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Is Korea Exploiting Its Trade Potentials in Africa? : Gravity Equation Analysis and Policy Implications*

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This study analyzes the Korea-Africa trade flows that present a typical inter-industry trade pattern, using the gravity model and the Hausman-Taylor Method. A number of studies of Korea's trade have been carried out previously; nevertheless, there hardly exists literature that focuses on the Korea-Africa trade. This exercise is a first-ever trial to investigate the Korea-Africa trade potentials by comparing the actual trade volume with the predicted one, through calculating fitted values based on regression coefficients. As a result, we find that the Korea-Africa trade still has room for expansion despite sharp increases in the decade. Among sub-regions, the western and southern African markets are particularly to be exploited further. We also confirm that tariffs, human networks and trade structure have significant impacts to Korea's exports to Africa. To harness export potentials, Korea needs to be proactive in FTAs. It is also imperative to implement policy to strengthen human networks, for instances, capacity building programs of local trade facilitators. The trade complementarities with many African countries, including Algeria, are highly likely to evolve favorably for Korea's exports with Africa's continuous economic growth; hence opening up new opportunities for Korea's exports and placing additional emphasis on policy efforts for favorable environment of trade with Africa.

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1. INTRODUCTION

The purpose of this study is to analyze the trade pattern between Korea and Africa using the gravity model that is well known for its robustness and convenience to investigate policy implications; hence being widely applied in the variety of empirical studies for trade flows. Africa, the continent we are focusing on here, is the one of the fastest growing areas in these days. From 1996 to 2010, Africa's average annual GDP growth amounted to about to 5% and per capita GDP increased year by year, by an average of 2.5% (AfDB *et al*., 2013). In this sense, not only traditional trade partners such as the Europe, the U.S. and Japan but also emerging economies like China and Brazil are strengthening the economic ties with the continent in order to facilitate their exports.[1)] Korea is also joining these movements by making efforts to build close relationship with African countries. The Korea Africa Economic Cooperation Conference (KOAFEC), for instance, was initiated in 2006 and since then became the permanent framework for cooperation between Africa (the African Development Bank) and Korea (the Ministry of Strategy and Finance). Notwithstanding the importance of the African markets to Korea and vice versa, the serious studies on the Korea-Africa relations, especially on the bilateral trade flows are extremely rare. This silence comes as a big surprise, showing a sharp contrast to China-Africa related studies that have been pouring out in these days. Such an academic ignorance on the Korea-Africa trade is the main motivation of this study. This exercise is a first-ever trial to narrow the knowledge gap on the Korea-Africa trade through empirical analysis based on the gravity model, given most existing literature on Korea's trade focusing on major trade partners such as the U.S., Europe, China and Southeastern Asia. The Korea-Africa trade is such a new research arena where few studies have

[1)] For example, at the 2009 Forum on China-Africa Cooperation (FOCAC), China pledged $10 billion in concessional loans to Africa. By 2007 BNDES, the principal funding agency for Brazilian infrastructure projects in Africa, had approved 29 projects amounting to US$742 million. Refer to Schiere (2011), White (2010) or African Economic Outlook 2011 (AfDB *et al*., 2011) for the details on the increasing engagement of emerging economies in Africa.

given answers to its characteristics, determinants and policy implications. Providing a starting point for investigation of the Korea-Africa trade is the novelty and contribution of this study.

To this end, we try to assess the bilateral trade flows between Korea and African countries using the gravity model to find out that how much Korea and African countries is exploring their trade potentials. The outcomes of the analysis are also reviewed in the sub-region context which is of special importance in the study on the African continent. For policy implications, we identify factors affecting Korea's export to Africa and try to answer the questions on what kinds of measures or actions should be taken to expand the economic cooperation between two regions.

The main findings are the followings. The trade volume between Korea and Africa has increased sharply in the past decade and there still remains room to grow. To Korea, the potential of exports is larger than the potential of imports. Among sub-regions in Africa, the export potentials in West and South Africa are to be exploited further by Korean firms. We also confirm that tariffs, human networks and trade structure have significant impacts to Korea's exports to Africa.

This paper is organized as follows: In section 1 we identify basic trade patterns between Korea and Africa. In section 2 we review related literature and in section 3 we explain estimation equations and data. In section 4 we discuss estimation results. In section 5, conclusion remarks are given with policy implications.

2. TRADE PATTERN BETWEEN KOREA AND AFRICA

Korea-Africa trade still remains marginal accounting for as less as 1% of Korea's total trade volume. Nevertheless, it is noticeable that Korea's export continues to increase since 2001 except for 2009 and 2012 when hit by the global financial crisis and the Eurozone crisis (table 1). Accordingly, Africa is attracting more attention as a new trade partner with Korea. The

Table 1 Korea's Trade with Africa (1998-2012)

(unit: mil. USD)

	1998	2000	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012
Exports	3,934	3,221	3,809	7,157	7,915	9,727	11,066	13,028	12,719	15,348	17,874	13,478
Imports	2,123	3,185	2,172	3,623	3,510	5,723	6,013	5,704	3,726	5,474	6,294	7,117

Source: UNCOMTRADE database.

characteristics of trade between the Korea and Africa can be summarized into sectoral and regional concentration. The trade is limited to several countries in terms of destinations and to such products as prime materials, automobile and cellular phone. Korea's major markets in Africa are countries like South Africa, Egypt, Algeria, Morocco, Nigeria, Ghana, Ethiopia and Libya (figure A1). The big eight markets account for 90% of total export to Africa. The products such as chemicals, automobile, machinery and refineries are main exports (figure A2). The share of heavy industry and ICT products is increasing over times, while the proportion of light industry products such as textile and rubber is decreasing. This pattern implies that Africa's demand for capital and endurable goods are increasing according to its industrialization and Korea well meet the demand with its competitive products. The reductions of light industries probably relate to the overall picture of the Korean light industry which faces challenges from China's cheap products. The imports from Korea to Africa are geographically more concentrated than the exports. The imports are largely limited to South Africa, Libya, Egypt, Algeria, Zambia and Gabon (figure A3). The main products imported by Korea from Africa are commodities such as crude oil and gas, iron ore, petroleum refineries, non-ferrous metals and agricultural production (figure A4). In summary, Korea and Africa trade is a typical North-South trade that Korea exports manufacturing goods to Africa and imports primary industry production.

