}Q_{jj} - kQ_{jj}^{\beta}$,

(7.2) $p_{jj} = k\beta Q_{jj}^{\beta-1}$

where kQ^{β} is total production cost, $k\beta Q_{jj}^{\beta-1}$ is the marginal cost of producing one unit of Q_{jj}, and β represents the degree of returns to scale of their production technology.

The price equation can be used to identify the indirect effect of a change in the exchange rate on the home price, p_{jj}, of importing country *j*. Because Q_{jj} is defined in equation (6.1), the home price of importing country *j* can be expressed with respect to the exchange rate as follows:

$$(8) \qquad p_{jj} = \frac{\left[\left(\frac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}}(\Phi)^{\frac{r}{r-1}}\left(e_{ij}\right)^{\frac{r}{r-1}}+1\right]^{\frac{(1-\beta)}{\beta}}}{(k\beta)^{\frac{1}{\beta}}\left[m_j + V_{ji}\left(\left(\frac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}}(\Phi)^{\frac{r}{r-1}}\left(e_{ij}\right)^{\frac{r}{r-1}}+1\right)\right]^{\frac{(1-\beta)}{\beta}}}$$

where $\Phi = \frac{p_{ii}^0}{p_{jj}^0}$ is the initial ratio of the home prices of country *i* and *j* and V_{ji} is the value of trade from country *j* to country *i*.

Furthermore, if country *j* is solely an importing country, Equation (8) can be simplified. For example, as Equation (8) shows, if country *j* only imports Q, then V_{ji} will be zero. As a result, Equation (8) will be reduced as follows:

$$(9) \qquad p_{jj} = \frac{\left[\left(\frac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}}(\Phi)^{\frac{r}{r-1}}\left(e_{ij}\right)^{\frac{r}{r-1}}+1\right]^{\frac{(1-\beta)}{\beta}}}{(k\beta)^{\frac{1}{\beta}}\left(m_j\right)^{\frac{(1-\beta)}{\beta}}}$$

Therefore, the indirect effect of a change in the exchange rate on the home price of importing country *j* can be obtained as follows:

$$(10) \qquad \frac{\partial p_{jj}}{\partial e_{ij}} = \left(\frac{(1-\beta)}{\beta}\right)\left(\frac{r}{r-1}\right)Z,$$

where $Z = \dfrac{\left(\dfrac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}} (\Phi)^{\frac{r}{r-1}} (e_{ij})^{\frac{1}{r-1}}}{(k\beta)^{\frac{1}{\beta}} (m_j)^{\frac{(1-\beta)}{\beta}}} \left[\left(\dfrac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}} (\Phi)^{\frac{r}{r-1}} (e_{ij})^{\frac{r}{r-1}} + 1 \right]^{\frac{(1-2\beta)}{\beta}}$.

As equation (10) shows, the direction of the indirect effect of a change in exchange rate on the home price of importing country *j* is determined by the degree of returns to scale and elasticity of substitution of importing country *j*. This study summarizes the indirect effects a change in the exchange rate has on the home price of importing country *j* and the direct effects a change in exchange rate has on the foreign price of exporting country *i* in Table 1.

The direction of the indirect effects a change in the exchange rate induces on the home price of importing country *j* is the same as the direction of the direct effects of a change in the exchange rate on the foreign price of exporting country *i* when importing country *j* shows a decreasing returns to scale for production technology, $(\beta > 1)$ given an elastic elasticity of substitution for importing country *j*. Therefore, it can be inferred that the relative prices between foreign and home prices do not change if the foreign price elasticity for import demand equals the home price elasticity for import demand and the indirect effect of a change in exchange rate equals the direct effect of a change in the exchange rate.

The direction, however, differs when importing country *j* shows an increasing returns to scale for their production technology, $(\beta < 1)$, given an elastic elasticity of substitution for importing country *j*. As a result, relative prices will change due to a change in the exchange rate even when the foreign price elasticity equals the home price elasticity and the indirect effect equals the direct effect. Given an inelastic elasticity of substitution of importing country *j*, the opposite result holds.

