Determinants of the Korean agricultural trade with the LDCs and the OECD countries

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Abstract: The study aims to analyze Korea's import trade in agricultural products with (i) the least developed countries (LDCs) and (ii) the Organization for Economic Co-operation and Development (OECD) countries. Extended versions of a gravity model are adopted and the balanced panel data for the unilateral trade over the period of 2003 to 2008 are constructed using the Harmonized System Codes. The Heckman two-stage analysis is incorporated to detect the potential selection bias arising from many zero trades. We find that only preferential tariffs on the LDCs have significantly contributed to the trade flows. However, in contrast, gross domestic products (GDPs), free trade agreements (FTAs), the applied tariff rates, and the exchange rates turn out to be statistically significant in the trade with the OECD countries, thus highlighting the possibility of the potential trade benefits associated with the trade policy reforms. The study is unique in that it empirically estimates the determinants of agricultural trade between the LDCs and developed countries and reveals the potential effectiveness of the preferential treatment and the implementation of the trade policy reforms.

Key words: agricultural trade patterns, duty-free market access, gravity model, preferential tariff

Korea is one of the world's major agricultural importers. Even though agricultural products are the most sensitive commodities in the country, Korea allows a duty-free market access of some agricultural products to the least developed countries (LDCs). Many developed countries have traditionally attempted to boost economic growth by prompting the LDC exports in the global market. Given the Korea's history as a developing country, the country is fulfilling its responsibility and role, commensurate with its international positioning, by supporting this cause.

However, even though LDCs have received much support and preferential treatment, their development continues to be slow and steady. Many recent studies have attributed this to the fact that their specializations in primary products are vulnerable and disadvantageous in the global trade market (UNCTAD 2011). Some studies (United Nations ESCAP 2007) have also highlighted their poor trading structures and corrupt governments.

This study aims to analyze the trade patterns between the LDCs and Korea and to discover the difference in trade patterns in comparison with the member countries of the Organization for Economic Co-operation and Development (OECD). Moreover, it focuses on agricultural products and fills in certain gaps; very few studies have attempted to explore the determinants of trade between Korea and the LDCs in recent years (De Benedictis and Salvatici 2011).

In order to investigate the relationship between the value of imports to Korea and other trade determinant variables, an extended version of a gravity model is established and estimated. It focuses on the agricultural products using data from the years 2003 to 2008. The lack of data for the LDCs prevents the use of more recent trade flows. Besides, it is to a safeguard against the potential abnormal agricultural trades caused by the global financial crisis of 2008.

One important contribution of this study is its exploration of key trade patterns. Moreover, it also analyzes the preferential treatment given to the LDCs and confirms whether it is merited. Compared to the OECD countries, agricultural trade with the LDCs is largely limited to several primary or semi-processed products including fish, tobacco, plants, and oil seeds. The empirical analysis of the LDCs' trade patterns is based on the Heckman two-stage (HTS) method, which addresses the data problem associated with many zero trades. Trade with the OECD countries is analyzed with a general balanced panel fixed effect model (FEM).

AGRICULTURAL TRADE WITH LDCS AND OECD COUNTRIES

In 1971, the LDCs were officially recognized by the United Nations (UN) General Assembly, with the intention of supporting its poorest and weakest UN members and guarding their interests. Forty-eight countries are classified as LDCs, and their combined population exceeds 880 million (UNCTAD 2012). This translates to about 12% of the world's population, and they account for about 2% of the world GDP. The LDCs consist of 33 countries from Africa, 14 from the Asia Pacific region, and 1 from Latin America.

The identification of LDCs is currently based on three criteria: the low-income criterion, the Human Assets Index (HAI), and the Economic Vulnerability Index (EVI).[1] An LDC may graduate from this group when it passes the graduation criteria. Since the official recognition of the LDCs, only three countries have graduated: Botswana in 1994, Cape Verde in 2007, and Maldives in 2011. About 75% of the LDCs' population consume less than 2 USD a day, and many children are dying from starvation. Solving this abject poverty problem gained support from many countries around the world, including Korea and the World Trade Organization (WTO), under the Doha Development Agenda (DDA). By 2008, they agreed to provide the duty-free market access for at least 97% of the LDC products (CPD 2006).

According to the Harmonized System (HS) 6-digit classification, Korea provided the LDCs with the duty-free market access for 4549 out of 5052 products in 2012 (MOSF 2012). About 241 agricultural and fishery products are subject to the duty-free access. However, the ratio of the preferential tariff received to cover agricultural products from the LDCs amounted to merely 3.8% in 2008 (Cho and Kim 2010).

