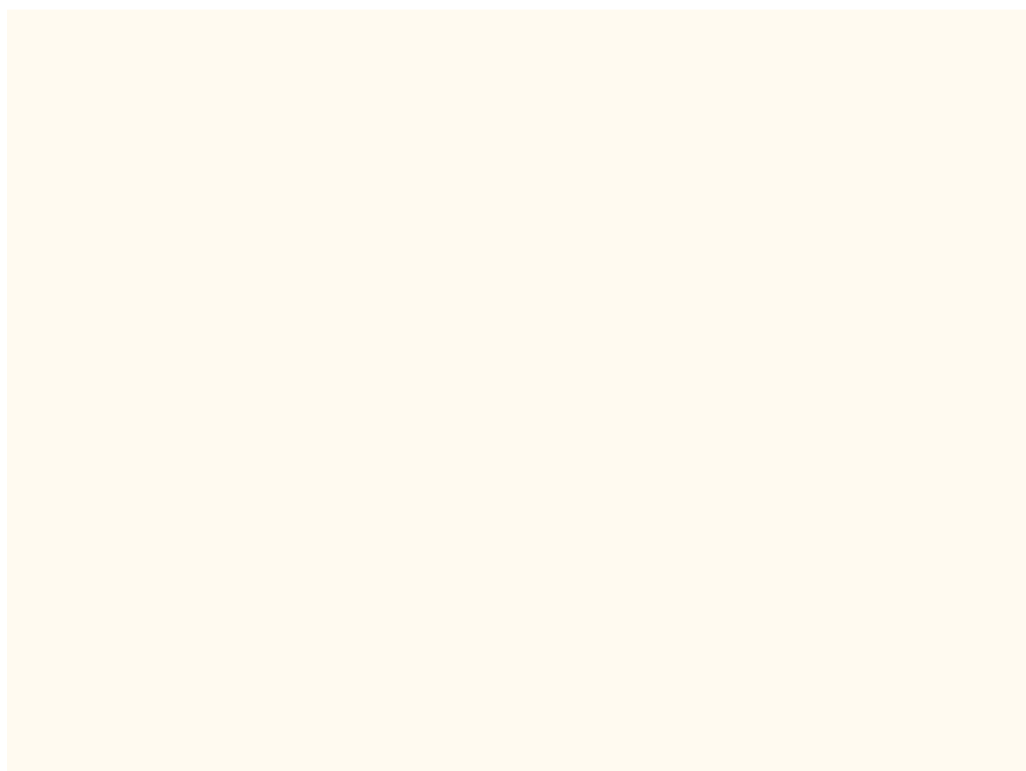




EE 482 : Public Policy and Industrialization

**THE REASSESS OF KOREAN
SELECTED INDUSTRIES**



Thammasat University
Faculty of Economics

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Executive Summary

Back in the time, the republic of Korea or we know as South Korea had suffered huge losses during 1950 to 1953 “Korean War”. After the War ended, the nation’s economy was in a shamble, infrastructure was destroyed and South Korea have to heavy reliant on U.S. aid. However, the country’s transformation from poverty to affluence has been phenomenal. Until 1996, South Korea became part of the Organization for Economic Cooperation and Development (OECD) and it never looking back since then, and today Korea is a fast growing and highly industrialized nation that all developing nations preserve as the role model. An important contributor in this growth process is the culture of innovation that prevails in South Korea, a friendly atmosphere for investors and extremely cordial relations with most of the countries in the Asian market. (source: Investopedia) Therefore, in this paper, we are mainly focus on industry sectors of South Korea since it is an important mechanism in nation development. We going to reassess of each main selected Korean industry.

Source of data

Source of data	Data	Brief information
Researchgate	The growth path of Korean economy	The graph of the Korean economic growth path
MUFG report	Korea economy and industry overview	-GDP of Korea -Major production sector share to GDP
statista	GDP distribution	GDP distribution
Trading economics	GDP growth	GDP growth
The bank of korea	GDP composition	-Graph and information about agriculture value-added to GDP -Graph and information about service value-added to GDP -Graph and information about industry value-added to GDP
OECD	Flow of trade	-Export product share size -Destination of Korea products -Origin of Korea import products -show percentage of Korea export in year 2001, 2011, 2017. -trade balance

International Trade centre (ITC)	Export	Quadrant analysis in 2018
OECD	<ul style="list-style-type: none"> -Domestic valued added in export -Gross export -Domestic Backward and Forward Multipliers -Global Backward and Forward Multipliers -Korea's IO-Table 	<ul style="list-style-type: none"> -Tiva index between 2005-2016 -Tiva in agriculture,forestry, fishery between 2005-2017 -Tiva index of Industry including energy between 2005-2017 -Tiva index of Manufacturing between 2005-2017 - Tiva index of Construction between 2005-2017 -Tiva index of Wholesale, retail trade and repair between 2005-2017 -Tiva index of Information, Communication between 2005-2017 -Tiva index of Finance and Insurance between 2005-2017 -Tiva index of Real estate between 2005-2017 -Tiva index of Professional, scientific, support service between 2005-2017 -Tiva index of Public administration, defence, education and health between 2005-2017 -Tiva index of Public administration, defence, education and health between 2005-2017 - Tiva index of Other services between 2005-2017 - Tiva index of Service between 2005-2017 - Global Backward and Forward Multipliers in 2011,2015 - Domestic Backward and Forward Multipliers in 2011,2015 -Network analysis in year 2000,2011 -Revealed Comparative advantage in year 2000,2010,2017

