Visualization, Economic Complexity Index, and Forecasting of South Korea International Trade Profile: A Time Series Approach*

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Abstract

Purpose – The recent growth of South Korean products in the international market is the benchmark for both developed as well as developing countries. According to the development index, the role of international trade is indeed crucial for the development of the national economy. However, the visualization of the international trade profile of the country is the prerequisite of governmental policy decision-makers and guidance for forecasting of foreign trade.
Design/methodology – We have utilized data visualization techniques in order to visualize the import & export product space and trade partners of South Korea. Economic Complexity Index (ECI) and Revealed Comparative Advantage (RCA) were used to identify the Korean international trade diversification, whereas the time series approach is used to forecast the economy and foreign trade variables.
Findings – Our results show that Chine, U.S, Vietnam, Hong Kong, and Japan are the leading trade partners of Korea. Overall, the ECI of South Korea is growing significantly as compared to China, Hong Kong, and other developed countries of the world. The expected values of total import and export volume of South Korea are approximately US$535.21 and US$ 781.23B, with the balance of trade US$ 254.02B in 2025. It was also observed from our analysis that imports & exports are equally substantial to the GDP of Korea and have a significant correlation with GDP, GDP per capita, and ECI.
Originality/value – To maintain the growth rate of international trade and efficient competitor for the trade partners, we have visualized the South Korea trade profile, which provides the information of significant export and import products as well as main trade partners and forecasting.

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Keywords: Economic Complexity Index, Forecast, International Trade, Visualization
JEL Classifications: C02, F44, F17, L25

1. Introduction

International Trade allows countries to exchange goods and services with the use of money as a medium of exchange. South Korea has experienced one of the largest economic transformations from the last five decades. It started with an agriculture-based economy in

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1960, and it became the 11th largest economy in the world in terms of gross domestic product (GDP) in the year 2016. Even though industrialization was the miracle for the economic development of Korea. However, indeed, the export-oriented trade policies of South Korea are one of the important factors of its success. South Korea is now one of the top exporters in the world, and its exports as a percentage of GDP increased from 25.9% in 1995 to 56.3% in 2012. In the current trade competition, South Korean trade policy and products in the international market are the benchmarks for both developed as well as developing countries.

International trade also has a significant impact on the economic development of the country. The countries are usually exporting the surplus and importing shortfall goods & services which maintain the financial balance of the country. The products & services that are exchanging between the countries are commonly consumer goods; such goods and services are ultimately consumed rather than used in the production of another good. On the other hand, capital goods are a durable product that is using in the production of goods such as machinery, raw material, and food products. Other transactions involve services, such as travel services and payments for foreign patents. The clear visualization of all such items is very much crucial for the efficient international trade of the nation. Viewing of all imports and exports product is also vital for future decisions and forecasting of trade volume as well as the estimation of RCA and ECI.

In this study, we provide a clear overview of South Korea's international trade profile and its projection. The paper structure includes, section first is on the overview of international trade and its role in economic development. The second section is about the brief literature review on Korean international trade and its forecasting. In section 3, we visualize all imports & exports of South Korea products and trade partners. Section 4 portrays the estimation of ECI and its comparison with top countries. Projection and prediction of ECI, GDP, GDP per capita, and import & export volume are included in section 5. The results of the analysis and conclusion are reporting in the final section.

2. Literature Review

International trade is an exchange of goods and services of a country with the rest of countries in the world, and foreign trade impacts significantly on the growth of GDP and development of the country (Mottaleb, 2007; Tsai, 1994). International trade includes the volume of imports & exports of different products (Helpman, 1999). During the last few decades, new research has dramatically advanced our understanding of the structure of world trade (Helpman, 1998). However, the explanation of foreign trade is still incomplete. We need a more technologically oriented trade theory and more emphasis on dynamics to understand the developments in international trade (Helpman, 1998). Foreign trade is a function of export and import volume of a country with its trade partners, which include different consumers, capital goods raw material, and services given by Moenius (2004). Visualization of these goods and services with import and export trade partners is indeed an essential component of world trade structure (Howard, 2009). Krempel and Plümper (2003) gave the comparative advantage of multivariate statistics and network visualizations of international trade. The trade production and protection database include annual data on trade flows (exports and imports), domestic production (output, value-added, employment), and trade protection is given by Nicita and Olarreaga (2007).