Table 1 also shows the relationship between the exchange rate and relative prices, $\frac{p_{ij}}{p_{jj}}$. Regardless of either the elasticity of substitution or the degree of returns to scale for importing country *j*, an appreciation in the exchange rate results in an increase in relative prices while a depreciation in the exchange rate results in a decrease in relative prices. Since relative prices represent the foreign price relative to the home price, an increase in relative prices will deteriorate import demand for foreign products while a decrease in the relative prices will encourage import demand for foreign products.

[Place Table 1 Approximately Here]

The effect that a change in the exchange rate has on import demand will now be examined using Equations (1), (6.2), and (9). We obtain the new import demand equation by replacing p_{ij} and p_{jj} in Equation (6.2) with Equations (1) and (9). The effect of the exchange rate change on import demand is shown by way of the following equation:

$$(10) \qquad \frac{\partial Q_{ij}}{\partial e_{ij}} = \frac{\left(\frac{1}{r-1}\right)G - \left(\frac{r}{r-1}\right)H - L}{K},$$

where *G*, *H*, and *L* are described in Appendix I.

As seen in Equation (10), the effect of a change in the exchange rate on import demand is an empirical question. However, the effect of a change in the exchange rate on the relative prices and import demand are summarized as follows:

$$(11) \qquad \frac{\partial Q_{ij}}{\partial e_{ij}} = \frac{\partial Q_{ij}}{\partial p_{ij}}\frac{\partial p_{ij}}{\partial e_{ij}} + \frac{\partial Q_{ij}}{\partial p_{jj}}\frac{\partial p_{jj}}{\partial e_{ij}}.$$

As discussed in Table 1, if a change in the exchange rate does not affect the relative prices, given r and β, then the sign of Equation (11) will be determined by the foreign and home price

elasticities, since the impacts of a change in the exchange rate on both p_{ij} and p_{jj} are the same as each other in this case. Otherwise, it is an empirical question.

Empirical Parameters of the Korean Beef Market

This study has focused on the impact the exchange rate has on both relative prices and import demand in a microeconomic framework. It seeks to identify the indirect effect a change in the exchange rate has on the foreign price of an exporting country. For an empirical application of this approach, this study attempts to estimate the degree of returns to scale for Korean beef production and the elasticity of substitution for Korean beef consumption using Equations (7.1) and (9), respectively, since these parameters affect the exchange rate. To accomplish these objectives, this study uses annual data from 1995 to 2007. Home and foreign prices and imported volumes were obtained from the Korean Customs Service. The United States, Australia, Canada, and New Zealand are major beef suppliers to Korea. Even though Korea imports from four different countries, U.S. dollars are used as the medium of exchange for these transactions. In most cases, exchange rate risk is borne by Korean beef importers. Korean banks usually provide hedging tools for short-term exchange rate risk. The exchange rates of the Korean Won and U.S. Dollar were obtained from the USDA.

Table 2 shows empirical parameters, including the market share of imported beef, degree of returns to scale for Korean beef producers, and elasticity of substitution for the Korean beef consumer. The market share of the Korean imported beef market fluctuated, ranging from 0.25294 in 1998 to 0.69709 in 2003. In 1998, the dramatic decrease in the market share of imported beef is likely due to the Korean financial crisis. At that time, the financial crisis depreciated the Won (the Korean currency unit) in foreign markets. As a result, even though the home price of beef exporting countries decreased, the foreign prices of beef imported into the

Korean market dramatically increased from previous years. After recovering from the financial crisis, the market share of imported beef increased to a maximum of 0.6709 in 2003. Since the reports of outbreaks of mad cow disease in both the United States and Canada, the Korean government summarily prohibited beef imports from the United States resulting in a decrease in the United States' market share of imported beef following 2003. The market share of imported beef is currently around 0.5 percent of total beef consumption in Korea.

