

## South Korea's potential export flow: a panel gravity approach

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### ABSTRACT

This study examines the export flow of South Korea by utilizing pooled ordinary least square (OLS) along with time fixed effects by employing augmented gravity approach. It has also attempted to find out the potential market for South Korean exports. In this study, we analyze comprehensive panel dataset for time period 2001-16 (16 years) covering South Korea's 189 importing nations. The result emerges robust to the requirement, time interlude and trade determinants. The empirical consequences are determined consistent through the gravity approach since the result discloses constructive coefficients for economic mass, bilateral exchange rate, trade agreements and trade openness in partner country and negative coefficients for distance and landlocked countries. The results also illustrate that the export pattern of South Korea hinges on the Heckscher-Ohlin (H-O) hypothesis, therefore be explicated by the dissimilarity in factor endowments for instance technology and advancement. We have found immense export potential with 94 countries including China, Japan, Hong Kong, Germany, France, Indian and the UK. Our analysis witnesses that strong policy implication and to diversification in the export leads South Korean exports at remarkable growth.

### Keywords:

Gravity model,  
Panel data,  
Export potential,  
South Korean exports

### Contribution/ Originality

The purpose of this paper is to analyze specification of the South Korean export performance and export potential with rest of the world by employing benchmark gravity approach to check the impact of various Marco-economic aspects. The findings reveal that the gravity equation fits the data reasonably well. To the best of authors' knowledge, there are very few studies those attempt to examine South Korea's export potential the rest of the world through gravity trade approach.

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## 1. INTRODUCTION

International trade is an elementary ingredient of the total exploitation attempt and nationwide development of a nation. This is, actually, a vital instrument for industrialization at the same time as entrée to foreign exchange is crucial for persistent economic progress. International trade relations amongst countries are becoming gradually more essential in a hastily changing in the international market, foreign associations and comprehensive concerns among economies have developed into supplementary noticeable surrounded by the international system. Foreign trade recognized its own distinctiveness in the international market. The whole way throughout human history, inhabitants obtained knowledge from their surroundings and acted upon by instantaneous inhabitants [Irshad \*et al.\*, \(2017\)](#). The cultural assortments among nations have its effect on foreign trade in a complex way. Additionally, trade among countries has its exceptional influences on culture and society. Similarly, there are huge opportunities those countries with similar cultural attributes to trade more strengthen. The benefits from trade could vary from nation to nation anchored in its nationalized interests, political, economic, strategic and regional state of affairs. Economies are subject to agree upon joint complimentary trade agreement when mutual liberalization is inaccessible [Irshad and Xin \(2017\)](#).

The majority trade assumptions apprehensions a qualitative subject of classifying the trade prototype, specifically which economies trade what type of products? Though, a quantitative query such that how much of those products are traded remnants as an additional significant pertaining. Indeed, accepting the influential features of mutual trade flows of a nation is a realistic experiential undertaking, since it unwraps a supplementary perspective on the state's strategies towards trade. Conquering empirics of recognizing the mutual trade volumes, for example, can advocate an advantageous free-trading collaborator and be able to speculate the amount of an omitted trade or unfulfilled mutual trade volumes. To analyze such circumstances, the gravity model turns out to be in greatly accepted approach as it deals with all kinds of trade flows such as exports, imports and bilateral volumes. The gravity approach is so-called in that it replicas the equation of gravity assumption in Newtonian physics [Sohn \(2005\)](#). The function of the physical gravity model to global trade is merely concerning every economy as a natural economic mass. Nonetheless, the gravity equation suited statistics astonishingly fit. Surely, it was the empirical achievement that completed economists' exploration of the hypothetical fundamentals of the gravity model. Consequently, from the 1980s the gravity equation was developed theoretically as an abridged structure commencing a variety of international trade models. Therefore, we can assume that the gravity approach emerges to be reliable among a great rank of trade models and literature.

This article investigates to what scope the gravity approach is appropriate to elucidate South Korea's bilateral trade volumes and to extort suggestions for South Korea's trade strategy and growth. Most of the previous studies treated with the trade flow of county-pairs in  $N \times N$  country situation, thus exclusion the particular country type of  $N \times 1$  situation mostly unproved [Wall \(1999\)](#) and [Sohn \(2005\)](#). Alternatively, investigating the bilateral trade flows in a sole country will appear to be an incredibly useful task, intrinsically this function of gravity approach be capable of present an analytical structure for a range of trade policy alternatives and utensils of the economy. A country like South Korea stands as 13<sup>th</sup> purchasing power parity and 11<sup>th</sup> nominal by gross domestic product and most active partner in G-20 economies also more industrializes member country of the OECD, actively participated in world trade which gives healthy profit to the country. According to CIA world factbook South Korea standing at 9<sup>th</sup> position importing from world and 5<sup>th</sup> largest exporting country in the world in the year 2016. In this article, authors' endeavour to exploit a gravity model to investigate the exports from South Korea to 189 importing partner during the period 2001 to 2016 and to find out which country has the capacity to absorb or potential for Korean exports.

Its remainder proceeds as follows, section 2 explained the export pattern of South Korea and section 3 briefly explained the theoretical developments with a literature review on gravity approach and empirical studies. The methodological aspects and data sources are introduced in section 4. Whereas section 5 reports and discusses estimation results from gravity approaches and the export potential

estimation by simple and fixed effect techniques. Finally, section 6 winds up with conclusions with policy implications.

### 1.1. Export pattern of South Korea

South Korea emergence as a huge exporter in the world market is a noteworthy development in the international trade structure. The narrative of South Korea’s economic enlargement is a textbook case of how an immature and underdeveloped economy transforms itself into an economic powerhouse which is acknowledged as one of the ‘tiger’ nations of East Asia. Korea has proudly modelled itself fundamentally following Japan, its earlier conqueror. Korea concurrently lessens imports, barring raw materials that are inadequate in the countryside; it was intended at sustaining a constructive stability of trade and mounting up a hoard of foreign reserves. South Korea merchandise exports US\$ 495 billion and imported US\$ 406 billion, resulting in a constructive trade balance of US\$ 89 billion in the year 2016.