According to World Trade Organization (WTO) in the "World Trade Statistical Review 2018" South Korea has emerging economics, and export-oriented policies of South Korea are one of the most critical factors of its economic success (Feenstra and Hamilton, 2006). South Korea is the fifth largest world exporter and ninth-largest importer of the world, as reported

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in the import-export solution in 2019. In 2017, trade represented almost 81% of its GDP (World Bank, 2019). Kim Samuel Seong-Seop, Chon Ka-Ye and Chung Kyu-Yoop (2003) conducted a study on the impact of the convention industry on the Korean economy, and it was reported that the convention industry impacts significantly on the Korean economy. According to a report of the UIA, Korea ranked the 24th with 109 conventions held in 2000 and the fourth in the Asia region (Korea National Tourism Organization, 2001). In 2018, it was reported that China, Japan, South Korea, Hong Kong, Singapore, Taiwan, India, Vietnam, Thailand, and Malaysia are the top 10 destinations and origins of imports and exports in Asia (Kim Samuel Seong-Seop, Chon Ka-Ye and Chung Kyu-Yoop, 2003).

South Korea is the 5th largest export economy in the world and the 6th most complex economy, according to the Economic Complexity Index (ECI). In 2017, South Korea exported US$596 billion and imported US$471 billion, resulting in a positive trade balance of US$124 billion. The GDP of South Korea was US$1.53 trillion, and GDP per capita was US$38.3 thousand (Feenstra and Hamilton, 2005). Empirical evidence from causality tests based on the two alternative approaches indicates that the causal link between real exports and real GDP growth is bi-directional, and determinants of growth are also found to be significant given by Awokuse (2005). Korea Composite Stock Price Index (KOSPI) tends to move in the same direction as the stock market indices in the USA and Europe. In contrast, the KOSPI moves in a direction opposite to those in other East Asian countries, such as Hong Kong and Japan, which have an antagonistic relationship with Korea (Na Sung-Hoon and Sohn So-Young, 2011).

Economic Complexity Index (ECI), in particular, has been successful at explaining cross-country differences in GDP/capita and economic growth given by Mealy, Farmer and Teytelboym (2018). ECI aims to infer information about countries' productive capabilities by making relative comparisons across its export baskets (Hidalgo and Hausmann, 2009). Forecasting the export and import volume in international trade is the prerequisite for a government to make a relevant policy and guide the global trade industry to develop healthier (Xiao, Gong and Zou, 2009). Time series model to forecast the growth in imports by major advanced economies and current results compare favorably to other trade forecasts, as measured by standard evaluation statistics, which can serve as a benchmark for more complex macroeconomic models given by Keck, Raubold and Truppia (2010). We find evidence supporting the view that the growth of real per-capita income has been reported by income, investment, and export growth, as well as government spending and exchange rate policies (Ghatak, 1998).

Besides, a few studies have examined and forecast the different aspects of international trade in South Korea. For example, Milesi-Ferretti and Giorgianni (1997) investigate the determinants of Korean trade flow and their geographical destination during the period of substantial economic transformation. Park Jeong-A et al. (2011) examine the steel resources in Korea using dynamic material flow analysis (MFA). Two-stage stochastic programming model framework in the forecast scenarios on the capacity expansion planning for chemical processing networks was proposed by Bok Jin-Kwang, Lee Hee-Man and Park Sun-Won (1998). The rapid economic development caused vertical Intra industry trade that the Korean economy experienced in the past thirty years, and horizontal intra-industry business was more random caused only by the aggregate volume of trade (Bhattacharyya, 2005).

In this study, we are visualizing the import & export volume with different trade partners of South Korea all over the world, whereas ECI was used to infer the country's productive capabilities, pattern, and comparison with trade partners. Additionally, the study was extended to forecasting the real export, import, GDP, GDP per capita, and ECI of South Korea by using a time series approach.

3. Visualization of International Trade

In this section, we will discuss top export destinations and import origins of South Korea in different continents and countries all over the world. Display of the high import & export products and its groups/categories are also discussed in this section.

3.1. Import and Export Visualization

According to World Trade Organization (WTO) in the "World Trade Statistical Review, 2018" South Korea has emerging economics, and export-oriented policies of South Korea are one of the essential factors of its economic success. During the last decade, the export volume increased from US$383 billion (B) in 2007 to US$596B in 2017 with growth rate 4.52%, became 3rd largest exporter of Asia and 5th largest exporter of the world. It is reported that about US$375B, which is 63% of the total export of Korea, is marketed in Asian countries, while US$92.8B 16%, US$78.1B 13%, US$27.5B 4.6%, US$12.3B 2.1%, and US$11B 1.89% are exported to North America, Europe, Oceania, Africa, and South America continents as shown in Table1.