Although the trade has resulted in growth and development for most countries, the LDCs have not received much of its benefits. Moreover, they are becoming marginalized, particularly in the agricultural sector. The developmental problems they face, in the terms of trade, are both internal and external. The former include a low productivity, weak infrastructure and trade structures, low education, and a rampant government corruption. The latter including a weak trade performance are caused by the characteristics of their products, which are usually primary products

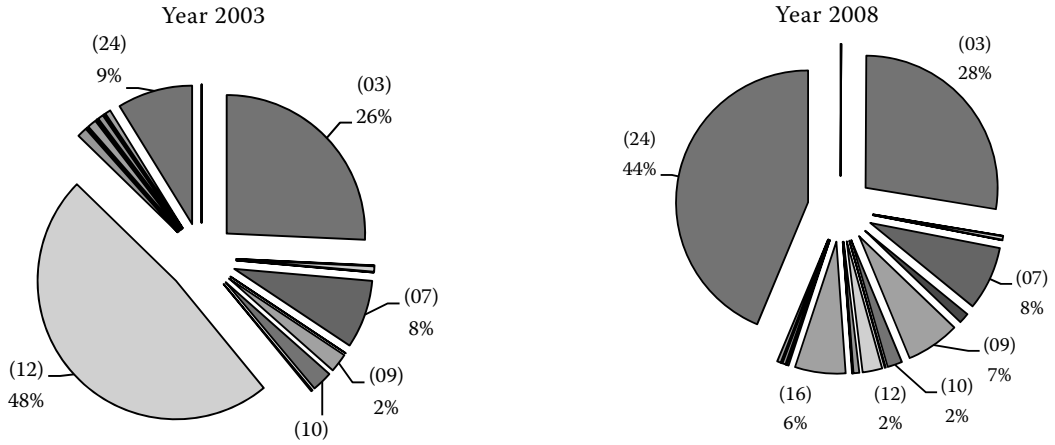

Figure 1. Product shares in the value of agricultural imports from LDCs in 2003 and 2008

HS 2-digits[2] are in parenthesis. The detailed description of HS codes is provided by the World Custom Organization at http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools/hs_nomenclature_2012/hs_nomenclature_table_2012.aspx

Source: KITA database (http://www.kita.org)

[1]Details of the criteria for identifying the LDCs can be found on the webpage of the Development Policy and Analysis Division of the UN (http://http://www.un.org/en/development/desa/policy/cdp/ldc/ldc_definitions.shtml).

[2]1 = Live animals; 2 = Meat and edible meat offal; 3 = Fish and crustaceans, molluscs and other; aquatic invertebrates; 4 = Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included; 5 = Products of animal origin, not elsewhere specified or included; 6 = Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage; 7 = Edible vegetables and certain roots and tubers; 8 = Edible fruit and

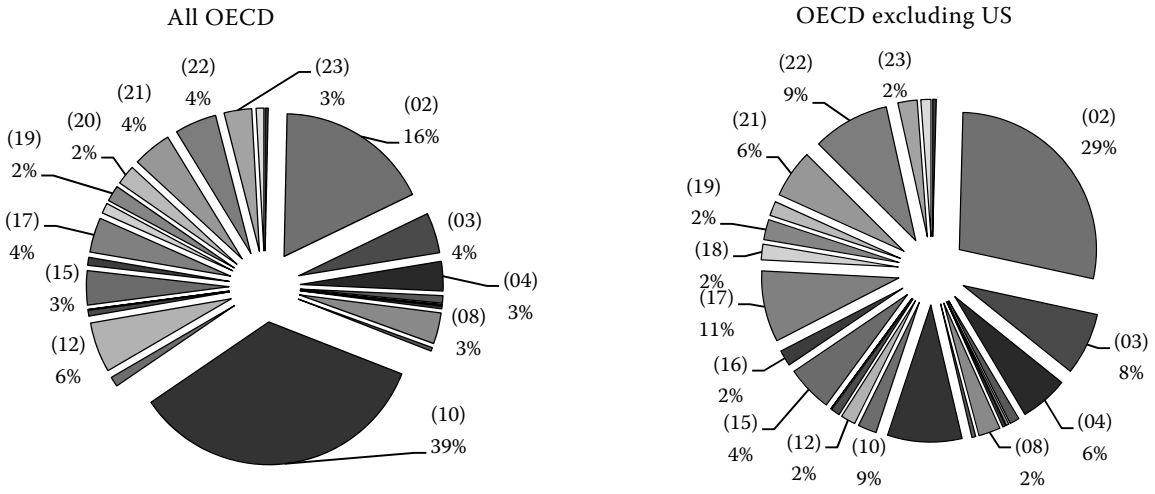

Figure 2. Product shares in the value of agricultural imports from the OECD Countries in 2008

HS 2-digits are in parentheses (see note 2)

Source: KITA database (http://www.kita.org)

that are vulnerable in the trading market. Moreover, owing to weak facilities, the LDCs' agricultural products are highly dependent on weather and climatic conditions, thus resulting in surpluses or deficits that they cannot control. Thus, more competitive and larger markets elsewhere are taking the LDCs' piece of the pie of the global market.

The LDCs participation in the agricultural product trading is very low although agriculture contributes a large portion to the total GDP for many LDCs, with the highest being up to 60%. Up to 90% of the labour force is employed in the agricultural sector in many LDCs. Therefore, the trade in agriculture is urgent and important for them to boost their economies. Traditionally, Korea has supported trading with LDCs by expanding the duty-free sectors in agriculture, and it hopes to increase this support. Although historically the preferential duty rates on agricultural products were limited to some products, this study attempts to explore the validity of their application and seeks evidence of their utility toward fostering trade with the LDCs.

Figure 1 shows that raw agricultural products are the main constituents of agricultural imports from the LDCs. They include the HS codes 03 (fish), 07 (vegetables and certain roots and tubers), 09 (coffee and tea), 12 (oil seeds and industrial plants), and 24 (tobacco). One of the most noticeable compositional changes in the import values occurred with tobacco; its share increased substantially from 7% to 44% between 2003 and 2008.