During the last five years the exports of South Korea have decreased at an annualized rate of -6.156%, from US\$ 563 billion in 2011 to US\$ 483 billion in 2016. In 2016 South Korea imported US\$ 389 billion, making it the 11th largest importer in the world. During the last five years the imports of South Korea have decreased at an annualized rate of -7.182%, from US\$ 501 billion in 2011 to US\$ 389 billion in 2016. As of 2016 South Korea had a positive trade balance of US\$ 93.7 billion in net exports, as compared to their trade balance in 1995 when they had a negative trade balance of US\$ 1.75 billion in net imports.

South Korea's exports will primarily comprise office telecom & electrical equipment, road vehicles & transport equipment and chemicals. Jointly these products will correspond to 54% of total exports in 2016. The product composition provided in (Figure 1). It can be seen that top ten products at (HS-2 digit) share 85% of South Korea’s entire exports to the world with the base year 2016. The values in US dollars billion are provided in appendix table A.

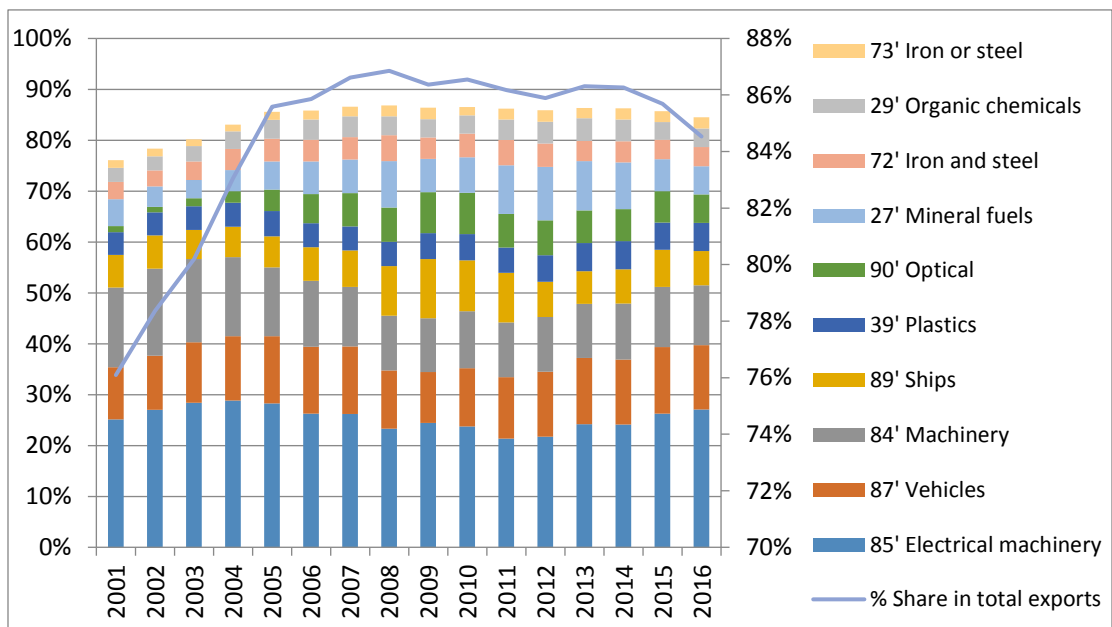


Figure 1: Export product composition of South Korea with World (% share)

Source: Authors’ compilation based on data UN COMTRADE 2017

South Korea's exports geographical composition countries will be China, the USA, Hong Kong, Viet Nam and Japan. Collectively these importers will comprise 57% of total exports in 2016. In (Figure

2) it can be seen that since 2001 the export share with the USA decreasing and with China increasing. The values in US dollars billion are provided in appendix table B.

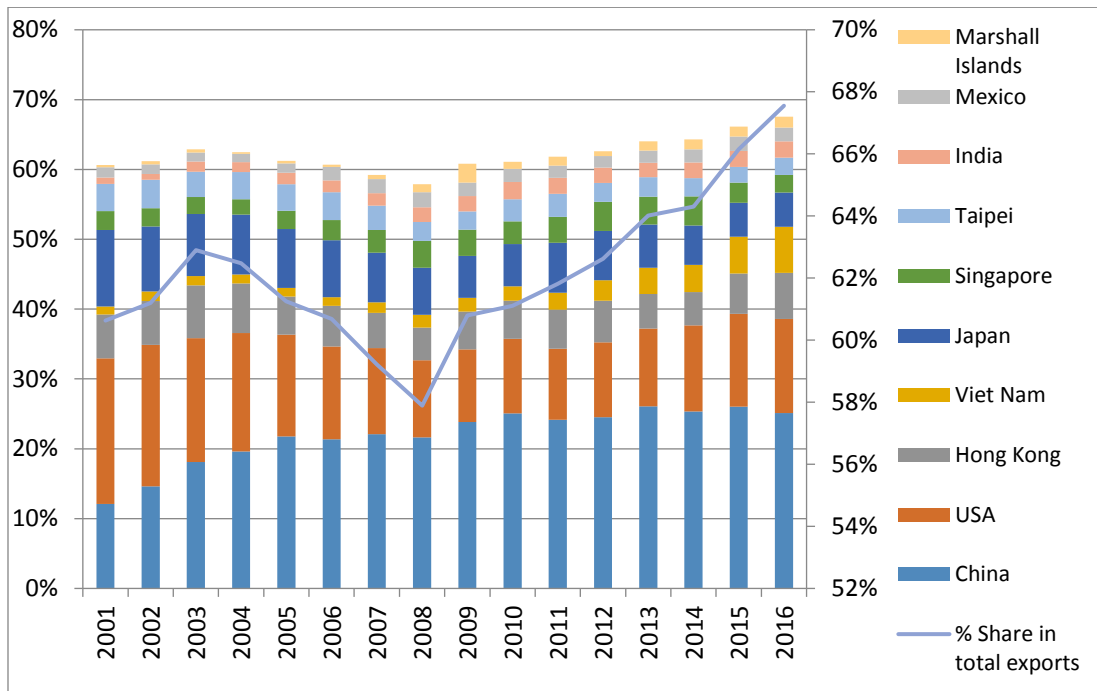


Figure 2: South Korea's export geographical composition by countries

Source: Authors' compilation based on data UN COMTRADE 2017

From a continental perspective, almost two-thirds (63.7%) of South Korea's exports by value were delivered to other Asian countries while 14.7% were sold to North American importers. South Korea shipped another 11.7% worth of goods to Europe. Just 1.9% is destined for customers in Africa.