Table 1. Distribution of Import and Export on Different Continents

Continent	Export in 2017		Import in 2017	
	value (billion US$)	%	value (billion US$)	%
Asia	375	63.00	301	64.00
North America	92.8	16.00	58.3	12.00
Europe	78.1	13.00	74.8	16.00
Oceania	27.5	4.60	19.6	4.20
Africa	12.3	2.10	6.96	1.50
South America	11	1.89	11.4	2.40
Total	596.7	100	472.06	100

The import volume of South Korea is increased from US$342B to US$472B during the last decade, with a growth rate of 3.27%, and South Korea became 4th and 8th largest exporter in Asia and the world respectively. It was observed from the analysis that countries of the Asian continent are importing US$301B, which is about 64% of the total import volume of South Korea, as shown in Table1. The import volume of South Korea is increased from US$342B to US$472B during the last decade, with a growth rate of 3.27%, became 4th and 8th largest exporter in Asia and the world respectively. It was observed from the analysis that countries of the Asian continent are importing US$301B, which is about 64% of the total import volume of South Korea, as shown in Table 1.

According to the results of Fig. 1, South Korea imported $58.3B (12%) from North America, US$74.8B (16%) from Europe, US$19.6B (4.2%) from Oceania, and US$11.4B (2.4%) from South America respectively.

According to the statistical report published by the observatory of economic complexity, South Korea is exporting US$537.83B, which 8.7% of total Asian export and 3.06% of the world total export volume. South Korea is exporting more than 4,419 items in the form of semiconductors, petrochemicals, auto parts, ships, wireless communication equipment, electronics, steel, plastics, and computers as primary products. These export products are exporting in 211 countries all over the world. Whereas China, USA, Vietnam, Hong Kong, Japan, Australia, Singapore, India, Germany, Mexico, and U.K. are the leading trade partners of South Korea. It was also reported in Table 2, about US$ 478B, which is 8% of total Asian

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import volume, and 2.7% of the total global import volume is marketed in Korea. The country is importing more than 4,525 products, including crude petroleum, integrated circuits, coal, and refined petroleum telephone equipment and office machines as primary import goods in 210 countries, including China, USA Japan, Germany, and other Asian countries as top import origins.

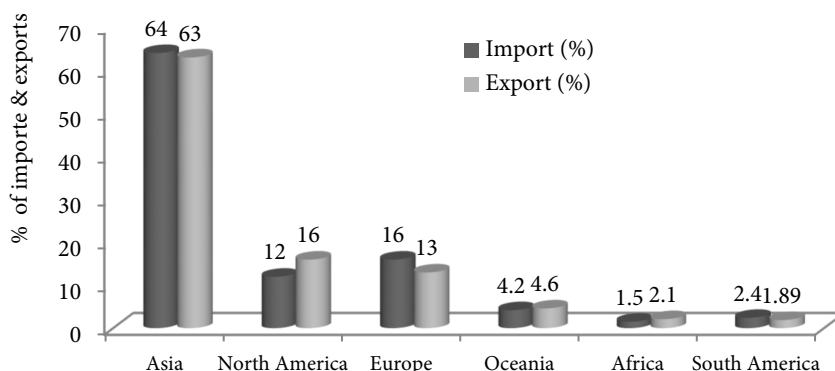**Fig. 1.** Import and Export Percentage in a Different Continent

Table 2. Distribution of Import and Export in Different Countries

Country	Export in 2017		Imports in 2017	
	Value (billion US$)	%	Value (billion US$)	%
China	149.86	25.11	98.14	20.79
United States	69.36	11.62	48.71	10.32
Vietnam	47.74	8.00	16.07	3.40
Hong Kong	34.84	5.84	20.02	4.24
Japan	26.86	4.50	54.17	11.48
Australia	18.66	3.13	17.96	3.81
Singapore	18.22	3.05	14.22	3.01
India	15.31	2.57	4.96	1.05
Germany	11.95	2.00	19.69	4.17
United Kingdom	9.20	1.54	6.59	1.40
Philippines	8.74	1.46	4.31	0.91
Malaysia	8.19	1.37	7.98	1.69
Indonesia	8.02	1.34	9.23	1.96
Thailand	7.46	1.25	5.12	1.09
Russia	7.02	1.18	12.1	2.57
Marshall Islands	6.87	1.15	0.02	0.01
Turkey	6.36	1.07	0.76	0.16
Canada	6.06	1.02	4.61	0.98
Saudi Arabia	5.15	0.86	17.71	3.75
Netherlands	4.29	0.72	6.32	1.34
Total	470.16	78.78	368.69	78.13