Figure 2 highlights the composition of import values from the OECD countries, which is more diverse than that from the LDCs. While imports from the latter mainly comprised raw products, imports from the former consisted of mainly processed products, denoted by the HS codes 04 (dairy products), 16 (meat preparations), 17 (sugar), 18 (cocoa), 19 (flour), 20 (vegetable preparations), 21 (edible preparations), and 22 (beverages), as well as semi-processed products denoted by the HS codes 02 (meat) and 15 (fats and oils). In 2008, grain recorded the largest share with 39%, followed by meat with 16%. If the largest grain exporter in the world, namely the US, is excluded from

nuts; peel of citrus fruit or melons; 9 = Coffee, tea, maté and spices; 10 = Cereals; 11 = Products of the milling industry; malt; starches; inulin; wheat gluten; 12 = Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder; 13 = Lac; gums, resins and other vegetable saps and extracts; 14 = Vegetable plaiting materials; vegetable products not elsewhere specified or included; 15 = Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes; 16 = Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates; 17 = Sugars and sugar confectionery; 18 = Cocoa and cocoa preparations; 19 = Preparations of cereals, flour, starch or milk; pastry cooks' products; 20 = Preparations of vegetables, fruit, nuts or other parts of plants; 21 = Miscellaneous edible preparations; 22 = Beverages, spirits and vinegar; 23 = Residues and waste from the food industries; prepared animal fodder; 24 = Tobacco and manufactured tobacco substitutes.

the calculation, meat contributes the largest share (29%), followed by grain (HS code 10), sugar (17), and beverages (22) with 11%, 9%, and 9% respectively.[2]

LITERATURE REVIEW

The literature review is divided into two parts. The first part deals with the gravity model, its use in the bilateral trade, and the manner in which it deals with the problem of controlling for zero values of trade. The second part deals with the recent studies that have discussed the LDCs trade and the preferential treatment toward them.

Gravity models

The classical gravity models generally use cross-sectional data to estimate trade determinants and relationships for a specific time period. However, in reality, cross-sectional data over several time periods provide a more realistic and useful information. Therefore, recent works have widely used the panel data estimation to capture the relationships among variables over time and to observe the trading partners' individual effects.

In this study, using the panel data estimation technique, we apply the generalized gravity model to analyze the Korea's import trade with the LDCs and the OECD countries separately. A FEM of panel estimation is appropriate to estimate the gravity model of the Korea-OECD import trade. Many gravity model estimations of panel data have encouraged the use of the FEM owing to its ability to control for unobservable multilateral resistances and activity variables. Feenstra (2002) agreed to the use of the fixed effects estimator because it does not require the custom coding. He also argued that while researchers should be suspicious of the other country-specific unobservables that the fixed effects may possibly identify, full information estimation would provide spurious results. Many other studies have used the FEM of the panel estimation when analyzing the gravity model. Rahman (2009) analyzed the determinants of the Bangladesh's imports using the gravity model with the FEM panel data and reported that the Bangladesh's imports are determined by the inflation rates, per capita income differentials, and the openness of the countries involved in trade with it.

Egger and Pfaffermayr (2003) analyzed the gravity model for 11 APEC countries, applied the FEM, and arrived at results that are widely in line with the theoretical priors. Martínez-Zarzoso and Nowak-Lehmann (2003) also analyzed an FEM of a panel data gravity model to assess the Mercosur-European Union trade, and they identified the important determinants of its bilateral trade flows as infrastructure, income differences, and exchange rates added to the standard gravity equation.

Many studies have focused on the panel data gravity analysis model in terms of trade patterns. However, problems with the traditional models owing to statistical issues, such as omitted variables and dropped observations, have led the more recent studies to develop the applied gravity research. Estrella (2012) and Linders and de Groot (2006) pointed out that in the case of zero values of trade, it is not possible to use the logarithmic form and that a heteroskedasticity problem arises. To overcome these problems, they used the HTS analysis. The merits of this method are that it addresses the heterogeneity problem and the selection bias. However, there are two difficulties; an appropriate (selection) variable is required in the first stage, and an inverse Mill's ratio (IMR) must be calculated. Of late, more researchers have adopted this method while studying bilateral trade.

Vollrath and Hallahan (2009) used panel data and the gravity framework to gauge the influence of the bilateral and regional free trade agreements (FTAs) on partner trade in the merchandise, agriculture, and clothing sectors. This framework uses different methodologies, including the Heckman selection model, to estimate the results. It provides strong empirical results where the regional trade agreements (RTAs) create trade in agriculture among countries belonging to a common reciprocal agreement, without diverting trade from the non-member suppliers. Significant determinants of trade include the exporter's and importer's incomes, distance, common border, and language similarity.

Gauto (2012) recently analyzed the effects of the Mercosur on the Paraguay's import flows by comparing the results of the Heckman correction for the selection bias and the Poisson pseudo-maximum-likelihood estimator to capture zero trade flows using the gravity model. Yu (2010) also analyzed the gravity model using the FEM to determine the effect of democracy on trade.

[3]The US accounted for 54% of the OECD countries' total agricultural exports to Korea in 2008.