UNCTAD.Stat	-Revealed Comparative advantage	
ATLAS of economic complexity	-Economic complexity index	-Economic complexity in year 2000,2011,2015,2017

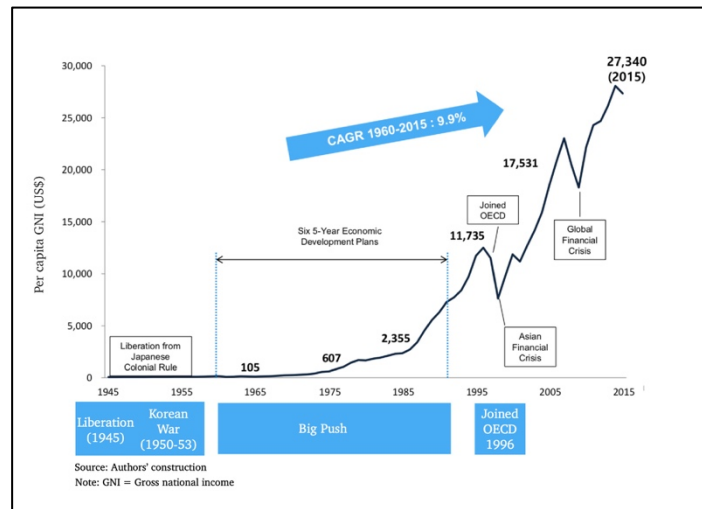
Overview of Korea Economics

The South Korean economy which a lot of people might know for the big companies like Samsung and Hyundai. South Korea is the 12th largest economy in the world, with a nominal GDP of \$1.62 trillion. The country has made through the incredible way in the past couple of decades to establish itself as a hi-tech, industrialized and become the high-income nation. Over the past around 40 to 50 years, South Korea has shown the incredible economic growth and global integration to become an industrialized economy. During the 1960s which before the implementing of Korea economics development plan, its GDP per capita was among the poorer countries in the world. South Korea entered the trillion-dollar club in 2004, drive by international trade and industrialization. It is among the top exporters in the world and presents great investment opportunities, reflected in its ease of doing business ranking. (source: Investopedia)

As mentioned above, before Koreans have everything today, it has gone through many things in the past decade. Korea was under Japanese colonial rule in year in 1910 to 1945 which disrupted its economic activities and, after that, in President Rhee regime (the year 1948 to 1960), economic growth is very slow since he gives a lower priority on economics development as well as Korean War occurred in 1950 to 1953 which make territorial division and resulting in the loss of economic integrity. By the beginning of the year 1961, South Korean has new president who give the priority to economy and he was implemented the Korean economic development plan which called “Miracle on Han River and Beyond”

There are both negative and positive initial conditions, the initial conditions that provides negatively impact to the development are, at that time, Korean per capital income was approximately \$82 USD which around the same level as Ghana and Sudan, after Korean War, their economics getting worse and had more crisis since they lacked of natural resources to export, infrastructure was destroyed during the war, and, people had low level of savings and high level of poverty. However, Korea still had a number of advantages e.g. abundant labor with high level of literacy and they had relatively equal income distribution.

Figure1. Graph of South Korea economics growth



From the figure above, as we mentioned, the development plan started in 1961 from that year and so on. It was the big push of Korean economics to gradually increased their income every year. Their income level went up to a pretty high level until the year 1996, Korea became a part of OCED country which could be implied and guaranteed that Korean economic growth was organically at the high level. Nevertheless, there were some interruptions to its economic growth which were the Asian financial crisis in 1997 and the Global financial crisis in 2008 but Korea performed very well to deal with the crisis and got back on track and continued its fast-growing economy. Korea has continued annual growth rate from year 1960 to 2015 at 9.9%.

Figure2. Result from development plan was

	1961	2015	
Per Capita GNI (US\$)	82	27,340	330 times
Commodity Exports (US\$)	41 million	527 billion	13,000 times
Trade/GDP Share (%)	3.3%	69.8%	66.5%p ↑
Trade	\$33million	\$96.3billion	6006 time
Life Expectancy	55 (1960)	82	27 years ↑
Enrollment Rate (%)			
High School	29.3 (1970)	93.5	3.2 times
University/College	9.0 (1970)	70.8	7.9 times

After implementing the development plan, not only per capita gross net income has increased but also brought up many factors raise along with it. Such as commodity Export, Trade per GDP share, Trade, Life expectancy and Enrollment Rate, etc. By the number of those factor increased in the large amount. This can imply Korean economics became better and people had a better quality of life to nowadays.