Table 2 shows the import and export volume of South Korea with different origins and destination countries all over the world. It was observed that about US$149.86B export volume of South Korea is with China, which more than 25% of the total export of South Korea. On the other side, the import volume of South Korea from China is about US$98.14B, which is more than 20% of the total import volume of South Korea. The country is exporting share volume (%): US$69.36B (11.65%), US$47.74B (8.0%), US$34.84B (5.84%), US$26.86B (4.50%) and US$18.66B (3.13%) to U.S, Vietnam, Hong Kong, Japan and Australia and import volume from these counties are US$48.71B (10.32%), US$16.07B (3.40%), US$20.02B (4.24%), US$54.17B (11.49%) and US$17.96B (3.81%), respectively.

3.2. Import, Export Product Space

The total volume of import and export of Korea, Republic of is worth US$471B and US$596B, resulting in a positive trade balance of US$125B in the shape of 4,525 import and 4,419 export products near about more 210 counties all over the world. These import & export products (items) are broadly classified into 22 groups. The main classes of products are machines, minerals, chemicals, metals, and instruments, etc. Results of Table 3 reveals that machines ($133, 28%), mineral products (US$177, 25%), chemical (US$40.2, 8.5%), metals ($38.7, 8.2%) and instrument (US$35.4, 7.5%) are contributing in the Korean import trade.

Table 3. Import (in US$B), RCA & Percentage

Products	Value	RCA	%
Machines	133.0	0.73	28
Mineral Products	117.0	1.30	25
Chemical Products	40.2	1.41	8.5
Metals	38.7	1.01	8.2
Instrument	35.4	1.06	7.5
Transportation	21.0	0.43	4.4
Textiles	14.9	0.70	3.19
Plastics and Rubbers	13.6	0.79	2.9
Foodstuffs	9.99	0.69	2.1
Animal Products	9.59	0.97	2
Vegetables	8.02	0.57	1.7
Miscellaneous	5.70	0.77	1.2
Stone and Glass	5.33	1.24	1.1
Precious Metals	4.04	0.49	0.86
Wood Products	3.21	0.69	0.68
Animal Hides	3.19	1.17	0.68
Paper Goods	3.93	0.75	0.83
Other Product	6.00	---	1.16

Additionally, Table 3 reveals the results of the Revealed Comparative Advantage (RCA) estimated by the formula given Balassa (1965). RCA indices offer a useful way of analyzing a country's comparative advantage based on demonstrated (i.e., actual) export performance. More specifically, the RCA of product i exported from j^{th} the country can be expressed as follows:

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$$RCA_{ij} = \frac{X_{ij} / M_{ij}}{\sum\limits_{i=1}^{n} X_{ij} / \sum\limits_{i=1}^{n} M_{ij}}; \forall j = 1, 2, 3, \ldots, p \tag{1}$$

Where i is denote the index for the region and j is an index for the sector. The exports of jth the sector in i^{th} the region are denoted by matrix X_{ij}, and the sum of the total export volume of jth the sector in the global market is denoted by M_{ij}.

The RCA index ranges from 0 to infinity, with one as the break-even point. That is, an RCA value of less than one means that the product has no comparative export advantage, while a value above 1 indicates that the product has a "revealed" comparative advantage. Thus mineral products (1.30), chemical products (1.41), metals (1.01), instrument (1.06), stone and glass (1.24), and animal hides' products (1.17) are having a comparative advantage over the Korean overseas trade. On the other side, machine (0.73), transportation (0.43), textiles (0.70), plastics & rubber (0.73), foodstuffs (0.69), animal (0.97), wood (0.69) and paper products (0.75) are obtaining comparative disadvantage over the Korean import trade as shown in Table 3.

Table 4. Import Products Value in Billion US$ and Percentage

Products	Value	%
Petroleum oils crude (POC)	55.97	11.86
Monolithic integrated circuits, digital (MICD)	33.07	7.01
Natural gas, liquefied (NGL)	14.37	3.04
Equipment for photographic laboratories (EPL)	13.66	2.90
Oil petroleum except crude oil (OPECO)	13.31	2.82
Bituminous coal (BC)	11.85	2.51
Transmit receive apparatus for radio, TV (TRART)	7.19	1.52
Parts of line telephone equipment (PLTE)	6.36	1.35
Parts and accessories' of data processing (PADP)	6.13	1.30
Part of machines and mechanical appliances (PMMA)	5.53	1.17
Monolithic integrated circuits, except digital (MICED)	5.43	1.15
Anthracite, not agglomerated (ANA)	4.07	0.86
Copper ores and concentrates (COC)	3.97	0.84
Medium-sized cars (MSC)	3.59	0.76
Machines and mechanical appliances parts (MMAP)	3.23	0.69
Optical devices appliances and instruments (ODAI)	3.08	0.65
Medium diesel engine cars (MDEC)	2.71	0.57
Medicaments Nes, in dosage (MND)	2.70	0.57
Photosensitive/led semiconductor devices (PSD)	2.60	0.55
Electronic printed circuits (EPC)	2.38	0.50
Other products (OP)	270.74	57.36