Preferential trade with the LDCs

A few Korean studies have focused on the preferential trade treatment meted out to the LDCs. While the general scheme of preferences (GSP) regarding the LDCs' preferential treatment has been analyzed, none of the studies have conducted an empirical analysis. Cheong and Lee (2005) analyzed the effects of the expansion in preferential tariff rates on the LDCs and the accomplishment of the GSP in developing countries. The objective of their study was to show scenarios of economic effects over the GSP implementation, and they concluded by anticipating increased exports from developing countries to Korea and more trade diversion effects. The study, in sum, analyzed the expected economic effects through the GSP and preferential tariffs granted to the developing countries and the LDCs. Moreover, Cho et al. (2011) analyzed strategic approaches for the introduction of the GSP scheme in Korea. The adoption of the GSP includes a preferential tariff system for the LDCs, and the study concluded that the GSP system is necessary to aid developing countries, including the LDCs.

The above-mentioned studies focused on Korea's interest in supporting the developing countries, including the LDCs, through the GSP or the preferential tariff duty system. This study also seeks to examine the effect of preferential duties on the LDCs and their other political and cultural effects. An important contribution of this study is its focus on the empirical data and its estimation, both of which are lacking in the previous studies. Further, this study concentrates on agricultural products. The empirical results of the determinants of trade between the OECD countries and Korea are compared with the determinants of trade between the LDCs and Korea. To the best of our knowledge, this study is the first to use the gravity model to study these empirical estimations for the Korean agricultural sector and the LDCs. Therefore, the results and implications are likely to help to support the Korea–LDC trade and to confront the barriers slowing down growth in the LDCs despite the international support provided to them.

THE GRAVITY MODEL AND DATA

Theoretical background of the gravity model

To analyze the determinant factors and import patterns of Korea's agricultural products with respect to the LDCs, this study uses the gravity model. The gravity model was first proposed by Tinbergen (1962) to explain the international bilateral trade, and it was called the "gravity model" by analogy with the Newton's law of universal gravitation. The basic theoretical model for trade between two countries takes the form of this law, as seen below.

$$F_{ij} = G\frac{M_i M_j}{D_{ij}} \quad (1)$$

where F is the trade flow, M is the economic mass of each country, D is the distance, and G is a constant. Equation (1) is converted into a more realistic form of a gravity model specification similar to the Newton's law and is denoted as Equation (2).

$$X_{ijt} = K\frac{Y_{it}^{\alpha} Y_{jt}^{\beta} U_{ijt}}{Dist_{ijt}^{\theta}} \quad (2)$$

The equation comprises the importing country i, exporter country j, and the time variant t, thus making it a three-dimensional model. X_{ijt} denotes imports from j to i in time t, Y is the economic size represented by the GDPs of both countries in time t, $Dist_{ijt}$ is the physical distance between countries i and j and also reflects the trade costs, and U_{ijt} is the error term.

The gravity model has mainly related the bilateral trade flows to the GDP levels of the countries and their geographic distances, thus showing that any two countries are positively related to their sizes and negatively related to the trade costs between them. Usually the gravity equation is expressed in the logarithmic form, as in Equation (3).

$$\ln(IMP_{ijt}) = \ln(k) + \alpha\ln(GDP_{it}) + \beta\ln(GDP_{jt}) - \\ - \theta(Dist_{ijt}) + U_{ijt} \quad (3)$$

where U_{ijt} is the disturbance term that is assumed to follow a normal distribution with 0 mean and σ_u^2 variance.

To analyze the factors that determine Korea's imports of agricultural products from the LDCs, this study focuses on a gravity model of the unilateral trade between the LDCs and Korea. This helps us to investigate and concentrate on the policy and cultural factors that determine imports. Examples of unilateral gravity models include those of Sevela (2002), Lissovolik and Lissovolik (2006) and Kim (2009).

Model specification

In our model, imports from country j to country i are explained by their economic sizes (GDPs), direct

geographical distances, exchange rates, preferential tariff rates (which are applied only to the LDCs), and some political variables. To determine the importing trade determinants between the LDCs and Korea, the important key variable is the preferential tariff rate, which is a special treatment, applied only to the LDCs. This preferential tariff rate was calculated using the World Bank's World Integrated Trade Solution (WITS) tariff information on each of the agricultural products imported by Korea from the LDCs. Instead of using an aggregated tariff rate, specific tariff rates set for specific agricultural products were used and recalculated to assess the weight of each product value. Moreover, normally a negative sign is expected on a tariff variable, and in the case of this study, a negative significant sign is highly likely owing to the preferential treatment characteristics. The preferential tariff rate, namely the privileged (low) tariff rate, availed of by the LDCs, is represented as the variable *PTff*. This can be expressed as equation (4).

$$\ln(IMP_{jt}) = f(PTff_{jt}|Z_{kjt}, u_{jt}) \quad (4)$$

where Z_{kjt} comprises of various variables affecting imports, and k is the number of variables. In this study, Z_{kjt} also encompasses the FTA, which is expected to enhance Korea's imports from the LDCs, the exchange rate, the GDPs of each country, and the physical distances.

Because the model only considers Korea's imports, country i (Korea) is excluded. Thus, the final equation is a two-dimensional model consisting of exporting countries j and year t. IMP_{jt} is Korea's import value of agricultural products from j countries. u_{jt} is an unobservable error term that affects the imports, and it is assumed to follow the normal distribution with 0 mean and σ_u^2 variance.