Current Situation of Korea

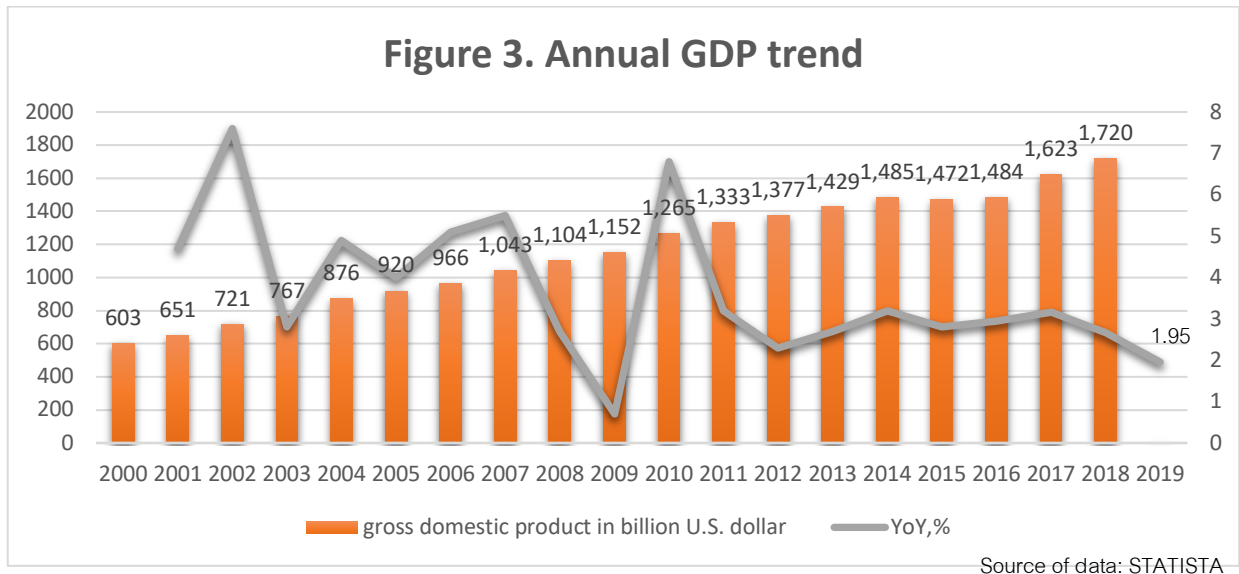


Figure4. Graph of South Korea economics GDP growth change in quarterly

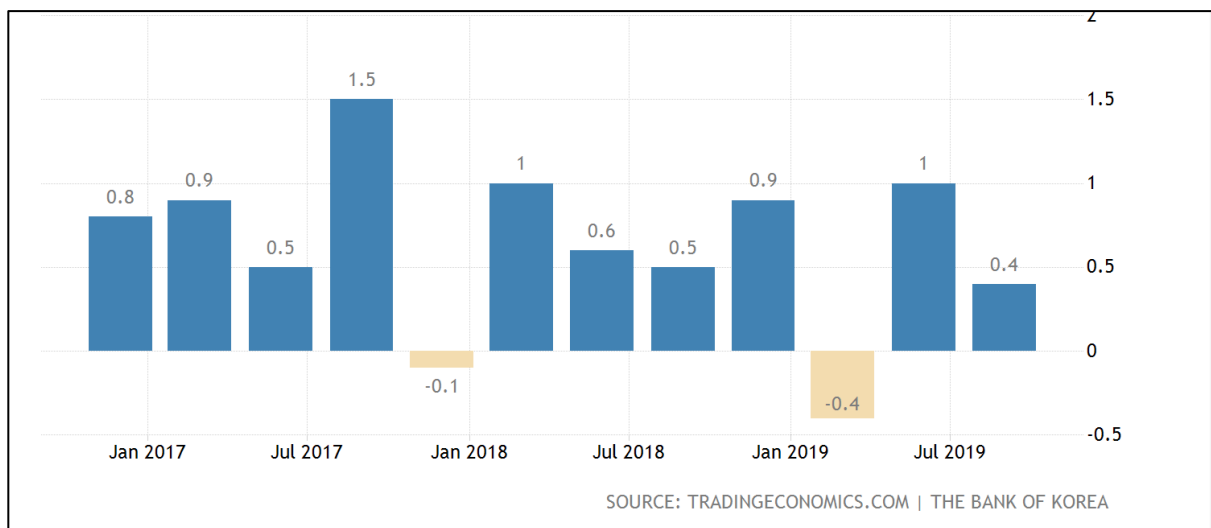


Figure 3. shows the Korea annual growth trend, as you can see from the figure, South Korea's GDP keep increasing every year but trend of Korea's growth rate slowed down in recent year.

From figure 4. can imply that South Korea's quarterly GDP growth declined to 0.4 percent in the three months to September 2019 from 1.0 percent in the previous quarter which lower than the market expectations of 0.5 percent. There is some evident show that the softer growth was mainly explained by a slower rise in services and declines in utilities and construction. On the expenditure side, less spending grows in household consumption and government while fixed investment shrank. GDP Growth Rate in South Korea averaged 1.78 percent from 1960 until 2019, reaching an all times high of 7.80 percent in the fourth quarter of 1970 and a record low of -7 percent in the first quarter of 1998. (source: The Bank of Korea)

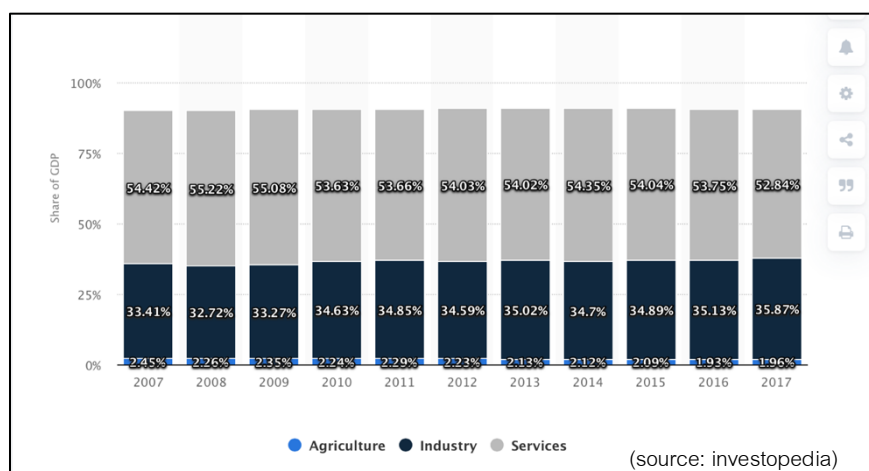
The reasons that make Korea become successful in a developing country due to having the right development plan as well as cooperation in many ways from the government. The key driver of this sustained growth, firstly, Korea had a supportive president who had vision and placed a high priority on economic development. The government set up various institutions to support this economic development such as KIST and KDI. Next, the Korean government saw the importance of human capital development, they had high investments in education since they would like to have a higher quality of workers and entrepreneurs. And lastly, it was about the right policy or the right development plan. At that time, 1960 to 1980, Korea government used outward-looking strategy to strengthen economic growth by having government intervention, they changed from being import substitution to export-driven industrialization country and targeted Heavy and Chemical Industries (HCI) in 1970. This policy worked so well, gross net income increases gradually and it had led Korea to become a developed country in nowadays.