### 1.2. Theoretical developments

The gravity model shapes that the bilateral trade volumes are optimistically associated to the product of the two countries' economic sizes and pessimistically connected to the remoteness between them.

The basic description of the gravity model takes the subsequent shape.<sup>1</sup>

$$BT_{ij} = A. (Y_i Y_j / D_{ij}) \dots\dots\dots (1)$$

Where  $BT_{ij}$  bilateral trade flows between South Korea ( $i$ ) country and partner country ( $j$ ),  $Y_i$  and  $Y_j$  are the GDP of countries ( $i$ ) and ( $j$ ),  $D_{ij}$  is the distance as proxy for trade cost between both countries and  $A$  is the constant of proportionality. Furthermore, the most important fundamental variables illustrated above, additional variables, for instance per capita GDP, population and land area, can be incorporated in the gravity model as alternatives for economic mass. Moreover, mannequin variables for example common language, adjacency, and colonial association, etc. can also be integrated to characterize chronological and enlightening factors.

Since an earlier couple of decades, modelling international trade flow has acknowledged substantial consideration amongst academic researchers. Plenty of them has attempted to elucidate the formation

<sup>1</sup> Deardorff (1998) employs this equation as a standard model

of trade flows among countries or country grouping. One of the most accepted international trade models comprehensively has been employed to originate policies and trade flows among nations. The gravity approach, which was initially established by Tinbergen (1962) and Poyhonen (1963) anchored in this thought that bilateral trade volumes between two economies hinge upon nationalized incomes as well as bilateral distance. Since then there are a huge quantity of empirical approaches that examined two-sided trade flows by employing the Gravity approaches, which is an eminent approach to model international trade (Redding and Venables, 2004; Guillaumont and De Melo, 2005; Liu and Xin, 2011; Novy, 2013; Ulengin *et al.*, 2015). The Tinbergen's hypothetical groundwork for gravity model was enhanced and customized by Anderson (1979), Bergstrand (1989), Deardorff (1998) and Anderson and Wincoop (2003).

In recent time, researchers and economists have formulated the experimental econometric estimations of the gravity approach by utilizing several factual and a mannequin variable in regards to trade flows of dissimilar economies. Such as, Byers *et al.* (2000) employed an impecunious gravity equation for three Baltic economies of Latvia, Estonia and Lithuania following the crumple of the Soviet Union. They have confirmed that trade flows of these countries were not merely abridged however also moved to the associates of the previous Soviet Union. A work by Porojan (2001) finds that trade flows-spatial possessions nexus by employing a gravity model for the European Union and a number of its possible members. Similarly, a research conducted by Papazoglou (2007) attempted to investigate potential trade flows for Greece to the EU member states. His result illustrates tangible exports of Greece fail of potential ones, whereas the contrary is accurate for Greek imports.

Ekanayake *et al.* (2010) analyzed the trade distraction effects of the regional trade agreements in Asia on intra-regional trade flows via employing a gravity equation with yearly data for 19 Asian economies for the duration of 1980-2009. Their conclusion corresponds to the destructive warning of ECO and constructive signs of BA, ASEAN and SAARC RTAs. A useful work done by Chen and Novy (2011), determines the trade incorporation across mechanized manufacturing in the European Union that considerable technological fences to trade in particular industries are the leading trade obstructions. According to Ulengin *et al.* (2015), formulated two gravity models to analyse Turkish textile exports to 18 chosen EU countries from 2005-2012. Their outcome proves the actuality that the quota boundaries are adjacent to Customs Union regulations. Irshad and Xin (2017) employed gravity for examined South Korea's international trade over the period 2001-16 by using dissimilar estimation techniques. Their results showed that the trade prototype of South Korea exports and imports hinges upon GDP, trade openness and regional trade agreements and bilateral exchange rates while negatively influence by transportation cost and geographically landlocked countries. Another research by Irshad *et al.*, (2018) examined China's trade composition with OPEC member counties over the year 1990-2016 by employing gravity model. The results established that China's bilateral trade with OPEC members positively influences on GDP, GDP per capita, trade openness in China and WTO member countries in OPEC, whereas unconstructively impact on trade cost and supports Linder Hypothesis.

At present core interest of gravity, investigation moves, ahead of mounting its hypothetical underpinning, in the direction of the empirical utilization of the gravity approach. Particularly, the model recognition for the empirical submissions remains a superior apprehension of the gravity assessment of the day. Taken as a whole, it can be observed that there has not been a staid effort to inspect South Korea export potential with the global market. Consequently, this study would endow with the novel and constructive outcome subsequently as to discover how diverse factors can influence the exports of South Korea to 189 importing countries in the world.

## 2. METHODOLOGY AND THE DATA SOURCE

### 2.1. The construction of model

Following the theoretical institution of gravity, the approach had been well-known, from the early 1990s advance researchers determined on the empirical function of the gravity equation. Numerous researchers' instigated a supplementary complicated however standardized structure of the gravity

where the particular weight was specified on the function of geological factors, for instance, border-sharing, distance and population, as determinants of bilateral trade streams. The utilization of dummy variables, for example, adjacency, common language and culture (religion) and historical ties can also be incorporated to symbolize geopolitical aspects. This study covers South Korean exports to 189 importing countries over the time 2001 to 2016.