This study used the average import unit price as the exporting country home price, as shown in Table 2. The average import unit price ranges from $2.69/kg in 2002 to $4.28/kg in 2007. However, the foreign prices for imported beef consistently increased until 2003 due to a depreciation of the Korean Won which came about as the result of the Korean financial crisis of 1998. However, the foreign price of imported beef decreased after 2003 due to an appreciation of the Won even though the home price of imported beef increased during this period. As a result of fluctuations in the Korean Won during the sample period, the historic behavior of the foreign price for imported beef exhibited a different pattern than the home price of imported beef for this same period.

The home price of Korean beef decreased with an increase in imports from 1995 to 1999. However, through political pressure from Korean beef producers, the government chose to increase price support for domestic beef following 1999. Since then, the domestic Korean price of beef produced/processed in Korea has consistently increased until 2007. In general, the cost structure of the Korean beef producer demonstrates decreasing returns to scale. The estimated returns to scale parameters of their cost functions are approximately 1.4 during this sample period. As a result, the estimated parameter implies that there is an economic restriction on increasing beef production without a subsequent improvement in production technology.

The CES utility assumption restricts the elasticity of substitution. The elasticity of substitution parameter of is expected to range between $-\infty$ and 1 and should not be zero. However, this restriction was not satisfied in the years 1996, 1997, and 1999.

[Place Table 2 Approximately Here]

Simulation

To simulate the effects of a depreciation and appreciation of the U.S. dollar on the relative prices and import demand in the Korean beef market, this study used the average value of r, ω, and β during this sample period of time. The average estimated values of r, ω, and β are -1.2319, 0.2647, and 1.4465, respectively during the sample period of time.[5] As a result, the Korean beef market showed an inelastic elasticity of substitution and decreasing returns to scale in production technology. Therefore, the Korean beef market is categorized by $r < 0$, $0 < \omega < 1$, and $\beta > 1$.

Tables 3 and 4 show the results of simulation for a depreciation and appreciation of the U.S. dollar, respectively. Table 3 shows that a depreciation of the U.S. dollar decreases relative prices. As shown in Table 1, if the indirect effect of a change in the exchange rate on the home price of Korean beef equals the direct effect of a change in the exchange rate on the foreign price of imported beef in Korean market, then relative prices will only be slightly impacted with a depreciation in the U.S. dollar, given the assumption that the foreign price elasticity for import demand equals home price elasticity for import demand. Since the empirical results show that the depreciation of the U.S. dollar decreases relative prices, it can be inferred that the direct effect of a change in the exchange rate on the foreign price of imported beef is greater than the indirect effect of a change in exchange rate on the home price of Korean beef. Furthermore, from the empirical results, this study infers that the absolute value of the foreign price elasticity for import demand is less than one because the increase in import demand is shown to be less than the

decrease in the relative prices induced by a depreciation in the U.S. dollar. Simulation results show that if the value of the U.S. dollar decreases by 50%, relative prices decrease by 52.79% and import demand increases by 25.98%.

Table 4 shows that with an appreciation in the value of the U.S. dollar, relative prices increase and this, in turn, decreases import demand. These results are consistent with the results that come about with a currency depreciation. As expected, an appreciation of the U.S. dollar affects relative prices more significantly than does import demand. However, both an appreciation and a depreciation of the U.S. dollar show similar effects on relative prices and import demand. If the value of the U.S. dollar increases by 50%, relative prices increase by 56.58% while import demand decreases by 14.38%. As a result, the effects of a change in the exchange rate on import demand are less than the effects on relative prices in both a depreciation and appreciation of the U.S. dollar. From these results, this study supports an inelastic price elasticity of the Korean beef consumer for import demand.

Conclusion and Recommendations for Further Study

This study elaborated on the effects that a change in the exchange rate would induce on local prices and import demand, since the exchange rate is determined in the foreign exchange market rather than by agricultural commodity trade. Thus, it is reasonable to believe that the exchange rate serves as an exogenous shock to agricultural trade flows. This study identified the direct and indirect effects of a change in the exchange rate on the foreign and home prices since the foreign price of the exporting country is directly affected by a change in the exchange rate. Simultaneously, the effects to the home price of the importing country may accrue through the substitutability between home and foreign products and the endogeneity of the foreign price.