We have wondered that if the Korean government did not choose heavy and chemical industries as their targeted industries at that time, will Korea become the 12th largest economy in presents? In our perspectives, we believed selecting the right targeted industry was as important as improving other factors in order to drive the economy.

So, let see the ratio of how much each sector contributes to GDP and see what are the major industry in Korea.

GDP Composition

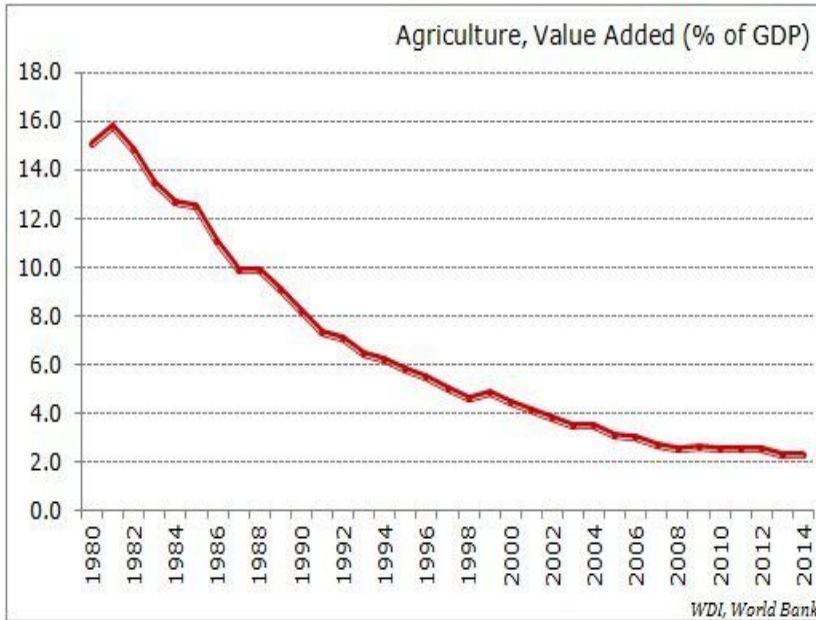
Figure5. Graph of Main Sectors contributed to GDP



The world bank categorized South Korea as a high-income country; an OECD nation member. The Korean GDP is largely supported by its industrial and services sector, which contributes 38.2% and 59.5% to the nation's gross domestic product. Meanwhile, the agriculture sector contributes only a very small amount to GDP which around 1.96% of total GDP.

Agriculture

Figure 6. Graph of Agriculture value added to GDP

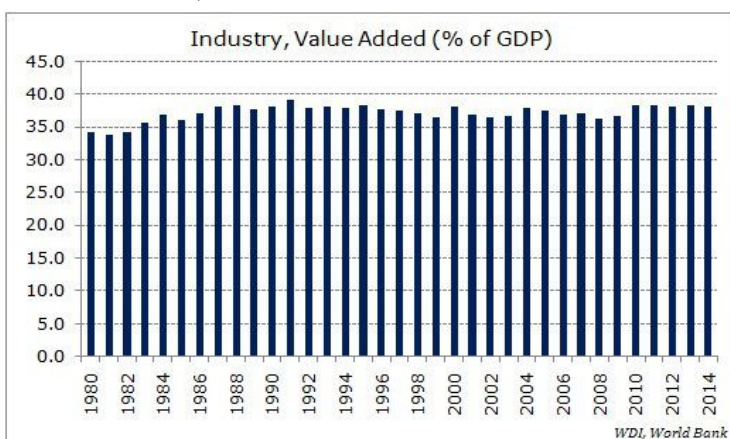


In the first period after Korea war, the country still relied a lot more on agricultural sector which at that time it contributed almost 50% of the nation GDP. But South Korea nation has been fast shifting to focus more on industry sector after the country development plan was implemented. As you see from the graph, this sector contribution has continuing drop after the year around 1980

and now, it stays at the stable rate approximately to 1.5 to 2.5%. The country has to rely heavily on the import of agricultural products and raw materials for processing. With increasing urbanization and rising labor costs, people have moved away from the agricultural sector. (source: Investopedia)

Industry

Figure 7. Graph of Industry sector value added to GDP



For industry sector, it quite constantly contributed to the GDP. The major industry of Korea is composed of manufacturing, mining, construction, electricity, and gas.