3. RELATED LITERATURE

3.1. African Trade and Korea-Africa Trade

Much of existing literature on African trade has reviewed the role of openness in economic growth. Sachs and Warner (1997) argue that the lack of openness to international markets is the main reason for the poor growth performance in Africa. Fosu (1990, 1996) and Rodrik (1998) show the positive effects of exports to economic growth in the continent. While Ouattara (1998) suggests that Africa should learn from the experiences of the Asian industrial countries, Ajayi (1997) and Rodrik (1999) are highly skeptical of the claims by the advocate of international economic integration (Ndedi and Bunwaree 2007). In general, the evidence on the growth effects of trade liberalization remains mixed (Greenaway *et al*., 2002; Esterly and Levine, 2003; Dollar and Kraay, 2003; Rodrik*et al*., 2004). Various arguments have been advanced to explain the limited effects of trade liberalization on growth. For instance, Baliamoune-Lutz and Ndikumana (2007) stressed the role of institution in harnessing the trade-led engine of growth. Poor infrastructure has been pointed out as a critical challenge for increasing African trade (Limao and Venables, 2001). In many cases, shipping costs represent a more binding constraint to greater participation in international trade than tariffs (De and Lee, 2009). Transportation costs of Africa are among the highest in the world, resulting in relatively low level of intra-African trade (Baresa *et al*., 2011). After the outbreak of global financial crisis, a series of studies delivered insights on the effect of the crisis to African trade. Kamara and Kang (2010) argued that the European sovereign debt turmoil sparked by the Greek debt crisis increased the fragility of Africa's economy given the strong trade linkages between Africa and the EU. Berman and Martin (2011) show that the African exporters are particularly vulnerable to a banking crisis in the countries they export to. In this context, emerging trade partners such as China, India, Korea and Brazil began to draw more attention of policymakers and researchers. While

studies of Africa's emerging partners has placed a great emphasis on China, a number of articles including Kang (2011), Park and Hur (2007) and Park *et al*. (2012) have tried to shed light on the status of Korea-Africa partnerships and strategies to maximize their potentials. Kang (2011) argued that Africa's economic growth presents opportunities for closer business ties with South Korea and Africa can benefit from knowledge sharing on policy and institutional issues through increased dialogue and cooperation. Park and Hur (2007) highlighted the importance of Africa as export markets, urging the Korean government to pay more attention to FTA agreement with South Africa[2)] and strengthening human network in Africa. There hardly exists, however, sufficiently strong evidence to support those claims. The main contribution of this study is to add empirical evidence to existing literature on Korea-Africa trade relationship. In addition, this exercise expands the geographical coverage of Korea-Africa study to all African countries, presenting regional disparities within Africa in terms of trade performance and potentials remained.

3.2. Gravity Model

The gravity Model, first introduced by Jan Tinbergen (1962), is well known to be intuitionally understood because it includes explanatory variables such as economic sizes and distances, which are considered to be of much importance in bilateral trades from even a common-sense standpoint. It is also preferred by researchers due to its convenience in adding explanatory variables which are of interest in some context, for examples, the quality of infrastructure and institutions in developing country's trade. The basic equation of the gravity model takes the follow form[3)]:

[2)] Park and Hur (2007) argue that the trade of Korea and South Africa would increase by 35.7% and 11.9%, respectively if FTA agreement is signed (as of 2005). This estimation is carried out through panel analysis but regression model, methodology, data and other details are not reported.

[3)] Refer to UNCTAD (2012), p. 30.

$$X_{ij} = \frac{Y_i Y_j}{Y}(D_{ij})^{-1}, \quad (1)$$

where X_{ij} is trade volume from country i to country j and Y_i and Y_j are the economic size of country i and j respectively. Y is income of the world. D_{ij} means the geographical distance between country i and j. The equation reflects the idea that the bilateral trade volume increases in proportion to the sizes of two countries and decreases to the distance between them. Despite the easiness and convenience, the gravity model had been criticized with the lack of theoretical foundation before Anderson (1979), for the first time, tried to explain the model with international trade theory. The theoretical framework was more strengthened after Bergstrand (1985 and 1989) showed that the gravity model is based on the monopolistic competition model by Krugman (1980). Evenett and Keller (2002) argued that the gravity model can also be applied to Hecksher-Ohlin model with continuum goods and the appropriate model specification is imperative to explain various trade patterns in different contexts. Anderson and van Wincoop (2003) developed a more sophisticate model, reflecting their founding that bilateral trade volumes depend on not absolute but relative trade costs between trade partners. According to Anderson and van Wincoop (2003), the equation (1) can be changed as follow.

$$X_{ij} = \frac{Y_i Y_j}{Y}\left[\frac{t_{ij}}{\Pi_i P_j}\right]^{1-\sigma}, \quad (2)$$

where X_{ij} is nominal trade volume from country i to country j and Y_i and Y_j are nomimal income of country i and j, respectively. t_{ij} is trade cost between i and j countries, Π_i and P_j are country i's and country j's price indices. Anderson and van Wincoop (2003) call Π_i and P_j Multilateral Resistance Term (MRT), denoting the easiness of market access to country i

and j from all other countries.[4] σ (>1) represents the CES elasticity of substitution. The equation (2) tells that trade volumes decrease in proportion to the ratio of trade costs and MRTs and trade costs between two countries is affected by the variety of factors such as tariffs, transportation costs, common cultural and historic characteristics and business networks.

The empirical studies using the gravity model have been carried out in the myriad of areas. McCallum (1995) applied the model to the bilateral trade between the U.S. and Canada, followed by the series of research on the boarder effects including Anderson and van Wincoop (2003). Rose (2000) used the model for the impact of Common Currencies to trade, Harrigan (2001) and Baier and Bergstrand (2001 and 2009) for trade costs and Limao and Venables (2000) for infrastructure and transport costs. When it comes to methodology, Egger (2002) argued the issues on trade potentials and Baldwin and Taglioni (2006) presented the several of errors and bias in applying the gravity model to empirical study on bilateral trade flows. As for regions, Prabir De (2010) employed the model to study the trade pattern of India; Söderling (2005) did for the Middle East and North Africa and Filippini and Molini (2003) for the Eastern Asia. A number of studies of Korea's trade have been carried out previously, including Sohn (2005) that analyzed Korea's trade pattern using the gravity Model. Nevertheless, there hardly exists literature that focuses on the Korea-Africa trade.

4. ESTIMATION EQUATIONS AND DATA

The strategies to assess Korea-Africa trade are the followings:

(i) To build a model fitting global trade flows and estimate it using the entire dataset including almost all countries, and then selectively use only the outcomes related to Korea and Africa.[5]

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[4] Regarding to the detailed interpretation of the equation, refer to Novy (2013) and Bergstrand *et al*. (2013).

[5] The purpose of the approach is to consider points that Π_i and P_j, MRTs (Multilateral Resistance Terms), are affected by the trade relationships with the rest of the world and the

(ii) To revise the general gravity model to fit the exports flows from Korea to Africa by adjusting explanatory variables.