To describe the indirect effect that occurs in the home price of the importing country as the result of a change in the exchange rate, this study used the price equation in which the profit of the importing country producers is maximized. This study then showed that the marginal effect of the exchange rate on the home price of the importing country depends on the degree of returns to scale of production technology and the elasticity of substitution for the importing country. In Table 2, this study provides the summary of the direct and indirect effects of a change in the exchange rate on the foreign and home prices and the relative prices along with the degree of returns to scale of production technology and the elasticity of substitution for the importing country.

To identify how import demand is impacted with a change in the exchange rate, this study derived a marginal import demand equation with respect to the exchange rate. However, this equation shows that the effect of a change in the exchange rate on import demand is a purely empirical question. Therefore, this study uses the Korean beef import market to identify the empirical effect of a change in the exchange rate on import demand. To do this, the empirical market share of imported beef, the degree of returns to scale of Korean beef producer, and the elasticity of substitution for Korean beef consumers are calculated.

Using the estimated empirical values of r, ω, and β, this study simulated dual scenarios of both a depreciation and an appreciation of the U.S. dollar so as to identify the effects a change in the exchange rate would have on relative prices and import demand. Simulation results show that the direct effect of a change in the exchange rate on the foreign price of the exporting country is greater than the indirect effect a change in the exchange rate would have on the home price of the importing country. This results in a decrease in relative prices when the U.S. dollar depreciates and an increase in the relative prices when the U.S. dollar appreciates. Import

demand is shown to increase when the U.S. dollar depreciates and decrease when the U.S. dollar appreciates. However, the effect of a change in the exchange rate on import demand is less than the effect on the relative prices in both scenarios, implying that the foreign price elasticity for import demand is less than one.

Further study

This study identified the importance of the indirect effect of the exchange rate on the home price of the importing country. However, this indirect effect will differ, depending on the utility structure and production technology of the importing country. Furthermore, the elasticities of foreign and home prices for import demand are critical in deciding the power of the exchange rate in affecting local prices and import demand. In the future, it will be important to analyze consumer and producer behavior in response to a change in home and foreign prices in the importing country. Furthermore, this framework could be extended to a pure bilateral trade model in which both countries simultaneously import and export. The identification of the indirect effect of the exchange rate in that scenario would be more complicated. However, through expansion of this approach, it would add clarity to the process by which the exchange rate impacts import demand in both countries.