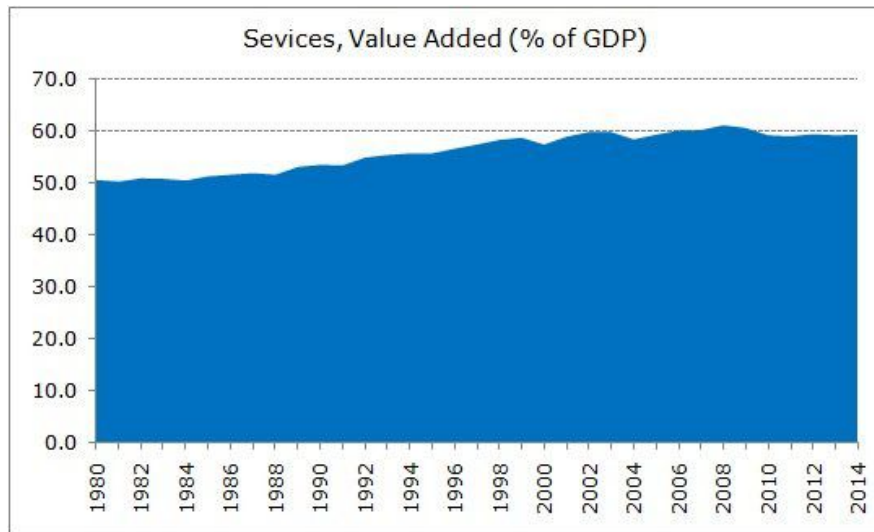
(source: Investopedia)

Service

From Figure 8, show that the services sector has gradually risen its contribution to the country's GDP. However, we believed the sector is yet to reach its optimal potential, as much of its growth has come by adding employees rather than through improving productivity. The sector provides employment to 70% of the Korean workforce. (source: Investopedia)

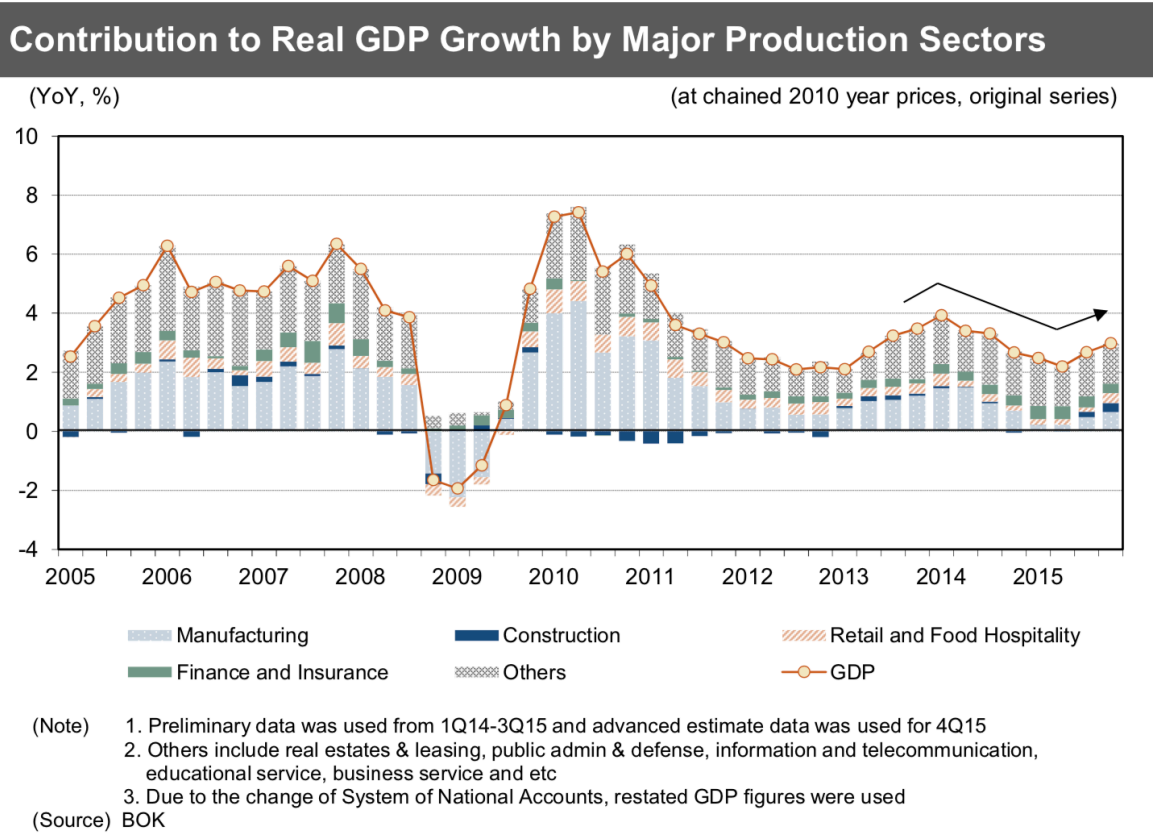
Figure 8. Graph of Service sector value added to GDP