Heckman two-stage process (dealing with zero trades)

The gravity model predicts that countries have a positive trade, even though the value or quantity may be small. Furthermore, the conventional log-linear formulation of the gravity model cannot include zero values, because the logarithm of zero cannot be defined. However, the data set of this study includes many zero trade values, implying that there are no products traded between some countries and Korea. Disregarding the zeros could bias the results. Specifically, if the geographic distance, low national income levels, and the lack of cultural or historical links reduce trade, leaving out the zero trades may result in an underestimation of the effects of these variables on trade (Rauch 1999). Therefore, ignoring the zero values may lead to a misrepresentation of the estimation results owing to the loss of information on trade.

To deal with this problem, this study uses the HTS analysis (Heckman 1979). The HTS method is a sample selection model, but it is also a commonly used method to deal with zero values in gravity models. Its selection mechanism is composed of two procedures. The first step estimates the probit model. The probit model's dependent variable is a binary variable Y_{jt}^*, which represents whether trade is observed between the two countries. If Korea imports from country j, then Y_{jt}^* takes 1 and 0 otherwise. This probit mechanism is set in Equation (5).

$$\begin{cases} Y_{jt} = 1 & if\ \ IMP_{jt} > 0 \\ Y_{jt} = 0 & if\ \ IMP_{jt} = 0 \end{cases} \quad (5)$$

The aforementioned probit model is analyzed through an unconditional estimation from the entire sample. Further, the second step of the analysis estimates the variables that affect imports. This procedure is a conditional estimation since it is estimated from a selected sample with no zero trade records. The expanded versions of the HTS analysis with the combined procedures appear below as equations (6) and (7).

$$\begin{aligned} \Pr(Y_{jt}) = {} & \alpha_0 + \alpha_1(PTff_{jt}) + \alpha_2(EX_{jt}) + \alpha_3 \ln(GDP_t) \\ & + \alpha_4 \ln(GDP_{jt}) + \alpha_5 \ln(Dist_j) + \alpha_6 (FTA_{jt}) \\ & + \alpha_7 (FOT_{jt}) + u_{jt} \end{aligned} \quad (6)$$

$$\begin{aligned} \ln(IMP_{jt})|Y_{jt} = 1| = {} & \beta_0 + \beta_1(PTff_{jt}) + \beta_2(EX_{jt}) \\ & + \beta_3 \ln(GDP_t) + \beta_4 \ln(GDP_{jt}) + \beta_5 \ln(Dist_j) \\ & + \beta_6(FTA_{jt}) + \beta_7 IMR + \epsilon_{jt} \end{aligned} \quad (7)$$

Note the existence of the identification problem that arises in the HTS analysis. As observed by Puhani (2000), this problem is noticed in the probit selection model. Such a model must contain a variable that is not in the ordinary least squares (OLS) model. Estrella (2012) suggested that this selection variable is required to solve the identification problem. This selection variable must affect the probit model, whereby it should distinguish whether trade takes place, but it must not affect the import value, which is the second model of the HTS. That is, we must have at least one variable for the probit model that has no effect on the import value.

For example, Helpman et al. (2008) used the "common language" and "common religion" as selection variables, and Shepotylo (2009) chose to use the "governance indicators of regulator quality." In line with the idea presented by Bouët et al. (2008), we use the "historical frequency of positive trade." This variable counts the frequency of trade (FOT) in the past years and accumulates the numbers up to the current year. None of the countries in our analysis has a border or a religion common with Korea. Therefore, the "historical frequency of trade" is used as the selection variable. The year 2003 serves as the starting year. The variable takes the value 1 if there is trade between the countries and 0 otherwise. Then, the numbers are accumulated each year until 2008.

We add a new variable, namely the IMR, to Equation (7) to handle the selection bias when using the HTS method. The IMR is computed as seen in Equation (8), where $\emptyset(Pr(\cdot))$ is the probability density function of Y_{jt}, and $\Phi(Pr(\cdot))$ is the cumulative distribution function of Y_{jt}.

$$IMR_{jt} = \frac{\emptyset(Pr(\widehat{Y_{jt}}))}{\Phi(Pr(\widehat{Y_{jt}}))} \quad (8)$$

Even though a correlation (corr $(U_{jt}, \epsilon_{jt}) \neq 0$) exists between the error terms of Equations (6) and (7), adding IMR_{jt} allows us to gain a consistent estimator. Appendix 1 explains the computation process for the consistent estimator in the framework of the HTS analysis.

Panel data

This study constructs balanced panel data of the Korea's agricultural product imports from the LDCs during the years 2003 to 2008. The term LDCs refers to 48 countries in total. However, owing to data deficiencies, our study covers 41 countries only; compared to the other countries worldwide, comprehensive country data are not readily available for some LDCs. Moreover, only agricultural products are treated in this study, and the data are sourced from the website of the Korea International Trade Association (KITA), which provides country, year, and commodity information as per the HS codes. The 10-digit HS codes for agricultural products, the most specified data category, range from HS codes 0 to 24.

The values of Korea's imports from the various LDCs are collected by the HS code and aggregated for each year over the sample period to create a dependent variable IMP_{jt}. The explanatory variables are GDP_{it}, GDP_{jt}, $Dist_j$, FTA_t, EX_{jt} and $PTff_{jt}$. The macroeconomic variables (GDP_{it}, GDP_{jt}, EX_{jt}) are collected from the World Bank's World Development Indicators (WDI) database. All the variables are changed into constant USD through the purchasing power parity. Variable EX_{jt} is the real exchange rate and it is calculated by transferring the nominal exchange rate in USD into the real exchange rate in KRW by using the consumer price index (CPI) $\text{real} = \text{nominal} \times \frac{CPI_k}{CPI_f}$. Here, CPI_f is the CPI of the exporters (LDCs) and CPI_k is Korea's CPI.