Korea is receiving near about US$ 471B amount of import volume in the form of 4,419 items (products) classified into 22 groups from 210 countries all over the world. The top export item in volume and percentage are given in Table 4 and reported as POC (US$55.97, 12%), MICD (US$33.07, 7%), NGL (US$14.37, 3%), EPL (US$13.66, 2.90%), OPECO (US$13.31, 2.82%), BC (US$11.85, 2.51%) and TRART (US$7.19, 1.52%), etc. It aggregated near about 57% of the total import volume of South Korea.

Table 5. Export Value, RCA and Percentage

Products	Value	RCA	%
Machines	251	0.85	42
Transportation	106	1.07	18
Metals	50.2	0.95	8.4
Chemicals	45.2	0.77	7.6
Plastics and Rubbers	40.4	1.24	6.89
Mineral	36.6	0.39	6.1
Instruments	29.1	0.53	4.9
Textiles	13.4	0.60	2.29
Foodstuffs	5.68	0.22	0.95
Paper Goods	3.51	0.41	0.59
Precious Metals	4.24	0.72	0.71
Stone and Glass	2.84	0.44	0.48
Miscellaneous	2.77	0.36	0.46

Table 6. Export Products Value in Billion US$ and Percentage

Products	Value	%
Monolithic integrated circuits, digital (MICD)	92.87	15.57
Oil, petroleum, bituminous (OPB)	32.57	5.46
Mediums sized cars (MSC)	18.96	3.18
Tankers	13.67	2.29
Optical devices, appliances, and instruments (ODAI)	13.38	2.24
Accessories of Data Processing equipment's (ADPE)	13.12	2.20
Floating submersible (FS)	11.14	1.87
Monolithic integrated circuits, except digital (MICED)	10.87	1.82
Cargo vessels other than tanker (CVOT)	10.70	1.79
Transmit-Receive apparatus for radio, TV (TRART)	10.23	1.71
Machines and mechanical appliances (MMA)	8.57	1.44
Parts for radio/TV transmit equipment (PRTTE)	7.63	1.28
Parts of Line telephone equipment's (PLTE)	7.49	1.26
P-Xylene	6.07	1.02
Small-sized cars (SSC)	6.05	1.01
Motor vehicle (MV)	5.87	0.98
Other products (OP)	3.27	54.87

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The total export volume of South Korea is about US$596B receiving from 211 countries in the form of 4,419 items classified into 22 categories. The main products categories in volume and percentage are machines products (US$251, 42%), transportation (US$106, 18%), metals (US$50.2, 8.4%), chemicals (US$45.2, 7.6%), plastics and rubber (US$40.4, 6.89%), mineral (US$36.6, 6.1%) and instruments products (US$29.1, 4.9%), etc. The main categories of export products are shown in Table 5, which aggregated near about 85% of the total export value of Korean trade. Additionally, Table 5 shows that transportation (1.07) and plastics & rubber (1.24) sectors are adding comparative advantage in the international trade of South Korea. Where machines (0.85), metals (0.95), chemical (0.77), mineral (0.39), instruments (0.53), textile (0.60), foodstuff (0.22), paper (0.41), precious metal (0.72), stone & glass (0.44) and miscellaneous products (0.36) are adding comparative disadvantages in the overseas trade of South Korea.

The main export items (value in billion US$, %) are MICD ($92.87, 15.57%), OPB ($32.57, 5.46%), MSC ($18.95, 3.18%), Tankers ($13.67, 3.18%), ODAI ($13.38, 2.24%), ADPE ($13.12, 2.20%), FS ($11.14, 1.87%), MICED ($10.87, 1.82%), CVOT ($10.70, 1.79%), TRART ($10.23, 1.71%), MMA ($8.57, 1.44%) and PRTTE ($7.63, 1.28%) etc. are shown in Table 6, which aggregated near about 46% value of total export volume of country.

4. Economic Complexity Index (ECI)

The economic complexity index measures the country's productive capabilities, and it is essential to understand the economic development of the country. ECI measures the knowledge intensity of the economy by considering the knowledge intensity of the products it exports and helpful to predict the current income level and provides a useful measure of economic development.