Source: world bank



Major production sector share to GDP

Figure 9. Major production sector share to GDP



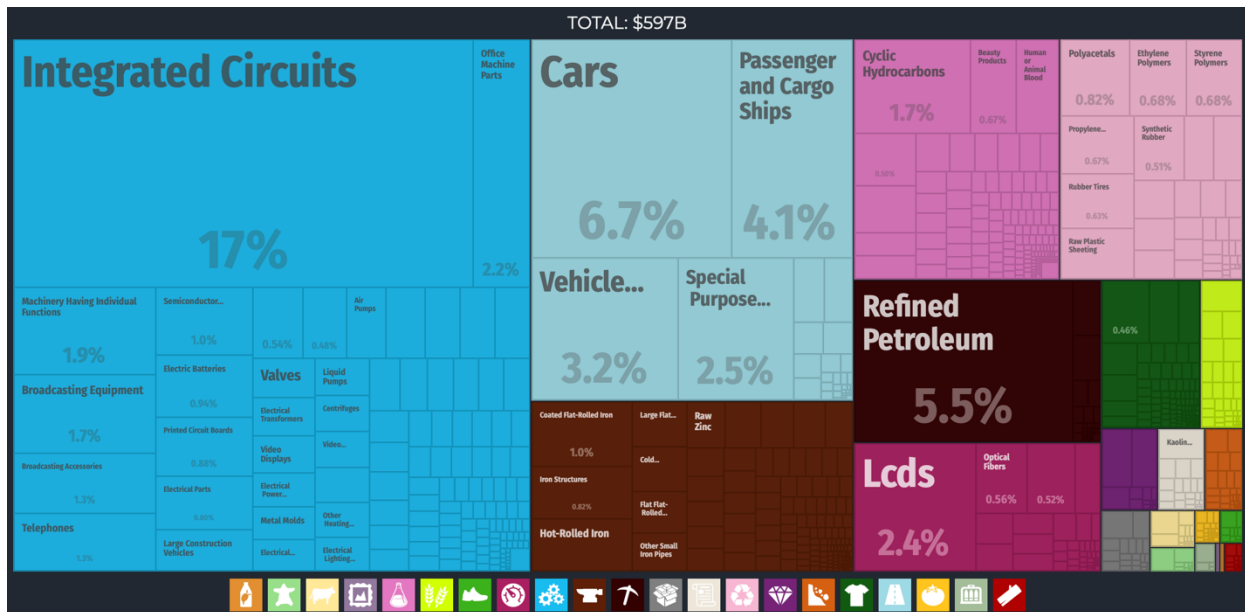
This figure shows that the major production sectors that contributed to real GDP are Manufacturing, Construction, Retail and Food Hospitality, Finance and Insurance and other sectors. As you can clearly see from the graph, manufacturing has contributed a large amount to the Korean GDP which follows by retail and food hospitality, finance and insurance, other sectors and construction provide a negative impact on GDP. The trend of manufacturing around the year 2005 to mid-2008 has fluctuated but in the small amount and slumped in the last half of 2008 due to the global economic crisis and turned back to positive again in the last quarter of the year 2009. Manufacturing performance after crisis contributed a very high growth in GDP from 2010 to 2011 and continuously slowed down. In 2015, the manufacturing sector contributed the lowest amount to GDP but there are going uptrend in the coming year. Finance and insurance sector, Retail and food hospitality sectors have been gradually increasing in recent years. For construction sectors, turning from negative impact to positive impact in 2015 and for other sectors still keep constant contribution to GDP for the whole period.

Flow of trade

Let's see which industries sectors are the main export of Korean product.

Figure 10. size of product sector which South Korea export in 2017

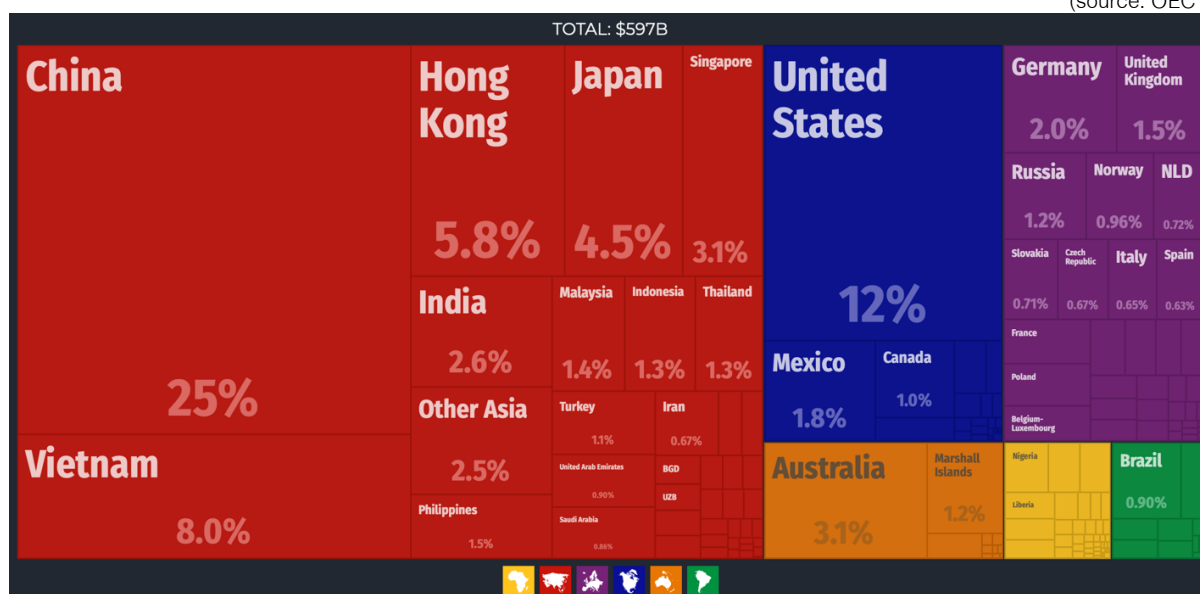
(source: OEC)



The data obtained from the OEC website show that the big 6 export product sectors of Korea are Machines (dark-blue) with 42% of total trade, follow by transportation sector (light-blue) 18%, Metals (light-brown) 8.4%, Chemical Product (pink) 7.6%, plastics and rubbers (light-pink) 6.8% and last one Mineral product (dark-brown) 6.1%. Before moving on, let's see the example of the product in each sector. In machines sector, composed of integrated circuits, telephone, machinery, broadcasting equipment, semiconductor, and electric batteries, etc. The transportation sector mainly produces cars, passenger and cargo ships, vehicle parts and special-purpose ships. Next, the metal industry, production is mostly related to iron and steel sheets like flat-rolled iron, hot-rolled iron, and large flat-rolled steel, etc. Examples of chemical products are a cyclic hydrocarbon, beauty products, disc chemicals for an electronic and cleaning product, etc. Plastics and rubbers products are many types of polymers, rubber tires, and other plastic products. Lastly, the mineral industry product is mainly refined petroleum. After knowing the example of the product of each industry sector, it gives a clearer image of what's Korea is doing.