The preferential tariff $PTff_{jt}$ data obtained from the World Bank's WITS database provides information about the impacts of tariff changes on trade flows. The preferential tariff rates, which are applied only to the LDCs, are provided in this database for all HS codes. Therefore, we collect the preferential tariff rates for all agricultural commodities and assign a weight to each share of the commodities in order to derive a specific preferential tariff rate for each year.

Table 1. Summary statistics of data, LDCs

Variables	Observations	Mean	Min	Max	Standard deviation
Import value (US $, million)	246	1.2	0	31	3.4
GDP of LDCs (constant 2005 international $, million)	246	19 700	200	210 000	30 600
GDP of Korea (constant 2005 international $, million)	246	1 150 000	970 000	1 300 000	132 000
Distance (km)	246	10 040.07	3 218	13 478	3 257.11
Number of FTAs	246	0.0731	0	1	0.2609
Exchange rate (real exchange rate)	246	0.8463	0.0011	10.5199	1.7259
Weighted tariff rate (preferential tariff rates)	246	8.8115	0	62.6803	13.3421

Source: World Bank Database

Table 2. Summary statistics of data, the OECD countries

Variables	Observations	Mean	Min	Max	Standard deviation
Import value (US $, million)	232	270	1 284	6 000	740
GDP of the OECD countries (constant 2005 international $, million)	232	1 250 000	8 900	15 000 000	2 470 000
GDP of Korea (constant 2005 international $, million)	232	1 150 000	970 000	1 300 000	132 000
Distance (km)	232	8 531.508	942.71	11 542.3	1 758.003
Number of FTAs	232	0.0646	0	1	0.2464
Exchange rate (real exchange rate)	232	0.01105	0.0004	0.2166	0.03457
Weighted tariff rate (applied rates weighted by product import shares)	232	13.8568	11.4	18.24	2.5099

Source: World Bank Database

The physical distance ($Dist_j$) represents the distance in kilometres between the Korean capital and the capital of each trading country. This information is sourced from the distance calculator "Distance From To."[4] FTA_{jt} a dummy variable equals 1 if an FTA has been signed between Korea and the LDC, and 0 otherwise. The information regarding the FTAs is sourced from the Korean FTA network.[5] Tables 1 and 2 provide summary statistics of the data.

MODEL ESTIMATION AND RESULTS

The panel data analysis may face unobservable individual heterogeneity problems. The heterogeneity is caused by differences in the individual preferences, endowments, and attributes. Researchers have suggested that the FEM and the random effect model (REM) be used to deal with this problem (Egger 2000; Egger and Pfaffermayr 2003; Cheng and Wall 2005; De Benedictis and Vicarelli 2005). While both models can be used to control for the unobserved heterogeneity, they differ in approach. The assumption in the FEM is that the individual specific effects are correlated with the independent variables, whereas the REM assumes the opposite. Moreover, in our gravity model, the FEM allows for variation with no structures, while the REM requires the unobserved heterogeneity to follow some probability constraints.

To estimate Equation (7), we must subdivide the error term ϵ_{jt} into the time and individual dimensions, thus resulting in Equation (9).

$$\epsilon_{jt} = \mu_j + \lambda_t + u_{jt} \quad (9)$$

Here, μ_j is the time invariant and identifies the individual exporters' country-specific effects, while λ_t is the country invariant and shows the time-specific effects. Moreover, u_{jt} represents the random time and the country-variant effects. To simplify the two-dimensional model, λ_t can be treated as a trend or dummy variable. However, when treating it as a time dummy, it can be expressed as a one-dimensional equation considering only individual effects, like Equation (10).

$$ln(IMP_{jt}) = \beta_0 + \beta_k \sum_{1}^{k} X_{kjt} + \mu_j + \lambda_t + u_{jt} \quad (10)$$

where j is the cross-sectional data (j = 1, 2,..., N), t is the time series data (t = 2003, 2004,..., 2008), and k is the number of explanatory variables (k = 1, 2,..., k). μ_j and u_{jt} are assumed to be independent error terms, where u_{jt} is independent of X_{kjt} and is assumed to be $u_{jt} \sim iid(0,\sigma_u^2)$.

The FEM's ($\beta_0 + \mu_j$) is estimated by the fixed panel individual parameters, while the REM's ($\beta_0 + \mu_j$) is estimated by the random variables that follow the probability distribution. If the assumption $cov(u_{jt}, X_{kjt}) = 0$ is valid, the FEM and the REM both need to

[4]See http://www.distancefromto.net/countries.php.

[5]See http://www.fta.go.kr.