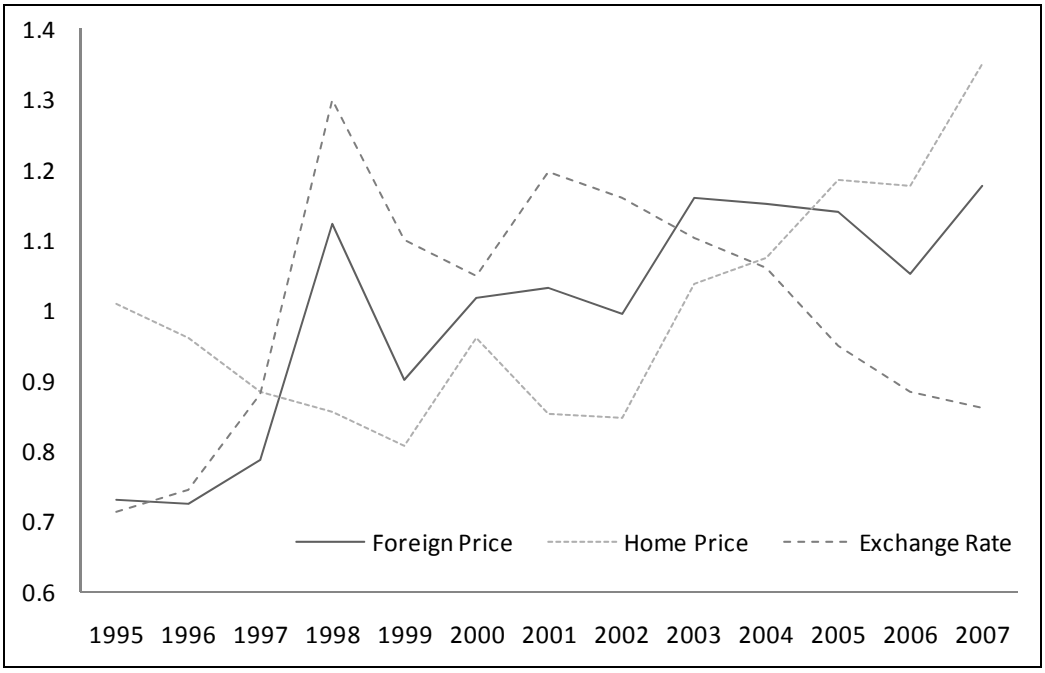

Figure 1. Home and Foreign Prices of Exporter and Exchange Rate in the Korean Beef Market

Table 1. Direct and indirect effects of the exchange rate on foreign and home prices.

		$0 < r < 1$ ($\omega > 1$)			$r < 0$ ($\omega < 1$)		
		$\beta > 1$	$\beta = 1$	$\beta < 1$	$\beta > 1$	$\beta = 1$	$\beta < 1$
$\frac{\partial p_{ij}}{\partial e_{ij}}$	$e_{ij} \uparrow$	(+)	(+)	(+)	(+)	(+)	(+)
	$e_{ij} \downarrow$	(-)	(-)	(-)	(-)	(-)	(-)
$\frac{\partial p_{jj}}{\partial e_{ij}}$	$e_{ij} \uparrow$	(+)	(0)	(-)	(-)	(0)	(+)
	$e_{ij} \downarrow$	(-)	(0)	(+)	(+)	(0)	(-)
$\frac{p_{ij}}{p_{jj}}$	$e_{ij} \uparrow$	0	(+)	(+)	0	(+)	0
	$e_{ij} \downarrow$	0	(-)	(-)	0	(-)	0

Table 2. Annual Empirical Parameters of Korean Beef Consumer and Producer

T	p_{ii}	p_{ij}	p_{jj}	Q_{ij}	Q_{jj}	e_{ij}	α	β	r	ω
1995	3.19	2463	5288	168367	154700	771.27	0.52115	1.44479	-9.02743	0.0997
1996	3.04	2444	5147	163360	174000	804.45	0.48423	1.44782	11.80448	-0.0926
1997	2.80	2660	5143	166091	237000	951.29	0.41204	1.44123	1.85493	-1.1697
1998	2.71	3793	4345	92026	271800	1401.44	0.25294	1.42799	0.125358	1.1433
1999	2.55	3037	4147	177479	239700	1188.82	0.42543	1.42050	1.036198	-27.6262
2000	3.04	3436	4587	237943	214100	1130.96	0.52637	1.42329	-2.7347537	0.2678
2001	2.70	3483	5408	180631	164400	1290.99	0.52352	1.43821	-4.6745045	0.1762
2002	2.69	3359	6545	315887	147400	1251.09	0.68184	1.44810	-0.8750452	0.5333
2003	3.29	3918	6512	325865	141600	1191.61	0.69709	1.45795	-0.6096377	0.6213
2004	3.40	3893	6112	160126	144900	1145.32	0.52496	1.46249	-4.51405	0.1814
2005	3.76	3848	6460	178331	152400	1024.12	0.53920	1.46268	-3.297409	0.2327
2006	3.72	3556	7085	212782	158200	954.79	0.57356	1.46113	-2.3256988	0.3007
2007	4.28	3975	7938	219607	171200	929.26	0.56193	1.46822	-2.7777047	0.2647
Mean	3.17	3374	5747	199884	182415	1079.65	0.51725	1.44649	-1.23194	-1.92826