4.1. Equation on Trade Potential Assessment

As the first step, a model is constructed based on Anderson and van Wincoop (2003), employing dummies for bilateral distances (d_{ij}), being landlocked ($landlock_{ij}$) and common boarder (con_{ij}) to reflect transportation costs. To consider the factors lowering the information costs of international trade, dummies are added for using common language ($lang_{ij}$), sharing colony experiences (col_{ij}). Rather than using tariffs directly, dummy variable for Regional Trade Agreement (rta_{ij}) is included. These specifications are mathematically expressed as equation (3).

$$t_{ij} = d_{ij}^{\delta_1} \exp(\delta_2 landlock_{ij} + \delta_3 con_{ij} + \delta_4 lang_{ij} + \delta_5 col_{ij} + \delta_6 rta_{ij}). \quad (3)$$

Substituting the equation (3) into the equation (2), we obtain the augmented linear model of the equation (4).

$$\begin{aligned} \ln(X_{ij}) = {} & \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) + \beta_3 \Pi_i + \beta_4 P_j + \beta_5 \ln(dist_{ij}) + \beta_6 landlock_{ij} \\ & + \beta_7 con_{ij} + \beta_8 lang_{ij} + \beta_9 col_{ij} + \beta_{10} rta_{ij} + \varepsilon_{ij}. \end{aligned} \quad (4)$$

There needs to be further considerations when we measure Π_i and P_j since they are unobservable. While Anderson and van Wincoop (2003) took the approach to directly estimate those using iterative methods, the method to use the fixed effects is widely used as the case of Harrigan (1996), Hummels (1999), Rose and van Wincoop (2001), Redding and Venables (2004). The fixed effects methods, by replacing the MTRs with importer and exporter dummy variables, allow us to easily obtain unbiased estimators about

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larger sample size provides more information to estimate.

average border effects across several countries (Feenstra, 2004). When dealing with panel data, we should consider the effects over time such as global business cycles. To control for the time effects, we added dummies for each year. Revising the equation (4) by controlling for country fixed effects and time effects leads us to the equation (5).[6)]

$$\begin{aligned}\ln(X_{ijt}) = {} & \beta_1 \ln(Y_{it}) + \beta_2 \ln(Y_{jt}) + \beta_3 dummy_i + \beta_4 dummy_j \\ & + \beta_5 \ln(dist_{ij}) + \beta_6 landlock_{ij} + \beta_7 con_{ij} + \beta_8 lang_{ij} \\ & + \beta_9 col_{ij} + \beta_{10} rta_{ijt} + \beta_{11} year_t + \varepsilon_{ijt}.\end{aligned} \tag{5}$$

The theoretical expectation of the sign of explanatory variables is as follows. The both signs of β_1, and β_2 are expected to be positive (+) as the bilateral trade volume increases in proportion to economic sizes; β_5, and β_6 are negative (–) as it decrease with longer distances. Firms would more easily understand the business practice of their trade partners when the countries where the firms are located use common language or share common colonial experiences or have common borders. Therefore, β_7, β_8, and β_9 are all inferred to have positive (+) signs. Finally, RTA (Regional Trade Agreement) would promote bilateral trades by lowering trade barriers. In that sense, β_{10} is also expected to show positive (+) sign.

4.2. Equation on Korea's Export Analysis

As a next step, we revise the general gravity model of the equation (5) to fit the exports flows from Korea to Africa since some variables of the equation (5) such as common border, common language and sharing colonial experiences cannot be employed in the Korea-Africa context. Between Africa and Korea, there is any case of Regional Trade Agreements unlike the

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6) This specification is not perfect since country fixed effects should be expressed with time-varying when MRTs vary over time. Nevertheless, given a reasonable short sample period, we assume here that they may not vary tremendously. The estimations were carried out with 5 year and 3 year sample period, yielding similar results. Only results form 5 year sample period are reported in this paper.

European countries that has maintained strong political and economic times with Africa. Instead, we directly put into gravity equation the tariffs of African countries on the Korean products. Then, we assume that that there exist unobservable characteristics of the Korea-Africa relationship that affect the bilateral trade and are reflected in the country dummy variables in the equation (5). We assume also that human networks are ones of the unobservable characteristics. Geographical, cultural and historic adjacency is believed to lower information costs during the trade and business activities. Considering irrelevance of such variables in the Korea-Africa context, we replace them with human networks. The human networks are considered to stimulate bilateral trade by providing Korean firms with information to do business in African countries and connecting them to local distribution channels as well as supplying other relevant conveniences. The academic study on the effects of human networks to trade has been carried out focusing on immigrant societies. Gould (1994) showed that immigrants in the U.S. promote the trade between their original countries and the U.S. Head and Ries (1998) found the same results with the immigrants in Canada, while Girma and Yu (2002) carried out a similar study for the U.K. The positive effects of immigrants to trade were ascertained by Rauch and Trindade (2002) who investigate the impact of Chinese social communities around the world. Rauch and Casella (2003) argued that human and social networks contribute to trade through matching activities that allow the foreign sellers to easily find appropriate retailers or assemblers to identify competitive parts suppliers. In this study, we also pay attention to the matching activities that would pay a substantial role in African markets which the Korean firms feel relatively uncertain and unfamiliar. According to the literature, we use the number of Korean immigrants in Africa as a proxy for human networks.

In addition, we consider trade structure as the unobservable characteristic. Trade structure is of significance in inter-industry trade case, where two countries specialized in different industries and trade their products to each other. As the composite of country *i*'s exports become more similar to country *j*'s imports, the trade complementarities improves. There are the

several measurements of trade complementarity, which are just different ways of representing the same concept. Sohn (2005) used the trade complementarity index (TCI) which is designed by Gormely and Morrill (1998) in order to control for trade structure. The TCI is defined as:

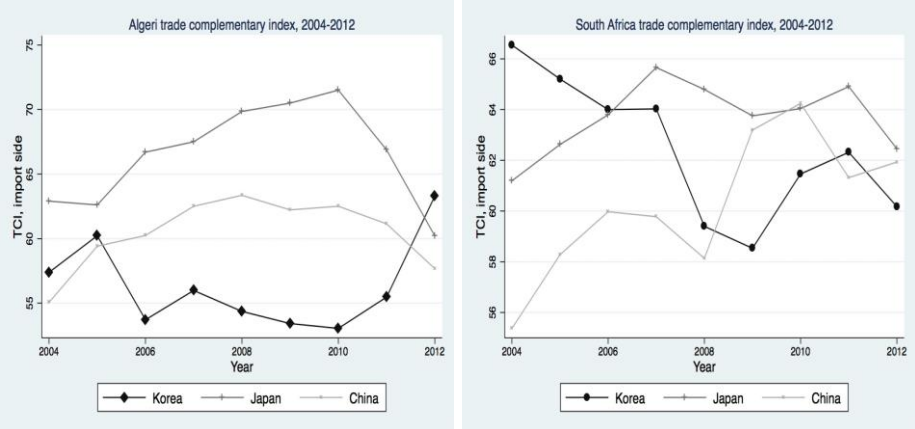
$$TCI^{ij} = \sum_{k=1}^{m}[X_k^i \times M_k^j] \div \sqrt{[\sum_{k=1}^{m} X_K^{i^2} \times \sum_{k=1}^{m} M_K^{j^2}]},$$

where i and j mean a country and its trade partner (i and j= 1, 2, …, N); k means a commodity group or sector (k=1, 2, …, m); X_k^i is the share of the sector k in the export of country i;); M_k^i is the share of the sector k in the import of country j. The TCI value ranges from 0 to 1. When two trading partners have same export shares the TCI becomes 0, while a country's export shares are identical to its partner's import shares (i.e., $X_k^i = M_k^i$), the TCI is 1. In this study, we employ the TCI as explanatory variable along with the Sohn (2005); however, use a more popular measurement which is introduced by Michaely (1996). The TCI is calculated as follow:

$$TCI^{ij} = 100\left[1 - \sum_{k=1}^{m}\left|M_k^i - X_k^j\right| / 2\right], \quad (6)$$

where M_k^i is the share of the sector k among country i's total imports from all over the world; X_k^i is the share of the sector k among country i's total exports toward the world. When a country's import share matches another country's export share (i.e., $X_k^i = M_k^i$), the index is equal to 100. On the contrary, the trade complementarity index is zero in case there is no good exported by one country but imported by the other. Sohn (2005) argued that TCI's effect to trade volume would be positive in inter-industry trade and negative for intra-industry trade. We also expect the TCI has positive effects to Korea's export to Africa which can be seen as an inter-industry trade. TCI's dynamics of Algeria and South Africa in figure 1 are also consistent with our assumption. Algeria whose imports from Korea have substantially increased presents an upward trend of TCI with Korea, while

Figure 1 Korea's Trade Complementary Index with Algeria and South Africa (2004-2012)



Sources: UNCOMTRADE database, author's calculation.

downward ones with Japan and China. South Africa has stagnated in terms of imports from Korea and TCI with Korea has steadily decreased unlike Japan and China. Finally, we move GDP variables[7] to the left side according to Anderson and van Wincoop (2003) since our interest lays in the coefficients of country pair variables between Korea and Africa. Incorporating those ideas, the gravity equation is revised as seen in the equation (7).

$$\ln(X_{it}/Y_t) = \beta_1 \ln(dist_i) + \beta_2 landlock_i + \beta_3 \ln(tariff_{it}) + \beta_4 \ln(tci_{it}) + \beta_5 \ln(diaspora_{it}) + \beta_6 yeardummy_t + \varepsilon_{ijt}, \quad (7)$$

where, $tariff_{it}$ denotes the tariff rate that country i imposes to Korean products at period t; tci_{it} denotes the Trade Complimentary Index between Korea and country i at period t; $diaspora_{it}$ the number of the Korean residents in country i at period t. As discussed earlier, the coefficients β_3 is expected to be negative (–), while β_4 and β_5 to be positive (+).

[7] In the equation that will be presented, the GDP of Korea is omitted because it is fixed.

4.3. Data for Analysis

For the equation (5), we used trade data from 149 exporters and 150 importers those each accounts for more than 0.001% of the global exports and imports. The period is covered from 2006 to 2011, except for 2009 when hardly hit by the global financial crisis. The bilateral trade flows (X_{ij}) were extracted from UNCOMTRADE database. GDP data is obtained from the World Development Indicator (WDI) database of the World Bank. Regional Trade Agreements (RTA) was supplied by de Sousa (2012), while country-pair dataset including distance,[8] landlocked location, border, colonial experience and language were constructed with CEPII database. As for the equation (6), we construct a dataset covering Korea and 41 African countries[9] during the period 2004-2012. The sources and characteristics of the bilateral trade flows and GDP are the same as used in the estimation of the equation (5). Tariffs dataset were extracted from the CONTAIN database of the UNCTAD with the weighted average tariffs of manufacturing products. The main exports of Korea to Africa are manufacturing products; hence justifying the selection of tariffs only from the manufacturing industries. To calculate TCI (trade complimentary Index), the sectoral bilateral trade flows[10] were extracted from UNCOMTRADE database and then compute them according to UNCTAD (2012). The full TCI dataset is presented in table A1. The dataset of the resident number was built with the foreign resident[11] data from the Ministry of Foreign Affair of the Republic of Korea.

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8) The bilateral distance is a great circle distance between the most populated (biggest) cities of two countries.

9) Cameroon, Gabon, Burundi, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Uganda, Algeria, Egypt, Mauritania, Morocco, Tunisia, Botswana, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe, Benin, Burkina Faso, Cape Verde, Cot d'Ivoire, Gambia, Ghana, Guinea, Mali, Niger, Senegal, Togo.

10) Sector classification was done according to ISIC2 (International Standard Industrial Classification of All Economic Activities, Rev.2). For details on the logic of TCI, refer to UNCTAD (2012).

11) It includes also temporal residents such as the employee of Korean local offices in Africa, students, etc. Since the Korean government publishes the reports on foreign residents on a bi-monthly basis, we filled omitted values using arithmetic average method.

5. ESTIMATION RERSULTS

5.1. Estimation Results of the Equation for Trade Potential Assessment

At first, we estimate the equation (5) with a Fixed Effect (FE) model and the results are reported in column 1 of table 2. The coefficient on log GDP is 0.208 for exporters and 1.081 for importers, both statistically significant at the 1% level. The coefficient on dummy for Regional Trade Agreement (RTA) is –0.0025 but statically insignificant. The coefficients on the rest variables such as distance, landlockedness, colonial experiences, common border and common language cannot be obtained because those are time-invariant. The next step taken was to employ a Random Effect (RE) model to estimate the coefficients including the time-invariant variables. Column 2 of table 2 reports coefficient estimates from the RE method, which have signs as expected earlier and statistical significance at 1% level.

We carry out Hausman test to test hypotheses in terms of bias or inconsistency of estimates obtained from Random Effects models. The result of Hausman test tells that the estimate could be biased or inconsistent. To address the issue, we employed the Hausman-Taylor (HT) model,[12] which use as instrument variables only the variables that are already included in the equation to be tested. Another advantage of the HT model is that we can obtain coefficients of time-invariant variables. In implementing the HT model, we supposed the GDP of exporters and importers are endogenous. The estimation results from the HT model are reported in column 3 of table 2. The estimates of coefficients on the log GDP of exporters and importers are almost the same as the ones obtained from the FE and RE model. The coefficient on distance is –1.378; the coefficient on landlockedness is –0.506. The coefficients of colony, common border, language and RTA are 0.618, 0.815, 1.263 and 0.382, respectively. The all estimates have statistical significance at the 1% level and signs as theoretically expected. The

[12] For details, refer to Hausman and Taylor (1981).