[6]The Hausman test's null and alternative hypotheses are H_0: $cov(u_{jt}, X_{kjt}) = 0$ and H_1: $cov(u_{jt}, X_{kjt}) \neq 0$, respectively. If the null hypothesis is valid, the REM is efficient to use as a consistent estimator. Otherwise, the FEM is efficient to use as a consistent estimator.

provide a consistent estimator. If $cov(u_{jt}, X_{kjt}) \neq 0$, the REM does not need to provide a consistent estimator, but we need to conduct the Hausman test.[6] Since the FEM cannot estimate the dummy variable (FTA) and the distance variable (which do not change over time), the estimated results of the FEM and the REM cannot correspond. Therefore, we are likely to commit an error in determining the model to be used by relying on the results of the Hausman test. Therefore, this study provides both the FEM and the REM; the former assumes the individual heterogeneity and the latter does not.

In this study, we use the STATA as the statistical processing software. Table 3 shows the estimated results using the FEM and the REM. According to the HTS procedure, the first step requires the estimation of the probit equation, following which the FEM and the REM are estimated in the second step. As Gujarati (2003) pointed out, an REM takes the intercept of a particular component as a random selection from a larger sample with a constant mean, and so, the intercept can be expressed as a deviation from the constant mean value. Moreover, because the REM does not estimate over n cross-sectional intercepts (unlike the FEM), it is said to be more economical with regard to the degree of freedom.

Table 3. Parameter estimates for Korea's agricultural imports from the LDCs

Variables	Probit	FEM	REM
ln(GDP of LDCs)	0.7705*** (0.1587)	–0.7930 (2.0042)	0.3697 (0.2759)
ln(GDP of Korea)	–1.5110 (1.7348)	4.9712 (3.0458)	3.5487** (1.4124)
ln(distance)	–1.5972** (0.7114)	dropped	1.1165 (1.1765)
Number of FTAs	dropped	dropped	2.6563 (1.8747)
Exchange rate	0.5476 (0.9367)	–0.0151 (0.8238)	–0.5579 (0.7967)
Weighted tariff rate	0.4324*** (0.0805)	–0.0469* (0.0250)	–0.0299 (0.0207)
Trade frequency	0.1432*** (0.0384)	–	–
IMR	–	–1.8362*** (0.6201)	–1.6816*** (0.5574)
Constant	37.5152 (47.4441)	–106.5576** (48.4082)	–104.4031*** (39.5450)
Observations	246	168	168
R^2		0.015	0.155

Figures in parentheses are standard errors.

***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

In the probit estimation, "FTA" is omitted owing to collinearity.

In the FEM, distance and FTA are omitted owing to time-invariant effects and collinearity.

According to Shepherd (2008), the advantages of the FEM include, (i) it requires less restrictive assumptions, (ii) it fits nicely with the gravity theory, and (iii) it is easy to estimate, even in multiple dimensions. On the other hand, the advantages of the REM include, (i) it does not eliminate the country-level variables, and (ii) it is not subject to the dimensionality constraint.

An FEM is known to be more robust in a gravity model but it cannot estimate the time-invariant effects such as the distance and dummy variables, because the inherent transformation disregards such variables. Even though we cannot implement the Hausman test in the HTS method, the fixed effects estimator is much more common in the gravity models than the random one. An REM imposes stricter conditions on the data by assuming that there is no unobservable individual heterogeneity. However, this is a strong assumption in realistic terms. For example, cultural differences and the dietary life differ among all countries, but estimating these items by parameterizing such differences is not possible, and this study cannot reflect all such characteristics in the estimation. Therefore, as Shepherd (2008) states in his workshop overview, in gravity modelling, the FEM estimates are consistent regardless of whether the "true" model is the FEM or the REM.

However, we provide the results for both the FEM and the REM; even though we prefer the FEM, the model loses its time-invariant variables by disregarding the distance and dummy data. Therefore, we emulate the studies that have provided both the REM and the FEM (Egger 2000; Glick and Rose 2002).

A statistically significant coefficient of the IMR under the FEM suggests that the model is consistently estimated when the selection bias is controlled. However, the model appears to do a relatively poor job at fitting agricultural imports by Korea from the LDCs. Insignificant GDP estimates hint that the sizes of the markets or income levels are not effective in explaining the agricultural trade between the LDCs and Korea. It would be difficult for the LDCs to satisfy the country's growing trend toward a safer, healthier,

Table 4. Parameter estimates for Korea's agricultural imports from the OECD countries

Variables	FEM	REM
ln(GDP of OECD)	–0.7617 (0.7029)	0.8793*** (0.2470)
ln(GDP of Korea)	1.7570*** (0.6595)	0.5650 (0.4375)
ln(distance)	Dropped	–0.2676 (0.8690)
Number of FTAs	0.3643* (0.1885)	0.2865 (0.1881)
Exchange rate	–15.2869*** (5.9389)	–9.0878* (5.2966)
Weighted tariff rate	–0.0359* (0.0205)	–0.0189 (0.0198)
Constant	–10.2202 (11.9448)	–19.0477 (14.0272)
Observations	232	232
R^2	0.3491	0.3948

Figures in parentheses are standard errors.
***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.
In the probit estimation, "FTA" is omitted owing to collinearity.
In the FEM, distance and FTA are omitted owing to time-invariant effects and collinearity.
Chile, Estonia, and Slovenia are excluded from the dataset because they became the OECD members in 2010. Slovakia, which switched its currency from the Koruna to the Euro on January 1, 2009, is also excluded from the data.

and environmentally friendly consumption. Besides, the lack of infrastructure, the capacity to innovate, the R&D investment, and export standards in the LDCs may hinder their market access to the country (Koning and Pinstrup-Anderson 2007; Amurgo-Pacheco and Pierola 2008).