The basic gravity equation in our case after transformed into log-linear shape so that it adjusts to the standard regression analysis and can be noted as an equation:

$$Ln(EXP)_{ij} = A + \alpha Ln(GDP)_i + \beta Ln(GDP)_j + \gamma Ln(Distw)_{ij} + \eta_{ij} \dots\dots\dots (2)$$

Where the  $Ln(EXP)_{ij}$  log of export volume of country “i” to “j”,  $Ln(GDP)_i$  and  $Ln(GDP)_j$  gross domestic product of South Korea *i* and partner country *j* respectively, meanwhile the log of weighted distance between country *i* and *j*  $Ln(Distw)_{ij}$  a proxy for trade resistance or transportation cost. Moreover,  $\eta_{ij}$  is the stochastic error term and *A*,  $\alpha$ ,  $\beta$ , and  $\gamma$  are the coefficients to be resulting empirically.

For this particular study, we employed augmented gravity equation for South Korea export flow can be written as:

$$Ln(EXP)_{ijt} = \beta_0 + \beta_1 Ln(GDP)_{it} + \beta_2 Ln(GDP)_{jt} + \beta_3 Ln(Distw)_{ijt} + \beta_4 Ln(APYD)_{ijt} + \beta_5 Ln(BEXR)_{ijt} + \beta_6 (TROPEN)_{jt} + \beta_7 (RTA)_{ijt} + \beta_8 (Landlock)_{jt} + \beta_9 (WTO)_{ijt} + \eta_{ijt} \dots\dots (3)$$

Where, *i* for South Korea, *j* for importing country, *t* for a time, *Ln* denote variables in natural logs,  $\beta_n$  is parameters.  $Ln(EXP)_{ijt}$  stands as exports of South Korea with the partner country.  $Ln(GDP)_{it}$  and  $Ln(GDP)_{jt}$  are Gross Domestic Product (GDP) of South Korea and partner country and  $Ln(Distw)_{ijt}$  weighted distance constructed as a function of bilateral distance weighted by population of particular country for calculating multi-lateral resistance term (Wei, 1996; Baier and Bergstrand, 2009).  $Ln(APYD)_{ijt}$  refers the absolute difference between South Korea’s GDP per capita and country *j*’s GDP per capita.  $Ln(BEXR)_{ijt}$  Symbolizes the bilateral exchange rates in terms of South Korea currency.  $(TROPEN)_{jt}$  trade to GDP ratio proxy for trade openness in partner country.  $(RTA)_{ijt}$  locates as dummy variable for regional trade agreements between country *i* and *j* in year *t*, it take value of 1 if both country have trade agreement in particular year otherwise 0.  $(Landlock)_{jt}$  a dummy variable for countries those have direct access to the sea it takes value 1 otherwise 0.  $(WTO)_{ijt}$  it is also a dummy variable for membership in World Trade Organization (WTO). It takes value of 1 if both countries are belonging to WTO in particular year otherwise 0.

The justification for the insertion of GDP and trade cost variables in the model is obviously manifested being these elements of the benchmark gravity model requirement. Whereas GDP of South Korea and its importing county in given year *t* are employed as a gauge of economic mass. According to literature, this variable is anticipated to be constructive and considerably associated to trade. Distance (trade cost) variable is employed in the examination as a proxy for transport expenditure between South Korea and the importing countries. This variable is predicted to have a pessimistic influence to trade as transport cost raise with the remoteness of countries. The influence of the income measure  $(APYD)_{ijt}$  is vague. The coefficient can have a constructive (+) sign, if nations fall in the H-O bilateral trade structure, whereas the unconstructive (-) indication of this variable can emerge then supports the Linder assumption. Similarly, the coefficient for the bilateral exchange rate is anticipated to be constructive (+) (for example, any raise in the South Korean currency leads to a raise in export volumes between South Korea along with an importing country). The supplementary openness in the country economy the bigger it will trade; therefore, we are anticipating the constructive (+) indication for trade openness. The countries don’t have direct access to sea less chances to import goods from outer world and this variable also expected negative sign. Trade agreements are always positively impact trade between countries, this will only possible when both countries agreed to cut maximum tariff or provide

maximum tariff reduction. Regional trade agreements (RTAs) have become increasingly prevalent since the early 1990s; the world witnessed a surge of RTAs. Being the world factory, Korea has also increased rapidly as a source of merchandise exports for RTA partners (Irshad *et al.*, 2014). So we believe that this variable also expected positive sign and the last one WTO, is incorporated to discover whether being a member of this group can have an impact on the trade linking countries or not. In order to cope up endogeneity problem, we have estimated the equation (3) also with time fixed effects; it will also help to control different other macroeconomic factors like global economics boom or recessions Silva and Tenreyro (2011).

The primary intention of this study is to discover potential countries for South Korean exports. The coefficients anticipated from the gravity model equation 3 is used to estimate the predicted exports of South Korea, and then these predicted exports are equated to the real exports to observe whether or not the export potential for South Korea exist. Equation (4) supplies the methodology employed to determine these potentials.

$$EXPP = \left[ \frac{\left( \frac{Actual}{Predicted} \right) - 1}{\left( \frac{Actual}{Predicted} \right) + 1} \right] \dots\dots\dots (4)$$

Where *EXPP* stands for export potential of South Korea in partner country. The positive one (+1) and negative one (-1) in equation (4) are utilized to regulate the export potential. Accordingly, the calculated potentials will be between negative one (- 1) and positive one (+ 1) where a constructive index value (0, 1) demonstrates a greater exports than what is forecasted through the model. Likewise, the exports have attained or surpassed the potential level while an unconstructive index value (-1, 0) discloses the contradictory situation Mohmand *et al.* (2015). In another method to calculate South Korean exports we will use the absolute difference between the potential and actual level of trade ( $\Delta T = Potential\ trade\ value - actual\ trade\ value$ ) to forecast the future trade direction or potential in new markets Gul and Yasin (2011). A constructive (+) value implies the opportunity of trade enlargement in the prospect whereas an unconstructive (-) value demonstrates that South Korea has surpassed its export potential with peculiar country. By applying differentiation indicators, we can categorize those economies with which South Korea has potential for the extension of exports otherwise.