Table 2 Estimation Results of the Equation on Trade Potential Assessment

Variables	FE (1)	RE (2)	HT (3)
lgdp_exporter	0.208*** (0.0437)	0.249*** (0.0432)	0.249*** (0.0433)
lgdp_importer	1.081*** (0.0453)	1.095*** (0.0449)	1.111*** (0.0448)
ldist		–1.666*** (0.0238)	–1.378*** (0.0345)
landlocked		–0.480*** (0.0953)	–0.506*** (0.100)
colony		0.759*** (0.127)	0.618*** (0.132)
contig		0.410*** (0.107)	0.815*** (0.117)
comlang_off		1.028*** (0.0488)	1.263*** (0.0539)
rta	–0.00253 (0.0425)	0.273*** (0.0336)	0.382*** (0.0357)
Constant	–12.94*** (0.705)	–0.666 (0.675)	–9.499*** (0.789)
Observations	78,286	78,286	78,286
R-squared	0.048		
Number of Country-pair	19,975	19,975	19,975

Notes: Dependent variable is log bilateral trade volume. Standard errors are reported in parentheses. FE, RE and HT means fixed effect model, random effect model and Hausman-Taylor model, respectively. *lgdp_exporter*, *lgdp_importer*, *ldist*, *landlocked*, *colony*, *contig*, *comlang_off* and *rta* denote exporter GDP in log, importer GDP in log, distance in log, landlockedness, sharing common colonial experiences, common border, common language and regional trade agreement, respectively. $^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$.

interpretation of the estimates results from the HT model is the following. Exports increases by 0.25% as their GDP grow by 1%. Imports increases by 1.11% as their GDP grow by 1%. As the distance between two countries

increase by 1%, the trade volume decrease by 1.38%. If either of two countries is landlocked country, the bilateral trade decreases by 0.51%. If both countries share common colonial experiences or their border is adjacent, or they use common language, the bilateral trade volumes decrease by 0.62%, 0.82% and 1.26, respectively. The effect of free trade agreement is substantial and statistically significant, increasing trade volume by 0.38%.

5.2. Assessment of Korea-Africa Trade Potentials

To assess the trade flows, we compare actual trade flows with predicted trade flows in the gravity model. The prediction is done by calculating fitted values based on the estimates of regression coefficients which are obtained through the HT Method. All the predicted exports and imports are reported in details with actual flows in table A2 and table A3, respectively. Among the period covered in this exercise, we take a look onto 2006 and 2011. First, we review the results about exports from Korea to Africa. In 2006, Korea's exports are below what the gravity model expected for the Cameroon, Central African Rep. and Gabon. In 2011, Korea overtraded in terms of export in Cameroon, while still underperforming in Central African Rep. and Gabon. As for East Africa, Korea's exports to Burundi, Rwanda and Seychelles were lower than expected by the model in 2006. The export to Burundi still fell short of the prediction in 2011. We may well conclude that Korea's exports are outperforming in the East Africa as a whole. In North Africa, the Algerian market was outstanding in terms of growth, going far over expectation. In Egypt and Tunisia, Korea exported less than prediction in 2006 but exceed the prediction in 2011. To the contrary, Morocco showed outperforming in 2006 but went into reverse in 2011. In Southern Africa, as of 2011 Madagascar, Mauritius, Mozambique, Namibia and Zambia remain below expectation, indicating overall regional underperforming. Korea's export to Madagascar was more than predicted in 2006 but went down below prediction in 2011. In contrast, Malawi undertrade with Korea in 2006, then overtrade in 2011. West Africa area

shows similar picture to Southern Africa. As of 2011, Korea's exports to Burkina Faso, Cape Verde, Gambia, Niger, Senegal and Togo are less than what are predicted by the gravity model, while exports to Cote d'Iviore, Ghana, Nigeria are more than predicted. In summary, we may conclude that there still remain good chances for Korea to increase exports to Africa. As of 2011, Korea has potentials to increase exports in 14 countries including Burkina Faso, Burundi, Cape Verde, Central African Rep., Gambia, Madagascar, Mauritius, Morocco, Mozambique, Namibia, Niger, Senegal, Togo and Zambia. As for sub-region, Korea has exports potentials in West Africa, Central Africa and Southern Africa, among others. With regard to imports of Korea from Africa, the actual and predicted volumes for African countries are reported in table A3. The number of the African countries that exported to Korea less than the model's expectation is 20 in 2006 and went down to 10 in 2011. We confirmed through this exercise that many countries still have room to increase their export to Korea, including Central African Rep., Kenya, Tunisia, Madagascar, Mauritius, Burkina Faso, Cote d'Ivoire and Togo.

5.3. Estimation Results of the Equation on Korea's Export to Africa

The next step is to review the estimation results of equation (6), which is specified to fit Korea's exports to Africa and suggest policy implications. In the same way for equation (5), we first test the equation using a Fixed Effect model. The results are reported in column 1 of table 3. The coefficient on TCI, which denote the structural complementation of trade, is 0.987 with statistical significance at 10% level. The positive sign is consistent with our theoretic expectation. The coefficient on tariff rates is –0.302 with significance at 5% level and negative sign as expected. The number of foreign residents has the coefficient of 0.129 with positive sign as expected but fails to show statistical significance. Since the coefficients of the rest time-invariant variables such as distance and landlockedness cannot be obtained through the FE model, a Random Effect model is employed. The

Table 3 Estimation Results of the Equation on Korea's Exports to Africa

Variables	FE (1)	RE (2)	HT (3)
ldist		–3.564*** (1.277)	–3.521* (1.955)
landlocked		–1.205*** (0.325)	–1.249*** (0.392)
ltci	0.987* (0.505)	0.728 (0.529)	0.914* (0.525)
ltariff	–0.302** (0.140)	–0.314** (0.131)	–0.310** (0.131)
ldiaspora	0.129 (0.148)	0.285*** (0.0868)	0.200* (0.107)
Constant	–10.45*** (1.976)	24.39** (12.32)	23.60 (18.76)
Observations	166	166	166
R-squared	0.237		
Number of Importers	31	31	31