α: market share of imported beef

p_{ii}: home price of exporting country's beef ($/kg)

p_{ij}: foreign price of exporting country's beef (Korean Won/kg)

p_{jj}: home price of Korean beef (Won/kg)

Q_{ij}: imported beef (1000kg)

Q_{jj}: Korean beef (1000kg)

β: degree of returns to scale of production

e_{ij}: Korean Won and U.S. dollar exchange rate (Korean Won/U.S.$)

r: parameter of elasticity of substitution

ω: elasticity of substitution

Table 3. Effect of U.S. Dollar Depreciation on Terms and Volume of Trade

	Exchage Rate	Terms of Trade	Volume of Trade	% Change	
	Won/$	p_{ij}/p_{jj}	Q_{ij}	Terms of Trade	Volume of Trade
Average	1109	0.52986	240670		
1%	1098	0.52405	241544	-1.10	0.36
2%	1087	0.51825	242429	-2.19	0.73
3%	1076	0.51246	243323	-3.28	1.10
4%	1065	0.50667	244228	-4.38	1.48
5%	1054	0.50090	245143	-5.47	1.86
6%	1043	0.49513	246069	-6.56	2.24
7%	1031	0.48937	247006	-7.64	2.63
8%	1020	0.48361	247953	-8.73	3.03
9%	1009	0.47787	248912	-9.81	3.42
10%	998	0.47213	249883	-10.90	3.83
15%	943	0.44358	254922	-16.28	5.92
20%	887	0.41524	260297	-21.63	8.16
25%	832	0.38712	266057	-26.94	10.55
30%	776	0.35923	272257	-32.20	13.12
35%	721	0.33158	278969	-37.42	15.91
40%	665	0.30418	286281	-42.59	18.95
45%	610	0.27703	294307	-47.72	22.29
50%	555	0.25014	303197	-52.79	25.98
60%	444	0.19722	324446	-62.78	34.81
70%	333	0.14552	352859	-72.54	46.62
80%	222	0.09521	395218	-82.03	64.22
90%	111	0.04653	475474	-91.22	97.56

Table 4. Effect of U.S. Dollar Appreciation on Terms and Volume of Trade

	Exchage Rate	Terms of Trade	Volume of Trade	% Change	
	Won/$	p_{ij}/p_{jj}	Q_{ij}	Terms of Trade	Volume of Trade
Average	1109	0.52986	240670		
1%	1120	0.53568	239804	1.10	-0.36
2%	1131	0.54151	238948	2.20	-0.72
3%	1142	0.54734	238102	3.30	-1.07
4%	1153	0.55318	237264	4.40	-1.42
5%	1165	0.55903	236435	5.50	-1.76
6%	1176	0.56488	235614	6.61	-2.10
7%	1187	0.57075	234802	7.72	-2.44
8%	1198	0.57662	233998	8.82	-2.77
9%	1209	0.58250	233203	9.93	-3.10
10%	1220	0.58839	232415	11.04	-3.43
15%	1275	0.61793	228591	16.62	-5.02
20%	1331	0.64766	224945	22.23	-6.53
25%	1386	0.67757	221462	27.88	-7.98
30%	1442	0.70766	218128	33.55	-9.37
35%	1497	0.73792	214932	39.27	-10.69
40%	1553	0.76834	211864	45.01	-11.97
45%	1608	0.79893	208914	50.78	-13.19
50%	1664	0.82968	206073	56.58	-14.38
60%	1775	0.89166	200693	68.28	-16.61
70%	1885	0.95425	195673	80.09	-18.70
80%	1996	1.01743	190971	92.02	-20.65
90%	2107	1.08119	186550	104.05	-22.49

Footnote 1.

According to the Marshall-Lerner condition, in order to improve the trade balance when a currency devalues, the sum of import and export demand elasticities should exceed unity. However, there have been circumstances under which this condition was satisfied yet the trade balance continued to deteriorate. The focus, therefore, has shifted to the short-run dynamics that trace the post-devaluation time-path of the trade balance, i.e., the J-Curve phenomenon (Bahmani-Oskooee, 2004).