**2.2. The data source**

The dataset is a balanced panel containing annual South Korean exports to 189 trading partners over the year 2001-2016 with total observations is (16×189=3024). Table 1 demonstrates the summary of variables that we have used in our model and the data sources from where we get data and make some manipulation to get fit into our model.

**Table 1: Description of variables and expected signs**

Notation	Variable	Value	Sign	Source
$Ln(EXP)_{ijt}$	Exports	US\$ 1000		Korean Statistical Information Service (KOSIS)
$Ln(GDP)_{it}$ $Ln(GDP)_{jt}$	Gross Domestic Product (GDP) South Korea and Partner country	US\$ 1000	+	World Development Indicators (2017)
$Ln(Distw)_{ijt}$	Weighted Distance (TC)	Kilometer	-	CEPII database
$Ln(APYD)_{ijt}$	Absolute GDP per-capita Differential	US\$ 1000	+/-	World Development Indicators (2017)
$Ln(BEXR)_{ijt}$	Bilateral Exchange rate	Korean Won	+	Korean Statistical Information Service (KOSIS )
$(TROPEN)_{jt}$	Trade Openness (Trade/GDP)	Ratio	+	UN Comtrade Database,

	Partner country			World Development Indicators (2017)
$(RTA)_{ijt}$	Regional Trade Agreements (RTA) Dummy	0,1	+	Asia Regional Integration Center <a href="https://aric.adb.org/fta-country">https://aric.adb.org/fta-country</a>
$(Landlock)_{jt}$	Land Lock (Dummy)	0,1	-	World atlas website <a href="http://www.worldatlas.com/">http://www.worldatlas.com/</a>
$(WTO)_{ijt}$	WTO (Dummy)	0,1	+	World Trade Organization

### 3. RESULTS AND DISCUSSIONS

#### 3.1. Panel cross-section dependence (CD) test

Cross-section dependence in macro panel data has acknowledged loads of consideration in the emerging panel time series literature over the past decade. This kind of correlation possibly will occur from worldwide common shocks with heterogeneous impact across countries, such as the oil crises in the 1970s or the global financial crisis from 2008 onwards. Alternatively, it can be the result of local spillover effects between countries or regions (Eberhardt and Francis, 2011; Moscone and Elisa, 2009). Before estimating gravity equation, CD test should be tested to observe whether the sample data are cross-sectionally dependent or independent. Otherwise, based on the assumptions (Breusch and Pagan, 1980; Pesaran, 2004), the results of our gravity equation would be prejudiced and incompatible. In accordance with the time and cross sections in our gravity equation, Pesaran’s (2004) residual CD test is calculated anchored in the pairwise correlation coefficients  $\hat{C}_{ij}$  in this fashion:

$$CD = \sqrt{\frac{2}{N(N-1)} \sum_{i=1}^N \sum_{j=i+1}^N \sqrt{T_{ij} \hat{C}_{ij}}}$$

We calculated CD test only for time-variant variables in our gravity equation because of CD test unable to define in case of time-invariant variables Esfahani and Rasoulinezhad (2017). Based on the result of Pesaran’s (2004) CD test, shown in Table 2, the null hypothesis (no CD in residuals) can be strongly rejected at the 5 percent level. It implies that all the panel time series have strong evidence for cross-sectional dependence.

**Table 2: Results of Pesaran’s (2004) CD test**

Variables	Pesaran’s CD test	Prob.
$Ln(EXP)_{ijt}$	235.91	0.00
$Ln(GDP)_{it}$	533.16	0.00
$Ln(GDP)_{jt}$	415.40	0.00
$Ln(APYD)_{ijt}$	152.09	0.00
$Ln(BEXR)_{ijt}$	179.64	0.00
$(TROPEN)_{jt}$	77.25	0.00

**Source:** Authors’ compilation from STATA 14.0

#### 3.2. Gravity model estimation

After confirming the cross-sectional dependency in our variables, the cross-country OLS regression and with time fixed effect regression outcomes for gravity equation (3) are presented in table 3. Taken as a whole performance of the gravity equation appears to be astonishingly fine with an R-square value of about 0.67 for simple OLS and 0.68 for time fixed effect and with the majority descriptive variables are greatly significant and appeared with expected signs, entailing that the gravity equation is successful in explicating South Korea’s export flow and that the gravity equation is considered appropriate to a sole country case. The coefficient of Korean and partner country GDPs are highly significant which means 1% increase in the Korean GDP raises exports 2.10% and 1.53% in both estimation techniques and similarly 1% increase in partner GDP boost up exports from Korea 1.01%



in both techniques. In regard to distance as a substitute for transport expenditure, the negative and significant indication calculated by both techniques symbolizes so as to with geological remoteness has a pessimistic (-) effect on Korean exports to 189 trading partners in our sample. A 1% increase in distance decreases the export flow by 0.86%. Furthermore, the impact of the dissimilarity between incomes (*APYD*) on exports is constructive and highly significant. That means a 1% increase in this variable will leads to a 0.2% raise in Korean exports to partner countries. This outcome support the H-O hypothesis which indicates that countries may trade more in their factor endowment is dissimilar. Furthermore, out results does not hold up the [Linder \(1961\)](#)'s theory who envisages a pessimistic indication of (*APYD*)and considers on the influence of income resemblances of nations on trade volumes.