Notes: Dependent variable is $\ln(X_{it} / Y_{it})$. Standard errors are reported in parentheses. FE, RE and HT means fixed effect model, random effect model and Hausman-Taylor model, respectively. *ldist*, *landlocked*, *ltci*, *ltariff* and *ldiaspora* denote log distance, landlockedness, log TCI, log tariff rates and log number of Korean residents, respectively. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

results are reported in column 2 of table 3. The estimates on the dummies of distance and landlockedness are respectively –3.564 and –1.205, with negative signs as expected earlier and significance at 1% level. The coefficient on TCI is 0.728 but it has no statistical significance; the coefficient on tariff rates is –0.314 with statistical significance at 5% level. As for the foreign residents, the estimated coefficient is 0.285 with statistical significance at 1% level. We tested the robustness of estimates obtained from RE model through Hausman test. The results of Hausman test implied that estimates high likely to be biased and inconsistent and hence we tested the equation through the Hausman-Taylor (HT) approach. We suppose

foreign residents as endogenous variables and obtained new estimates as shown in column 3 of table 3. The coefficients on distance and landlockedness are –3.521 and –1.249. The statistical significances exist at 10% and 1%, respectively. The coefficient on TCI was 0.914 with statistical significance at 10% level; tariffs was –0.310 with significant at 5% level; and foreign residents was 0.200 with 10% significance. According to the results, we may well make a conclusion that the Korea's export volume to African importer's GDP decreases by 3.52% as distance increases by 1%. When TCI increases by 1%, exports would increase by 0.91%. Every 1% tariff cut has effect to increase trade flows by 0.31%. Finally, increase in the number of foreign residents by 1% leads to 0.2% increase in export volume.

6. CONCLUSION AND POLICY IMPLICATIONS

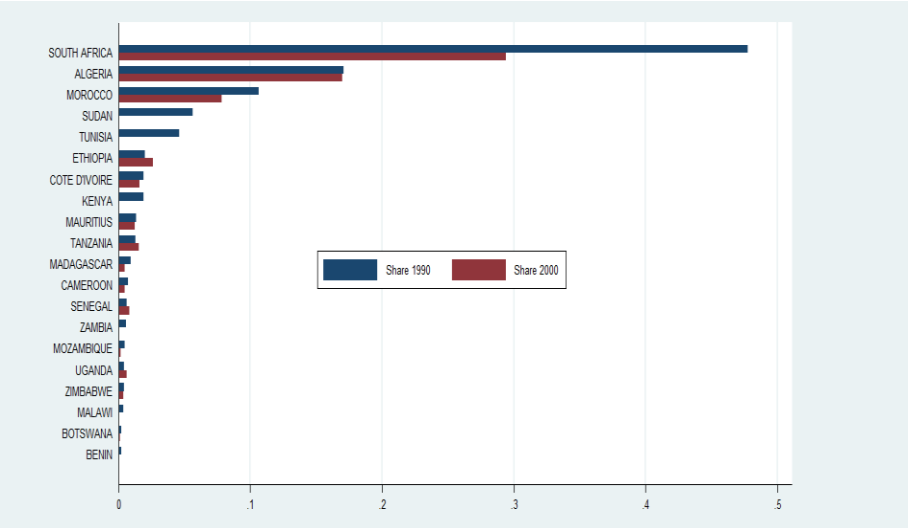
The trade between Korea and Africa is a typical inter-industry trade. Korea exports to Africa manufacturing products such as automobile, machineries, electronic products and chemical products, while imports primary commodities such as crude and gas, metals and agricultural production. It is often simply taken for granted, even in academic papers, that Africa has a great trade opportunity with Korea. However, there has been little research which has sought to empirically validate it in any systematic way. This study for the first time attempts to analyze and assess the bilateral trade flows between Korea and African countries using the gravity model. Africa, generally speaking, has positive trade potentials given the current conditions as claimed by the precedent studies but, when we look into details, huge disparities are found among African countries, implying that a uniform approach to facilitate trade would be inappropriate. As Korea-Africa trade has remarkably increased in the past decade, its potential to expand is accordingly being exhausted in the fast pace in some sub-regions such as East and North Africa. To the contrary, Central,

Southern and West Africa show relatively slow growth in trade with Korea, suggesting huge export potentials to be exploited further by Korean firms. Even though the potential of imports, from the standpoint of African countries, is larger than the one of exports, there still remains good chance for many African countries to expand exports to Korea.

Narrowing down the scope to Korea's exports to Africa, we found contributing factors that are similar to the ones identified in different regional contexts. We confirmed that tariff cut would promote Korea's exports. In addition, human networks such as Korean residents in Africa are also identified as contributing factors, as well as complementarities of trade structure. Based on the results of the estimation, we assessed the possibility of further increases in exports to Africa and tried to identify policy measures to materialize it. First, there needs to make efforts to lower trade barriers. FTA with Africa would be one of the best options in that main exports of Korea are the high-end manufacturing product, which is highly elastic to price and facing strong competition with the product of Europe that has maintained strong economic and political ties with Africa. The result of this study implies that it is also imperative to expand human networks, given cultural and information gaps between Korea and Africa. Various measures can be considered to increase the numbers of Korean or African persons who have interests and capacity in facilitating trade between Korea and Africa. For examples, exchange programs of study and vocational training and capacity building programs by the Korea government such as Knowledge Sharing Program (KSP) could be relevant. It is also noticeable that in many African countries including Algeria TCI (Trade Complementary Indicator) are highly likely to evolve favorably for Korea. This is because Africa would demands more high-end and durable goods such as automobile and smart phone as well as intermediary goods such as parts, components and machineries if Africa continues its economic growth and makes a progress in developing industries. These changes will open up new possibilities for Korea's exports to Africa, placing additional emphasis on policy efforts to create more favorable environment for trade between Korea and Africa.

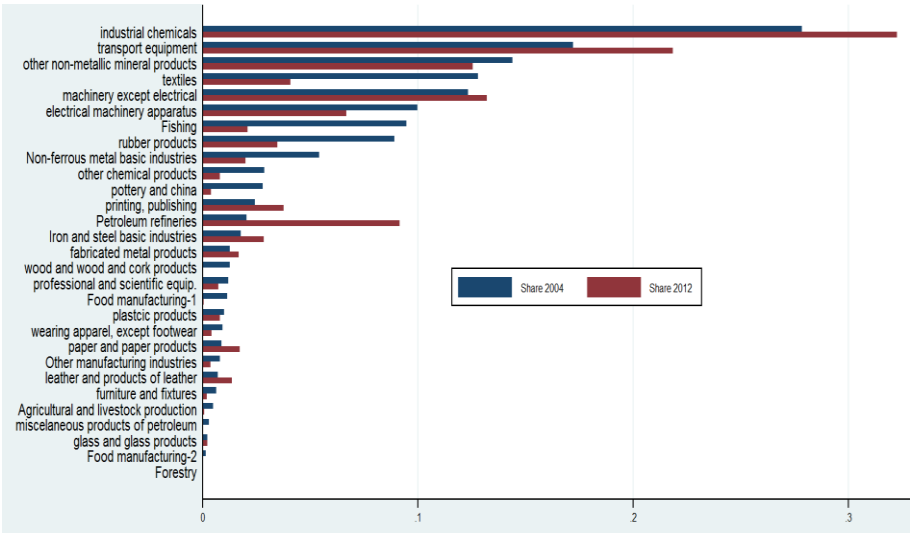
APPENDIX

Figure A1 Partner Share in Total Exports (2004-2012)