Figure 11. Destination of product which South Korea export to in 2017

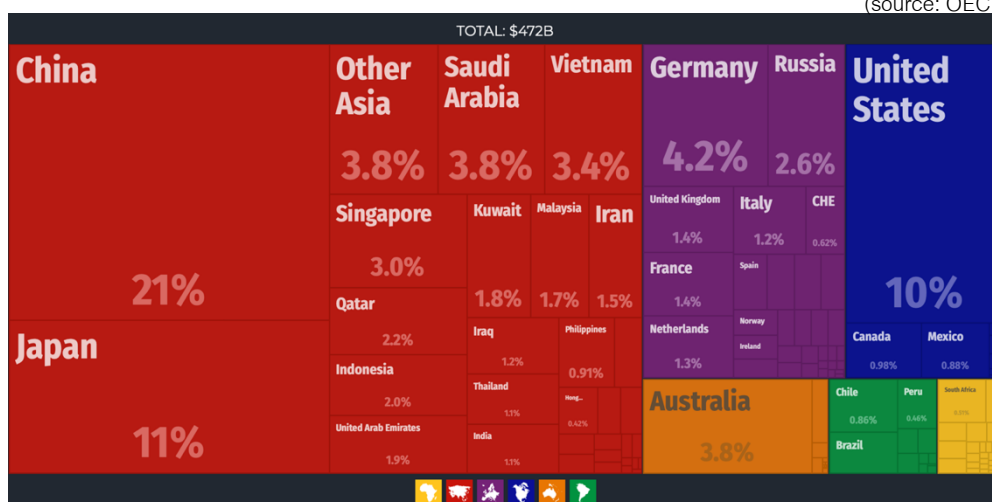
(source: OEC)



As you can see from figure 11, Korean products, more than half of total export (63%) mainly serve Asian demand, especially to China, and follow by a similar amount of percentage in North America and Europe continent with 16% and 13% respectively. Meanwhile, Korea exports its product less to Oceania, Africa, and South America.

Figure 12. Origin of product which South Korea import from in 2017

(source: OEC)

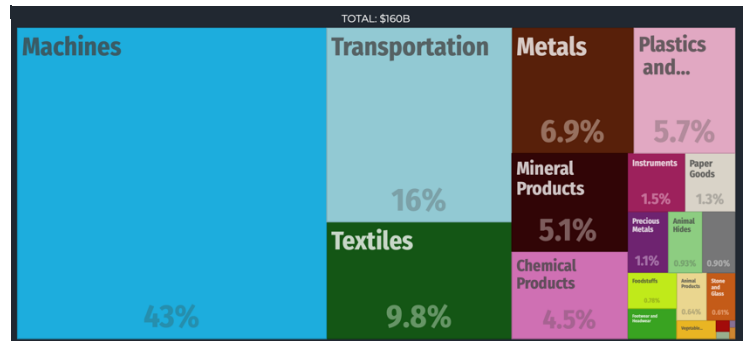


From figure 12. Showed the origin of product which South Korea import from, mostly from Asian countries. Followed by European region and North America.

If we look at figure 11 and figure 12, you will see that Korea has heavily relied on China both import and export side. Meanwhile, the importance of North America and Europe are changing depend on which side you are looking at. For export, North America is most important than Europe, but, on import side, European region is more important. However, Oceania, Africa, and South America have less contributed to both Korea import and export.

Figure 13. Show percentage of South Korea export in 2001

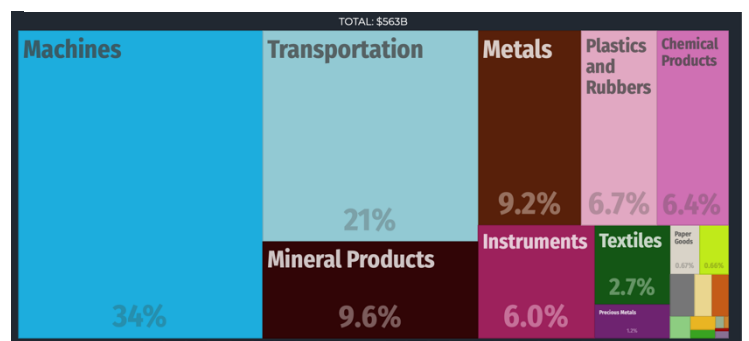
Figure 13. show the percentage of product sector that South Korea export in 2001. The top 5 products, Korea export most is Machines with almost half of total percent of exportation (43%) follow by 16% of transportation, 9.8 % of textiles product, Metals 6.9% and, Plastics and rubbers 5.7%



(source: OEC)