**Table 3: Gravity results after applying equation (3)**

Explanatory Variables	Simple OLS Coefficients	Time Fixed Effect Coefficients
<i>Constant</i>	-42.89 (4.45)***	-31.33 (7.47)***
<i>Ln(GDP)<sub>it</sub></i>	2.10 (0.22)***	1.53 (0.36)***
<i>Ln(GDP)<sub>jt</sub></i>	1.01 (0.02)***	1.01 (0.02)***
<i>Ln(Distw)<sub>ijt</sub></i>	-0.86 (0.06)***	-0.86 (0.06)***
<i>Ln(APYD)<sub>ijt</sub></i>	0.17 (0.03)***	0.18 (0.03)***
<i>Ln(BEXR)<sub>ijt</sub></i>	0.07 (0.01)***	0.07 (0.01)***
<i>(TROPEN)<sub>jt</sub></i>	0.91 (0.07)***	0.89 (0.07)***
<i>(RTA)<sub>ijt</sub></i>	0.12 (0.07)	0.16 (0.07)**
<i>(Landlock)<sub>jt</sub></i>	-0.80 (0.07)***	-0.81 (0.07)***
<i>(WTO)<sub>ijt</sub></i>	0.18 (0.12)	0.18 (0.18)
R-square	0.67	0.68
Root MSE	1.83	1.82
F-Stat (Prob.)	1014.91 (0.00)	405.29 (0.00)
Observations	3024	3024

**Note:** Robust standard errors are in parenthesis

\*\*\*, \*\*, \* denotes significance level at 1, 5 and 10 percent respectively

With respects to the bilateral exchange rate, it appears with highly significant and positive impact on exports from South Korea in both estimation approaches. We have found positive coefficients for this variable, means that by 1% depreciation of the South Korean currency (Won) versus importing partner countries' currencies will enlarge export flow nearly 0.07% the same coefficients from both estimation methods. In case of (*TROPEN*) trade openness in partner countries also very important for Korean exports and our gravity results proved that this variable in highly significant and positively influence on South Korean exports which means that importing countries have great potential to absorb the exports from South Korea. The results show that the Korean exports are boost up about 0.91% and 0.89% with 1% increase in trade openness in partner country. Irrevocably, RTA integration enhanced trade developments among partners [Irshad and Xin \(2014\)](#). Regional trade agreement variable appeared with expected positive sign but only significant in fixed effect method. South Korea exports more to those countries who have a trade agreement with Korea which means 1% increase in trading

partner who signed agreement with South Korea increases exports by 0.17% [=  $\text{Exp}(0.16)-1$ ] only in case of fixed effects. An RTA aims to integrate two countries or more than two countries by removing the majority or all of the tariffs on goods and be supposed to convey economic benefits to both sides of the RTA partners or FTA assist the free flow of trade and investment and bring as regards closer economic integration among the binding parties by eliminating tariff/limits on each other's commodities *Irshad et al. (2016)*. Our gravity results also proved that countries don't have direct access to sea negatively impact trade flows. A 1% increase in landlocked countries decreases exports 1.2% [=  $\text{Exp}(0.8)-1$ ] and 1.25% [=  $\text{Exp}(0.81)-1$ ] respectively. It is extensively believed that the international trade organization, WTO, increases trading systems and encourages trade (*Irshad et al., 2016*). But we have found positive insignificant impact of WTO membership on South Korean exports which means that WTO membership countries does not influence on exports from South Korea.

### 3.3. Estimation of export potentials

The idea of trade potential has been broadly considered by a plenty of researchers examining international trade, predominantly amongst eastern European economies. As noted above, we use the coefficients' from fixed-effect method to evaluate trade potential, for both potential estimation techniques as mentioned above. To conclude, we have to compare the estimation outcomes of both sets of results. Designed for minimalism, we segregate the whole duration (2001-2016) into four sub-sections to estimate the average results of forecasted/predicted (P) and actual trade (A). The trade probable/potential outcome, anchored in the coefficients of the equation (3) with time fixed effects. At this time, we only thrash out the domino effect for the latest period 2013-2016 see (Table 4).

We have calculated potential export flow for South Korean exports to 189 trading partners. The favourable results suggest that South Korea own adequate potential (approximately) to enlarge its exports to 94 countries. The highest potential lies with countries China, Japan, Hong Kong, Germany, France, Indian and the UK, while actual exports have exceeded with countries Viet Nam, Singapore, USA, Mexico, Saudi Arabia, Philippines, Indonesia and Australia. In fact, Korea's top importing partners are China, USA, Viet Nam, Hong Kong, Japan, Australia, India, Singapore and Mexico according to the base year 2016 but our results show that Viet Nam, USA, Singapore, Mexico and Australia are the countries with exhausted potentials.

**Table 4: Export flow potential countries in case of South Korea (2013-16)**

Country	Potential US\$ million*	Potential $\Delta T$ #	Country	Potential US\$ million*	Potential $\Delta T$ #
China	104200	-0.274	Mali	-2	0.013
Japan	66792	-0.535	Dominica	-4	0.537
Hong Kong	27015	-0.273	Rwanda	-5	0.165
Germany	14045	-0.500	Burkina Faso	-7	0.156
France	9073	-0.610	Northern Mariana Islands	-7	0.377
India	6679	-0.218	Palau	-7	0.561
UK	4983	-0.282	Ethiopia	-8	0.027
Belgium	4542	-0.496	Haiti	-11	0.146
Netherlands	4419	-0.325	Benin	-13	0.153
Spain	4121	-0.500	Guyana	-13	0.404
Switzerland	2678	-0.634	Kiribati	-16	0.816
Italy	2118	-0.241	Seychelles	-18	0.755
Canada	1827	-0.156	Madagascar	-18	0.080
Sweden	1535	-0.486	Antigua and Barbuda	-19	0.600
Finland	1057	-0.615	Trinidad and Tobago	-19	0.112
Ireland	979	-0.529	Samoa	-22	0.676
Romania	786	-0.425	Honduras	-22	0.107
Poland	711	-0.101	Central African Republic	-23	0.047
Venezuela R.B.	674	-0.487	Brunei Darussalam	-23	-0.019
Ukraine	662	-0.515	Ghana	-25	0.044