Footnote 2.
See Magee (1973) and Bahmani-Oskooee and Ratha (2004).

Footnote 3.
As a result, even though $e_{ij} = \frac{p_{ij}}{p_{ii}}$ is true, $\frac{\partial e_{ij}}{\partial p_{ij}} = 0$ and $\frac{\partial e_{ij}}{\partial p_{ii}} = 0$.

Footnote 4.
Given the fact of transportation costs and barriers to trade, the absolute version of the law of one price rarely holds. Instead, the foreign price equation would be augmented by market distorting parameter, γ as follows: $p_{ij} = \gamma_j e_{ij} p_{ii}$, where γ_j represents supplemental costs when goods flow from country *i* to country *j*.

Footnote 5.
We use the value of 2007 for ω because the average estimated value is negative due to the extremely large negative number in 1999.

Footnote 5.
Although the United States is not the only beef exporting country in the world, all beef trade is denominated in U.S. dollars. Major exporting countries include: the United States, Australia, Canada, and New Zealand. Among them, the United States and Australia are the biggest exporters.

Appendix I

$$G=(1-\alpha)^{\frac{1}{r-1}}(e_{ij})^{\frac{2-r}{r-1}}(p_{ii})^{\frac{1}{r-1}}(k\beta)^{\frac{1}{\beta}}(m_j)^{\frac{r-\beta}{\beta(r-1)}}\left[\begin{array}{l}(1-\alpha)^{\frac{1}{r-1}}(e_{ij})^{\frac{r}{r-1}}(p_{ii})^{\frac{1}{r-1}}(k\beta)^{\frac{1}{\beta}}(m_j)^{\frac{r(1-\beta)}{\beta(r-1)}}+\\(\alpha)^{\frac{1}{r-1}}\left[\left(\frac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}}(\Phi)^{\frac{r}{r-1}}(e_{ij})^{\frac{r}{r-1}}+1\right]^{\frac{r(1-\beta)}{\beta(r-1)}}\end{array}\right]$$

$$H=(1-\alpha)^{\frac{1}{r-1}}(e_{ij})^{\frac{1}{r-1}}(p_{ii})^{\frac{1}{r-1}}(k\beta)^{\frac{1}{\beta}}(m_j)^{\frac{r-\beta}{\beta(r-1)}}\left[(1-\alpha)^{\frac{1}{r-1}}(e_{ij})^{\frac{1}{r-1}}(p_{ii})^{\frac{1}{r-1}}(k\beta)^{\frac{1}{\beta}}(m_j)^{\frac{r(1-\beta)}{\beta(r-1)}}\right]$$

$$L=(1-\alpha)^{\frac{1}{r-1}}(e_{ij})^{\frac{1}{r-1}}(p_{ii})^{\frac{1}{r-1}}(k\beta)^{\frac{1}{\beta}}(m_j)^{\frac{r-\beta}{\beta(r-1)}}\left[(\alpha)^{\frac{1}{r-1}}\left(\frac{r(1-\beta}{\beta(r-1)}\right)\left[\left(\frac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}}(\Phi)^{\frac{r}{r-1}}(e_{ij})^{\frac{r}{r-1}}+1\right]^{\frac{r+\beta-2r\beta}{\beta(r-1)}}\right]$$

$$K=\left[(1-\alpha)^{\frac{1}{r-1}}(e_{ij})^{\frac{r}{r-1}}(p_{ii})^{\frac{1}{r-1}}(k\beta)^{\frac{1}{\beta}}(m_j)^{\frac{r(1-\beta)}{\beta(r-1)}}+(\alpha)^{\frac{1}{r-1}}\left[\left(\frac{1-\alpha}{\alpha}\right)^{\frac{1}{r-1}}(\Phi)^{\frac{r}{r-1}}(e_{ij})^{\frac{r}{r-1}}+1\right]^{\frac{r(1-\beta)}{\beta(r-1)}}\right]^2$$

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