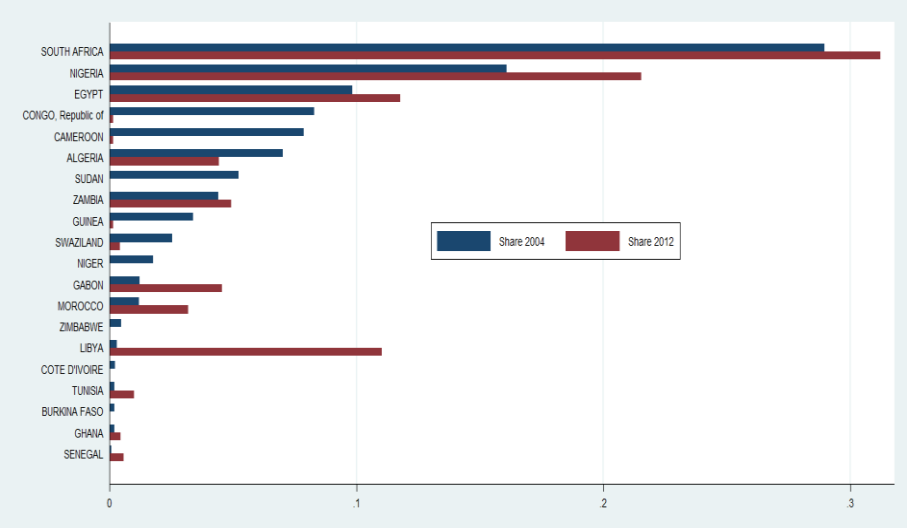
Sources: UNCOMTRADE database, author's calculation.

Figure A2 Sectoral Share in Total Exports (2004-2012)



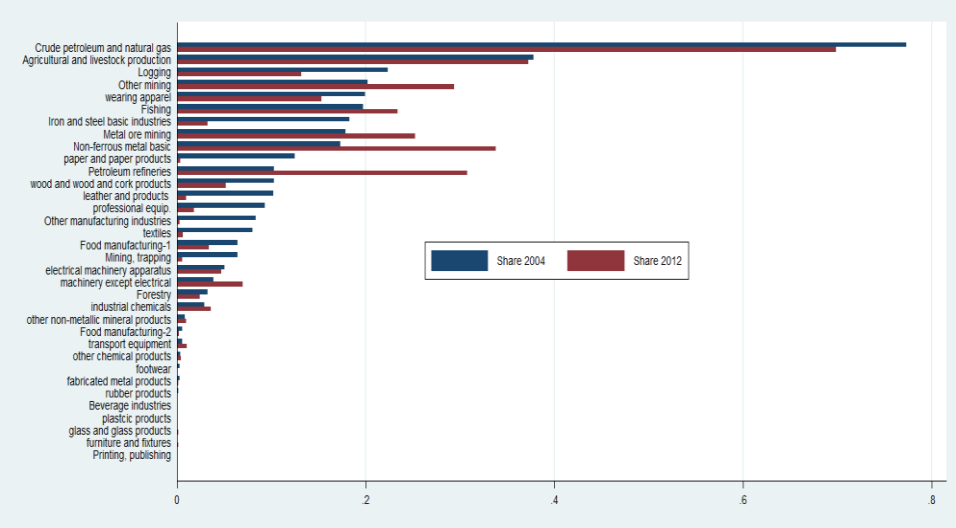
Sources: UNCOMTRADE database, author's calculation.

Figure A3 Partner Share in Total Imports (2004-2012)



Sources: UNCOMTRADE database, author's calculation.

Figure A4 Sectoral Share in Total Imports (2004-2012)



Sources: UNCOMTRADE database, author's calculation.

Table A1 TCI (Trade Complementarity Index) of Korea

Country	Region	TCI			Country	Region	TCI		
		2004	2012	Change (%)			2004	2012	Change (%)
Cameroon	Central	51.4	50.1	–2.6	Mozambique	Southern	56.0	54.0	–3.5
Gabon	Central	56.8	56.5§	–0.6	Namibia	Southern	56.3	57.4	2.1
Burundi	East	53.0	46.4§	–12.4	South Africa	Southern	66.5	60.2	–9.6
Ethiopia	East	63.2	63.7	0.8	Swaziland	Southern	43.1	47.8§	11.0
Kenya	East	53.4	40.8§	–23.7	Zambia	Southern	57.2	57.1§	–0.2
Rwanda	East	50.5	58.9	16.5	Zimbabwe	Southern	54.7	61.4	12.2
Sudan	East	44.2	58.5§	32.3	Benin	West	40.3	40.4‡	0.2
Tanzania	East	59.3	61.2	3.2	Burkina Faso	West	52.1	54.5	4.6
Uganda	East	53.9	61.7	14.5	Cape Verde	West	43.5	51.6	18.7
Algeria	North	57.4	63.3	10.3	Cote d'Ivoire	West	51.5	44.2	–14.1
Egypt	North	55.8†	55.3	–1.0	Gambia	West	33.8	61.3§	81.4
Mauritania	North	22.3	50.8	128.0	Ghana	West	59.1*	62.6§	5.9
Morocco	North	58.5	56.7	–3.1	Guinea	West	43.9	63.7§	45.1
Tunisia	North	59.7	39.8§	–33.3	Mali	West	49.6	54.8	10.5
Botswana	Southern	54.4	48.3	–11.1	Niger	West	42.8	50.4	17.8
Madagascar	Southern	49.2	49.5	0.6	Senegal	West	43.5	48.2	11.0
Malawi	Southern	51.1	58.6§	14.6	Togo	West	37.3	54.5	45.9
Mauritius	Southern	48.7	49.1	0.8					

Notes: * 2005, † 2008, ‡ 2010, § 2011.
Sources: UNCOMTRADE database, author's calculation.