Pakistan	517	-0.242	Kyrgyzstan	-36	0.144
Bulgaria	447	-0.649	Russia	-36	-0.035
Portugal	302	-0.255	Micronesia	-39	0.837
Lithuania	293	-0.386	Guinea	-42	0.527
Bangladesh	214	-0.079	El Salvador	-50	0.221
Macao	207	-0.611	Bolivia	-50	0.388
Belarus	202	-0.689	Azerbaijan	-56	0.110
Latvia	192	-0.516	Djibouti	-57	0.802
Denmark	169	-0.136	Kenya	-60	0.116
Sri Lanka	157	-0.212	Tanzania	-69	0.170
Morocco	154	-0.183	Myanmar	-77	0.055
Austria	150	-0.088	Dominican Republic	-78	0.180
Tunisia	146	-0.290	Senegal	-97	0.424
Estonia	136	-0.428	Nicaragua	-103	0.466
Nigeria	132	-0.111	Yemen	-107	0.340
Congo D.R.	120	-0.676	Cyprus	-113	-0.180
Cuba	114	-0.526	Laos	-119	0.588
Serbia	109	-0.432	Luxembourg	-123	-0.122
Bosnia and Herzegovina	101	-0.811	South Africa	-123	0.002
Sudan	74	-0.191	Togo	-129	0.485
Namibia	65	-0.857	Turkmenistan	-143	0.443
Nepal	60	-0.576	Costa Rica	-143	0.442
Croatia	56	-0.233	Lebanon	-151	0.352
Moldova	52	-0.762	Uruguay	-162	0.474
Cameroon	50	-0.418	Paraguay	-173	0.800
Zambia	37	-0.428	Argentina	-177	0.104
Albania	36	-0.500	Guatemala	-184	0.353
Equatorial Guinea	33	-0.696	Fiji	-186	0.658
Gabon	27	-0.403	Cayman Islands	-208	0.221
Botswana	21	-0.448	Mongolia	-230	0.607
Montenegro	20	-0.873	Turkey	-277	0.023
Chad	19	-0.833	Kazakhstan	-282	0.195
Iceland	19	-0.236	Israel	-286	0.125
Macedonia	19	-0.437	Greece	-294	0.054
Uganda	18	-0.352	Oman	-310	0.194
Côte d'Ivoire	17	-0.089	Thailand	-328	0.024
Mauritania	14	-0.434	Cambodia	-365	0.412
Jamaica	13	-0.227	Congo	-406	0.455
Afghanistan	13	-0.120	Kuwait	-417	0.159
Bahrain	12	-0.024	Ecuador	-429	0.426
Maldives	11	-0.489	Libya	-448	0.370
Mozambique	11	-0.087	Algeria	-517	0.303
Lesotho	10	-0.968	Colombia	-626	0.336
Niger	9	-0.585	Peru	-731	0.389
Andorra	9	-0.805	Hungary	-777	0.358
Armenia	8	-0.274	Jordan	-798	0.603
Greenland	7	-0.995	Czech Republic	-840	0.276
Swaziland	6	-0.421	Bahamas	-877	0.960
Suriname	5	-0.230	New Zealand	-887	0.436
Bhutan	5	-0.427	Egypt	-902	0.291
Mauritius	5	-0.061	Iraq	-1010	0.433
Tajikistan	5	-0.108	Angola	-1033	0.564

Papua New Guinea	4	-0.081	Malta	-1094	0.861
Georgia	4	-0.031	Norway	-1172	0.189
Malawi	4	-0.116	Slovenia	-1218	0.619
Aruba	3	-0.273	Uzbekistan	-1448	0.863
Timor-Leste	3	-0.174	Chile	-1488	0.601
Qatar	3	-0.010	Malaysia	-1723	0.123
Guinea-Bissau	3	-0.853	Bermuda	-1782	0.991
Burundi	2	-0.472	Panama	-2331	0.880
Belize	2	-0.125	UAE	-2428	0.242
St. Pierre and Miquelon	2	-0.999	Brazil	-2557	0.194
Comoros	2	-0.867	Liberia	-2852	0.992
Sierra Leone	1	-0.097	Iran	-2967	0.582
Tonga	1	-0.468	Slovakia	-3219	0.732
Barbados	1	-0.042	Australia	-4534	0.306
Nauru	1	-0.612	Indonesia	-4560	0.308
Gambia	0	-0.128	Philippines	-4845	0.388
Zimbabwe	0	-0.011	Saudi Arabia	-4893	0.429
Sao Tome and Principe	0	-0.255	Mexico	-5818	0.393
Tuvalu	0	-0.096	Singapore	-7317	0.246
Grenada	0	0.056	Marshall Islands	-7681	0.999
Eritrea	0	-0.117	USA	-18416	0.158
Solomon Islands	0	-0.098	Viet Nam	-22426	0.756
Vanuatu	-1	0.083			

**Note:** \*Positive value indicates export potential, otherwise exhausted potential

#Negative value indicates export potential, otherwise exhausted potential

**Source:** Authors' calculation based on equation (4) and  $\Delta T$  formula

#### 4. CONCLUSION AND POLICY IMPLICATIONS

All models along with estimation methods formulated ultimately undergo limitations and restrictions. The current research is empirically based and hence relies greatly on the accessibility, comprehensiveness, moreover legitimacy of the data. The gravity equation of trade also has its strengths over and above restrictions. In general trade relations between dissimilar nations ought to be greater if they are moderately closer, have sharing borders, a similar culture and language, and close social relations and trade agreements. Political affairs (conflicts/tensions or friendships/coordination) are occasionally extra dominant than economic and viable deliberation.