The RCA is used to define a discrete matrix M_{ij}, which is equal to 1 if the country j has RCA in product i and 0 otherwise, i.e. $M_{ij} = 1$ if $RCA_{ij} \geq 1$, and $M_{ij} = 0$ if $RCA_{ij} < 1$. The matrix M_{ij} allows defining the diversity and ubiquity of ith the product of the jth country. Diversity of country defines as where the number of products that are exported by a country with comparative advantage and can be estimated by $k_i^{(0)} = \sum_{i=1}^{N} M_{ij}$. Where ubiquity is the number of countries that export the same product with comparative advantage can calculate by $k_j^{(0)} = \sum_{i=1}^{P} M_{ij}$. Finally, the ECI is defined as:

$$ECI_i = \frac{K_i - \langle K \rangle}{std(K)} \qquad (2)$$

Where K_i is the eigenvector of $\tilde{M}_{ii'} = \frac{1}{k_i^{(0)}} \sum_{j=1}^{p} \frac{M_{ij} M_{i'j}}{k_j^{(0)}}$, associated with the second largest eigenvalue, vector associated with the largest eigenvalue is a vector of ones (Hartman et al., 2017).

South Korea has emerging economics, and export-oriented policies of South Korea are one of the essential factors of its economic success. The continuous and exponential growth of Korean ECI is shown in Fig. 2, which resembles Germany and the United States. It was also observed that from the last two decades, the ECI of South Korea has a significant increasing trend. During the period 2012-15, the average value of ECI of Korea is more than the ECI value of Germany, the United States, China, and Hong Kong. On the other hand, the ECI of

Japan is at the top from 1985 to 2019. Fig. 2 also shows that there is a declining trend in the current ECI of South Korea.

Fig. 2. Trend of ECI Value of the Top Six Countries
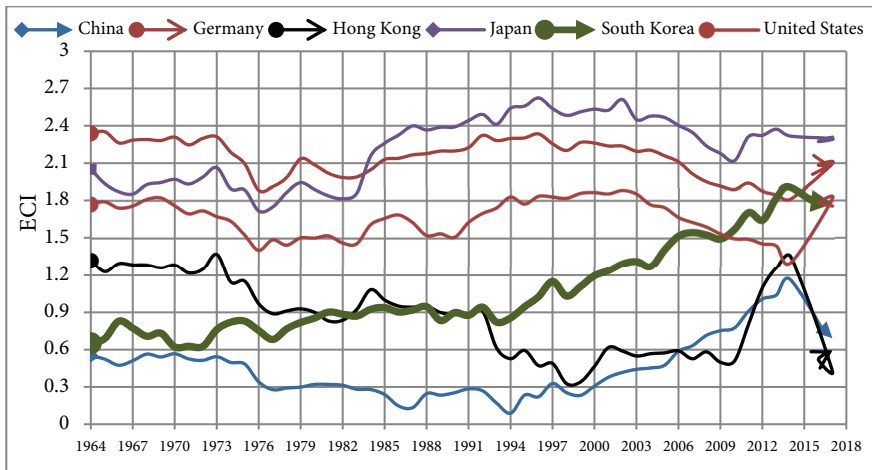
South Korea managed to transform almost its entire export portfolio into more sophisticated products, such as cars, hydrocarbons, and polyethylene during 1990, which is the main reason for South Korea's development. Fig. 3 shows the structural transformation of South Korea from 1970 to 2000.

Fig. 3. Export Product Structural Transformation of South Korea

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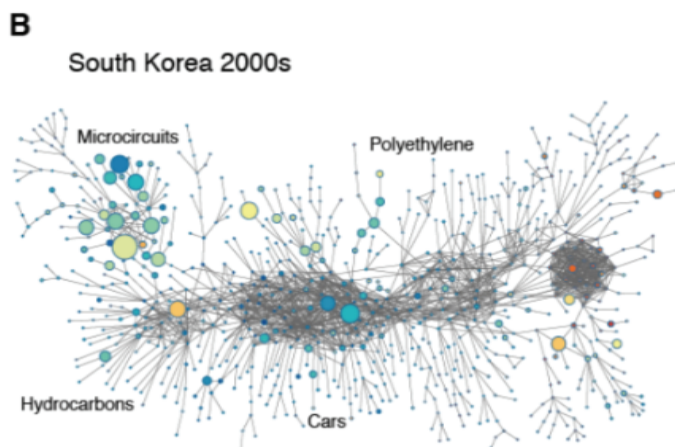A Time Series Approach

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Table 7 shows the ECI ranking of the top 10 countries of the world and the corresponding GDP per capita. It was observed from table 7 that Japan has a high ECI value (ECI=2.30938), and the corresponding GDP per capita is about US$39287. The GDP per capita of Switzerland is on the top (US$82839) with ECI value is 2.24386. On the other hand, South Korea has the 6th position in world ECI ranking with value ECI value 1.77613, and the corresponding GDP per capita is US$31363, as shown in below Table 7.