Table A2 Korea's Export Potentials to Africa

Country	Sub-region	Actual Export (*A*)		Predicted Export (*P*)		Gap (*A*/*P*, %)	
		2006	2011	2006	2011	2006	2011
CAMEROON	Central	12.17	37.77	24.38	36.84	49.90	102.50
CENTRAL AFRICAN REP.	Central	0.01	0.31	1.58	2.51	0.42	12.47
GABON	Central	1.46	n/a	9.51	20.81	15.38	n/a
BURUNDI	East	0.44	0.95	3.18	6.50	13.92	14.64
ETHIOPIA	East	82.58	134.86	36.30	84.96	227.52	158.73
KENYA	East	126.92	n/a	101.17	162.99	125.45	n/a
RWANDA	East	1.27	12.16	3.35	7.64	38.01	159.03
SEYCHELLES	East	3.01	n/a	3.37	3.64	89.36	n/a
SUDAN	East	283.91	n/a	50.40	101.23	563.29	n/a
TANZANIA	East	66.91	97.54	47.30	86.00	141.47	113.42
UGANDA	East	26.31	154.25	18.96	34.94	138.75	441.47
ALGERIA	North	445.56	1615.12	163.20	302.41	273.01	534.08
EGYPT	North	263.54	1735.31	362.26	895.29	72.75	193.83
LIBYA	North	n/a	n/a	39.97	n/a	n/a	n/a
MOROCCO	North	328.15	443.69	280.91	458.44	116.82	96.78
TUNISIA	North	118.18	241.77	120.78	173.96	97.84	138.98
BOTSWANA	Southern	5.52	12.16	2.24	3.84	247.03	316.51
LESOTHO	Southern	n/a	n/a	0.30	0.57	n/a	n/a
MADAGASCAR	Southern	23.29	31.77	18.54	36.67	125.61	86.62
MALAWI	Southern	5.22	21.40	9.02	17.91	57.86	119.52
MAURITIUS	Southern	34.07	78.68	49.46	93.64	68.89	84.03
MOZAMBIQUE	Southern	12.50	26.03	30.93	60.21	40.41	43.23
NAMIBIA	Southern	3.67	4.39	7.91	13.40	46.41	32.77
SOUTH AFRICA	Southern	1,746.03	2,265.17	1,083.58	1,804.76	161.13	125.51
SWAZILAND	Southern	0.17	n/a	3.32	4.77	5.21	n/a
ZAMBIA	Southern	8.84	17.51	13.10	25.87	67.45	67.69
ZIMBABWE	Southern	9.98	33.57	6.85	13.35	145.79	251.47
BENIN	West	6.44	n/a	8.07	13.55	79.78	n/a
BURKINA FASO	West	n/a	18.36	10.08	19.71	n/a	93.18
CAPE VERDE	West	0.77	1.21	2.03	3.82	37.75	31.57
COTE D'IVOIRE	West	70.69	88.35	44.38	65.78	159.30	134.31
GAMBIA	West	0.08	0.20	1.89	2.77	4.48	7.23
GHANA	West	119.46	336.92	47.62	101.35	250.87	332.42
GUINEA	West	2.25	n/a	9.14	18.18	24.62	n/a
MALI	West	3.50	n/a	16.30	31.11	21.45	n/a
NIGER	West	1.70	5.59	4.42	7.96	38.48	70.22
NIGERIA	West	610.94	667.83	316.90	580.76	192.79	114.99
SENEGAL	West	22.62	41.76	47.72	79.63	47.40	52.44
TOGO	West	n/a	8.47	7.85	14.34	n/a	59.10

Sources: UNCOMTRADE database, author's calculation.

Table A3 Korea's Import Potentials from Africa

Country	Sub-region	Actual Import (*A*)		Predicted Import (*P*)		Gap (*A*/*P*, %)	
		2006	2011	2006	2011	2006	2011
BENIN	West	0.28	12.38	0.81	1.06	34.90	1,164.12
BURKINA FASO	West	0.04	0.03	0.76	1.03	5.83	2.86
BOTSWANA	Southern	1.10	0.81	0.52	0.70	208.87	116.15
CENTRAL AFRICAN REP.	Central	0.22	0.32	0.33	0.43	66.35	73.43
COTE D'IVOIRE	West	0.27	2.53	27.34	35.04	0.98	7.22
CAMEROON	Central	425.82	41.98	5.90	7.60	7,213.30	552.52
ALGERIA	North	577.54	130.43	16.96	22.85	3,404.87	570.71
EGYPT	North	450.00	690.85	316.67	455.11	142.10	151.80
ETHIOPIA	East	2.64	19.73	6.29	8.93	42.03	220.96
GABON	Central	16.27	39.64	3.93	5.50	413.82	720.88
GHANA	West	15.41	28.27	16.43	22.84	93.75	123.79
GUINEA	West	132.45	10.32	1.62	2.22	8,166.17	464.91
KENYA	East	5.12	17.60	29.69	38.77	17.23	45.40
LIBYA	North	1.91	248.83	9.59	n/a	19.96	n/a
LESOTHO	Southern	0.11	0.29	0.15	0.21	73.68	139.61
MOROCCO	North	87.32	137.26	94.67	123.98	92.23	110.71
MADAGASCAR	Southern	1.65	1.82	5.38	7.36	30.71	24.77
MALI	West	0.24	69.32	1.01	1.37	23.57	5,054.34
MOZAMBIQUE	Southern	0.57	23.77	8.17	11.12	7.02	213.72
MAURITIUS	Southern	1.67	7.90	17.26	23.37	9.70	33.80
MALAWI	Southern	4.30	14.55	5.12	7.01	83.89	207.68
NAMIBIA	Southern	81.33	36.31	4.19	5.53	1,942.03	656.42
NIGER	West	1.44	14.07	0.34	0.46	419.84	3,072.23
NIGERIA	West	625.69	799.21	26.72	35.91	2,341.71	2,225.56
RWANDA	East	0.00	0.64	0.29	0.41	0.37	155.49
SUDAN	East	235.75	22.34	4.15	5.69	5,679.30	392.26
SENEGAL	West	4.58	21.02	3.68	4.84	124.67	434.46
SWAZILAND	Southern	36.55	7.67	8.70	11.07	419.98	69.27
SEYCHELLES	East	0.61	0.86	2.72	3.25	22.50	26.29
TOGO	West	3.48	0.19	1.86	2.50	187.25	7.64
TUNISIA	North	14.46	42.66	41.04	52.25	35.23	81.64
TANZANIA	East	8.01	45.09	11.11	14.90	72.15	302.58
UGANDA	East	1.69	10.68	3.35	4.50	50.57	236.99
SOUTH AFRICA	Southern	1,385.06	3,105.44	1,129.73	1,486.17	122.60	208.96
ZAMBIA	Southern	432.51	500.70	3.68	5.03	11,753.35	9,955.63
ZIMBABWE	Southern	19.39	7.24	7.20	9.81	269.48	73.88

Sources: UNCOMTRADE database, author's calculation.

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