South Korea has appeared as a larger exporter and maker within the international market. His swift economic enlargement has principally been attained through a growing export flow. Therefore, it is imperative to investigate to what scope the gravity equation is appropriate to enlighten Korea's export flows to the international market and to find out the potential countries. The pragmatic results demonstrate that the gravity equation is incredibly successful in explicating Korea's export flows and that the gravity approach is appropriate to a particular nation/economy case. The results appeared with coefficient on the trade composition variable explains that Korea's export composition pursues a Heckscher-Ohlin nature. Hence Korea's export volumes relay more on the aspects, for instance, comparative advantage and diverse improvement phases than economies of scale otherwise product diversities. The empirical outcome illustrates that a rise in GDPs connotes an increase in export flow between South Korea and 189 trading partner countries. Furthermore, we have encountered the constructive impact of trade openness in partner country and trade agreements on the export of South Korea, whereas the results disclose that trade distance nexus and landlocked countries are negative for these countries and in case of WTO membership does not influence on South Korean exports to 189

importing countries. In regards to the bilateral exchange rate, we have found the significant positive influence of it on the South Korean exports to 189 importing countries. Put differently, the downgrading of the Korean currency (Won) versus the 189 importing countries' currencies will augment the export capacity. The Korean government is recently endeavouring to promote the exchange rate monetization reformation; therefore, the drastic fluctuation of the exchange rate is comparatively normal. The income level specifies the stage of economic growth in addition to the mass and superiority of consumer markets. We also observed that South Korea's exports are generally consumed by rich (high-income) countries or industrialized traders. Consequently, the more urbanized and bigger economics are linked with the larger size of trade with South Korea. Industrial policies are responsible to manipulate exports to world market [Irshad and Xin \(2017\)](#).

The results from potential estimation suggest that South Korea has immense export potential in 94 countries including China, Japan, Hong Kong, Germany, France, Indian and the UK, while actual exports have exceeded with countries Viet Nam, Singapore, USA, Mexico, Saudi Arabia, Philippines, Indonesia and Australia. In fact, Korea's top importing partners are China, USA, Viet Nam, Hong Kong, Japan, Australia, India, Singapore and Mexico according to the base year 2016 but our results show that Viet Nam, USA, Singapore, Mexico and Australia are the countries with exhausted potentials.

Taken as a whole, it can be distinguished that consequent supplementary factors might manipulate South Korean export to world markets, for instance, geopolitical apprehensions, tariffs and pricing, as well as import replacement strategy in importing countries, the authors' recommend future research studies with bigger dataset regarding these factors philanthropic improved results are fewer miscalculations. Though, from our standpoint, this research, demonstrates constructive and has some appealing outcomes and conclusion, which can facilitate exporters and policymakers to accomplish a healthier vision of South Korean exports to the international market.

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## Appendix

Table A1: Descriptive statistics

Variables	Mean	Median	Maximum	Minimum	Std.Dev.	Jarque-Bera	Prob.	Sum	Observations
$EXP_{ijt}$	11.33	11.56	18.79	0	3.2	380.97	0	34275	3024
$GDP_{it}$	20.73	20.74	20.98	20.42	0.17	191.12	0	62715	3024
$GDP_{jt}$	17.05	16.9	23.5	10.3	2.4	5.22	0.07	51548	3024
$Distw_{ijt}$	9.06	9.09	9.9	6.8	0.5	2005.6	0	27386	3024
$APYD_{ijt}$	1.6	1.6	4.9	-1.7	1.6	125.3	0	7455	3024
$BEXR_{ijt}$	4.03	7.8	10.1	-4.6	2.8	218	0	12203	3024
$TROPEN_{jt}$	69.41	59.49	429.4	9.94	44.12	45356.6	0	209913	3024
$RTA_{ijt}$	0.12	0	1	0	0.3	3836	0	378	3024
$Landlock_{jt}$	0.18	0	1	0	0.39	1368	0	561	3024
$WTO_{ijt}$	0.77	1	1	0	0.42	830.6	0	2322	3024

Note: All variables are in log form except dummies

Table A: Product composition of South Korean exports (US\$ billions)

HS-2	2001	2003	2005	2007	2009	2011	2013	2015	2016
85' Electrical machinery	37.8	55.1	80.5	97.4	88.8	119	135	138	134
87' Vehicles	15.4	23	37.5	49.2	36.5	67.1	72.8	69	62.7
84' Machinery	23.6	31.8	38.6	43.4	38.2	59.7	59.3	62.1	58.2
89' Ships	9.7	11.1	17.2	26.6	42.5	54.1	35.9	38.4	33.1
39' Plastics	6.6	9	14.3	17.7	18.4	27.7	31.2	28.2	27.6
90' Optical	1.8	3.1	11.9	24.1	29.3	36.5	35.9	32.5	27.6
27' Mineral fuels	8	6.9	15.7	24.6	23.8	53.1	54.1	33.1	27.5
72' Iron and steel	5.1	7.1	12.8	16.4	15.5	27.6	22.3	20.2	18.7
29' Organic chemicals	4.2	5.8	10.5	15.2	13.1	22.5	24.9	18.2	17.9
73' Iron or steel	2.3	2.6	4.4	7	8	11.7	11.2	11.2	11.1
Total	150	194	284	371	364	555	560	527	495

Source: Authors' compilation based on data UN COMTRADE 2017

Table B: South Korea's exports geographical composition (US\$ billions)

Country	2001	2003	2005	2007	2009	2011	2013	2015	2016
China	18.2	35.1	61.9	82	86.7	134	146	137	124
USA	31.4	34.4	41.5	45.9	37.8	56.4	62.3	70.1	66.7
Hong Kong	9.5	14.7	15.5	18.7	19.7	31	27.8	30.4	32.8
Viet Nam	1.7	2.6	3.4	5.8	7.1	13.5	21.1	27.8	32.6
Japan	16.5	17.3	24	26.4	21.8	39.7	34.7	25.6	24.4
Singapore	4.1	4.6	7.4	11.9	13.6	20.8	22.3	15	12.5
Taipei	5.8	7	10.9	13	9.5	18.2	15.7	12	12.2
India	1.4	2.9	4.6	6.6	8	12.7	11.4	1	11.6
Mexico	2.1	2.5	3.8	7.5	7.1	9.7	9.7	10.9	9.7
Marshall Islands	0.5	1.0	1.1	2.3	9.7	7.1	7.5	7.5	7.7
Total	150	194	284	371	364	555	560	527	495

Source: Authors' compilation based on data UN COMTRADE 2017