Table 7. Economic Complexity Ranking in 2018

ECI Rank	Country	GDP per capita	ECI
1	Japan	39287	2.30938
2	Switzerland	82839	2.24386
3	Germany	48196	2.07537
4	Singapore	64582	1.86534
5	Sweden	54112	1.80773
6	South Korea	31363	1.77613
7	United States	62641	1.75541
8	Finland	49960	1.70679
9	Czech Republic	22973	1.64381
10	Austria	51513	1.62894

5. International Trade Forecasting

In this session, we are forecasting the critical economic and international trade variables, such as total exports, imports, GDP, GDP per capita, and ECI. Time series technique through which we can predict the future values of a particular variable based on the previously observed values of that variable. Time series analysis may be a simple and effective way to

make forecasts when causal relationships are less clear. In the approach of forecasting, we are usually conducting the policy of simulation and at the same time. In order to characterize trade growth and balance, we prefer to focus on the total volume of import and export of the country. The proposed time series forecasting model by using a following mathematical model calculates the future values of a variable on the bases of the linear combination of past observations and a random error together with a constant term.

$$y_t = c + \sum_{i=1}^{n} \varphi_i y_{t-i} + \varepsilon_i = c + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \ldots + \phi_n y_{t-n} + \varepsilon_t \tag{3}$$

Where c is constant, $\phi_i (i = 1, 2, 3, \ldots, n)$ are the n model parameters having past n observations $y_{t-i} (i = 1, 2, 3 \ldots n)$ and $y_t \, and \, \varepsilon_t$ is respectively the actual value and random error at a time t.

Here we are using the penal data of total imports, exports, GDP, GDP per capita, and ECI index of South Korea from 1995 to 2018 in order to predict the behavior and performance of these economy variables in the next six years.

Fig. 4. Forecasting of Total Exports, Imports, GDP, GDP per capita, and ECI

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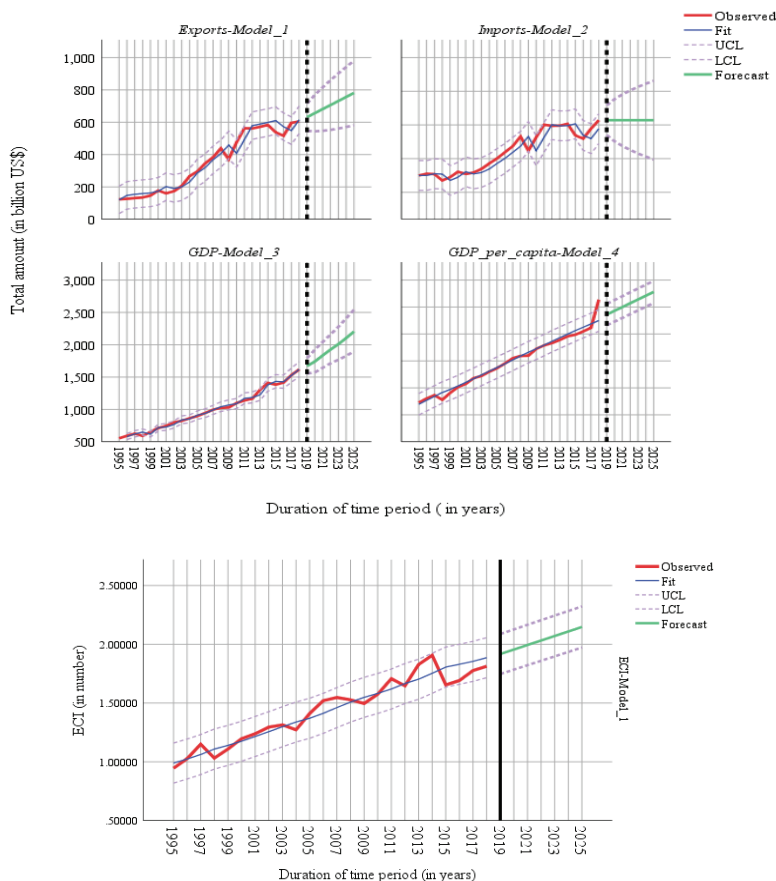A Time Series Approach

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Fig. 4 shows the forecast, observed, and fitted value of total exports, imports, GDP, GDP per capita, and ECI value of south Korea. It was noted that exports, GDP, GDP per capita, and ECI of South Korea have increasing trade where the total imports have constant movement in the next six years. The expected growth in total exports, imports, GDP, GDP per capita, and ECI value of South Korea in the next six years are shown in Table 8.