The tariff rate data are sourced from the World Bank and denote the average of the effectively applied rates for primary products weighted by the product import shares corresponding to each partner country.[7] For the years where the tariff data were unavailable, these were estimated by calculating the average of the preceding and the next years' tariff rates. The negative and significant estimate for the tariff rate confirms that the provision of the preferential market access facilitates imports from the LDCs. Although the coverage rate of agricultural products in the preferential treatment falls significantly short of the national average, duty-free imports turn out to be effective motivators of trade with the LDCs. Similar results have been recorded in the literature (Cipollina and Salvatici 2010; Raimondi and Olper 2011).[8]

Potential explanations of the relatively weak fitting of a gravity model include a high export concentration and rigidity (UNDP 2011). The LDCs tend to export a small number of agricultural products to a small number of preferred markets (UNCTAD 2012). They are less export dependent compared to the world average (Edo 2011).

By contrast, agricultural imports from the OECD countries appear to yield the expected parameter estimates in Table 4. As mentioned before, the FEM is appropriate to explain the panel gravity model since it captures the country effects and assumes the unobservable individual heterogeneity. The FEM is an unrestricted model since the intercept and other parameters are allowed to vary across the trading countries. However, even though the REM allows for heterogeneity in the cross-section, the effects are built by a specific distribution, and thus it cannot explicitly provide proper individual effects. Therefore, even though we report the results of both models, the OECD–Korea trade estimation uses the FEM.

The GDP for Korea shows a positive and significant parameter value. The growing demand for the more westernized and high quality food is compatible with the fact that agricultural imports from the OECD countries are mostly processed products such as cheese, wine, and chocolate. This contrasts with the LDC exports to Korea that are mostly primary unprocessed products (Figures 1 and 2).

The FTA shows a positive significant sign, which implies that, the number of FTAs between the OECD countries and Korea will increase the Korea's imports. Even though only three countries (Iceland, Norway, and Switzerland) have been FTA partners with Korea since 2006, the influence turns out to be significant and relevant. The recently ratified FTAs with the European Union and the United States are expected to reinforce the positive response. The negative coefficient for the real exchange rate agrees with our expectations. As the value of the Korean won

[7]The tariff rates are calculated by multiplying the import shares by the compiled weighed tariff rates.
[8]Evenett (2008) provided a literature review of the empirical models that estimated preferential margins under the European Union's preferential trade schemes.

depreciates, its imports decrease. The findings for the tariff rates are also as expected. The parameter estimate implies that the relationship between the tariff level and import is negative, which is in line with the LDCs' case. Overall, agricultural imports from the OECD countries appear to fit better with the theoretical model specifications.

POLICY IMPLICATIONS AND CONCLUSIONS

This study aimed to analyze the different trade patterns of agricultural products between Korea and two country groups: the LDCs and the OECD countries. Exports from the LDCs to Korea consist primarily of low-value unprocessed products, while the OECD countries mostly export high-value processed products. In particular, the fact that a number of product categories record zero imports from the LDCs indicates the presence of structural difficulties, biased consumer preferences, trade barriers, and policy impediments.

Many agricultural exporters among the LDCs are located in Africa, which can be one reason for the low bilateral trades; the trade costs may be quite high if raw products have to travel a considerable distance to the market. This is partly explained by the high levels of the export concentration from the LDCs to the nearby European destinations. Historical and cultural ties and preferential trade arrangements such as the "Everything But Arms (EBAs)" trade initiative, which grants a duty-free and quota-free market access, also account for the LDC exports being highly focused on the European Union's markets.

By contrast, the Korea's preferential trade arrangements in favour of the LDCs are in a dismal state, with only 241 agricultural and fishery products claiming the duty-free market access in 2008. Such low coverage rates, despite the benefit of preferential tariffs, support our interpretation.

The empirical analysis based on the extended version of the gravity models reinforces the interpretation of the current trade patterns. In contrast to the case of the OECD countries, a weak relative representation by the model suggests that agricultural exports from the LDCs have their limitations. The results include statistically insignificant responses from the economic production or income levels and exchange rates. The ineffectiveness of the GDP in explaining unilateral imports could be attributed to the large differences in the sizes of their economies, the lack of export varieties, and/or the geographical concentration of exports by the LDCs.

From a policy perspective, the significant relationship between tariff rates and imports indicates that a preferential tariff arrangement, such as the duty-free market access, actually promotes imports from the LDCs. This result suggests that the market access will be promoted if Korea expands the scope of the preferential tariffs or lowers other trade measures on agricultural products. It also confirms the possibility that furthering the special and preferential treatment under the FTAs is likely to enhance the bilateral trade.

Besides, in order to encourage imports from the LDCs, other non-trade measures such as the rules of origin requirements, complicated procedures to claim preferential duties, and sanitary, phytosanitary, and technical measures, must become transparent and less complicated. Korea may want to ensure a better participation in the WTO-led "Aid for Trade" initiative, which seeks to mobilize resources to overcome the trade-related limitations confronted by the LDCs.

This study is noteworthy in that it fills in the gaps left by the previous empirical studies that focused on agricultural trade between Korea and the LDCs. However, the data unavailability is a concern and it could affect the robustness of the results. The future research may, therefore, address this limitation by expending greater efforts on collecting data and identifying the model specifications.

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