Table 8. Forecasting of Total Exports, Imports, GDP, GDP per Capita & ECI

	2019	2020	2021	2022	2023	2024	2025
Exports	631.47	656.43	681.39	706.35	731.31	756.27	781.23
Imports	535.21	535.21	535.21	535.21	535.21	535.21	535.21
GDP	1670.66	1741.56	1835.33	1925.37	2009.98	2102.58	2204.24
GDP p/c	28595.86	29296.87	29997.89	30698.90	31399.92	32100.94	32801.95
ECI	1.91717	1.95554	1.99391	2.03228	2.07065	2.10902	2.14739

Moreover, it has observed from the results of the time series model (5.1); the expected growth of total exports is from US$596 B in 2018 to US$781.23B in 2025. On the other hand, the predicted growth of total imports in South Korea remains the same from 2019 to 2025 (US$535.21B). Where the expected GDP and GDP per capita of South Korea in 2025 is about US$2,204.24B and US$32,801.95, respectively. In the next six years, the ECI of South Korea is increasing from 1.77613 to 2.14739, as shown in Table 8.

Table 9. Correlation between ECI, Exports, Imports, GDP, and GDP per Capita

	ECI	Exports	Imports	GDP	GDP per capita
ECI	1.000	0.965**	0.955**	0.949**	0.948**
Exports		1.000	0.991**	0.952**	0.953**
Imports			1.000	0.922**	0.935**
GDP				1.000	0.985**
GDP p/c					1.000

Note: ** denotes that correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation analysis results showed that there is a significant correlation between total exports and total imports with ECI. It has observed from Table 9, and there is also a significant correlation between total exports and total imports with GDP and GDP per capita. The import and export are equally substantial to GDP and GDP per capita of South Korea. On the other side, ECI, GDP, and GDP per capita are showing a significant positive correlation.

6. Conclusion

The visualization and forecasting of imports, exports, GDP, and GDP per capita are beneficial for international trade. Whereas global trade analysis, visualization, and forecasting are increasingly demanding for very detailed and precise understating. This study endeavors to visualization, prediction, and estimation ECI of South Korea international trade. ECI and time series forecasting analysis proved to be an excellent technique to visualize, diversify, and

predict the future of the global business of South Korea. It also provides the possible direction of improvement and benchmarks for comparison purposes. Besides this, an attempt has been made to estimate the comparative advantage of different import & export products in the global market. Further, the study was extended to find the correlation between the total imports & exports with country GDP and ECI.

From a practical point of view, the conclusion can be drawn in three different ways as per the objectives of the study. The first one is about the visualization of country imports-exports volume and its origins-destinations. It was concluded that Asian countries, especially China, Vietnam, Hong Kong, and Japan, are more feasible for international trade, which import about 40% of the total import of Korea and near about 50% of export respectively. The machines, mineral, chemical, and metal products are mostly imported from other countries, which about 70% of the total import volume of Korea. On the other side, more than 50% of total exports are machines, transportation metal, and chemical products. Transportation, plastics, and rubber product have a comparative advantage in the Korean trade.

Our analyses have some critical implications for the application of these measures to the development context. In particular, by making the difference between ECI and diversification of imports and exports, we can distinguish between the roles these measures play in the development process. The continuous and exponential growth of ECI value since 1999 indicates the strength and significant potential of South Korean international trade. Thus it was concluded that the overall ECI value of South Korea is growing significantly as compared to China, Hong Kong, and other developed nations. It has observed from our analysis there is also a significant correlation between total exports and total imports with GDP, GDP per capita, and ECI.

Additionally, it was observed from the result that exports, GDP, GDP per capita, and ECI value of country are having increasing trade where the total imports have constant movement in the next six years. The expected value of total import and export volume is approximately US$535.21 and US$ 781.23B, with the balance of trade US$ 254.02B. In contrast, the predicted value of GDP and GDP per capita is about US$2,204.24B and US$32,801.95 approximately. Finally, the exponential growth in ECI is concluded that in the next decade, South Korea becomes a benchmark in the global market for the rest of the world.

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