Figure 14. Show percentage of South Korea export in 2011

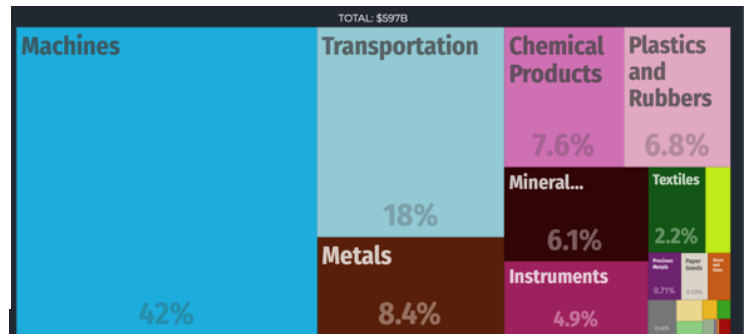
Figure 14. show the percentage of product sector that South Korea export in 2011. The top 5 products, Korea export most is machines 34%, Transportation 21%, Mineral Products 9.6%, Metal 9.2%, and 6.7% of Plastic and rubber product.



(source: OEC)

Figure 15. Show percentage of South Korea export in 2017

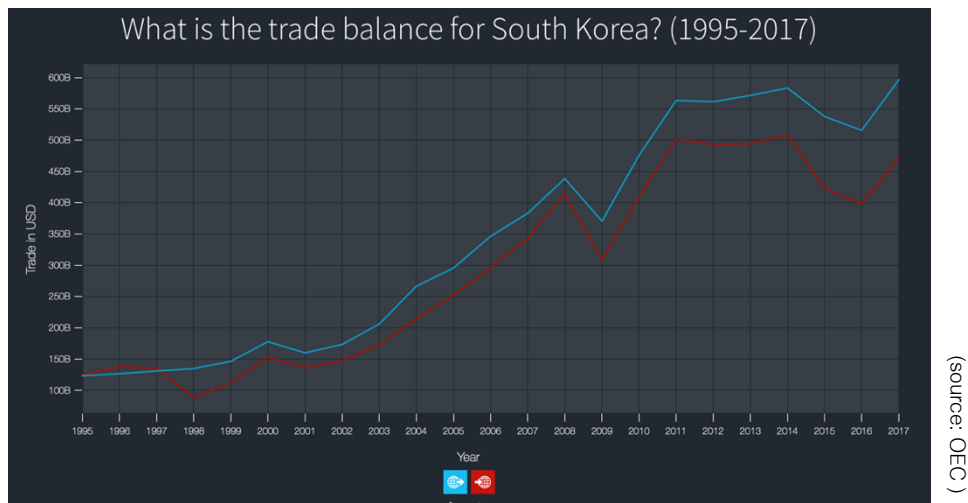
Figure 15. show the percentage of product sector that South Korea export in 2017, The top 5 products, Korea export most is Machines 42%, transportation 18%, Metals 8.4%, Chemical products 7.6%, and Plastics and rubbers 6.8%



(source: OEC)

So, let's compare the percentage of South Korea export product in 3 main years; 2001, 2011, and 2017. You can see that in all 3 years, the machines industry is the number one sector which exports a lot to the world and follows by the transportation sector. What interesting is that in the year 2001, the textile industry still be the top export sector but after 10 years, in the year 2011, the textile sector has a lower share of export which not even in the top6 of Korea export products. In the year 2011, the mineral sector become the 3rd largest share of a country export product instead of textile but, however, it has to lose to the metal sector in the year 2017 share of the export product. Which Metal industry ever be the 4th largest share in 2011. After 2011, the chemical product sector and plastics and rubber sector play a more significant role in Korea export products.

Figure 16. Graph of South Korea trend balance in 1995 - 2017



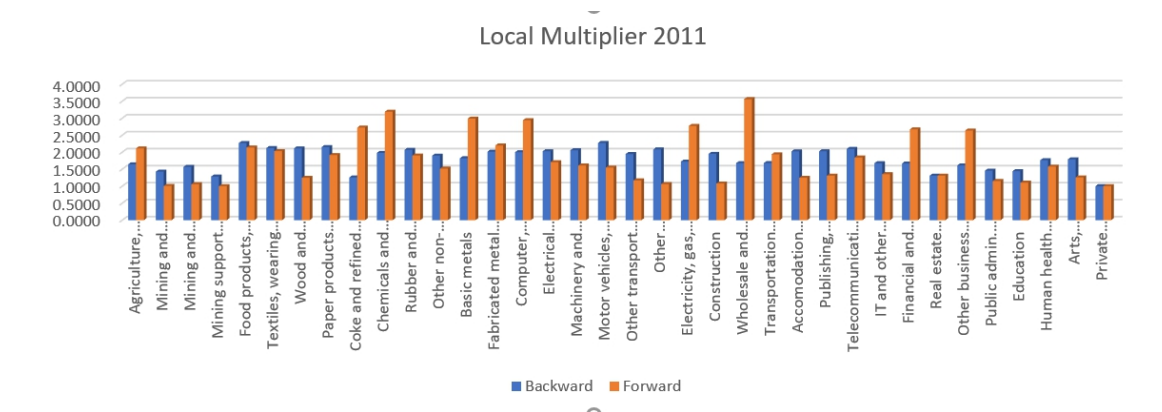
The last figure, figure16, you can see that before 1997, South Korea had trade deficit which implied it import more than export but thanks to Asian finance crisis, Korea received help from USA and other countries in term of FDI and it covert itself to become export oriented and have trade surplus after that and so on. The trend of trade balance export and import are moving along together in the same direction.

And these information above are the basic information of main industry in South Korea. Therefore, let's re-evaluate the performance of each industry on how effective these industries are measuring by various indicators.

Indicators

Domestic Backward and Forward Multipliers

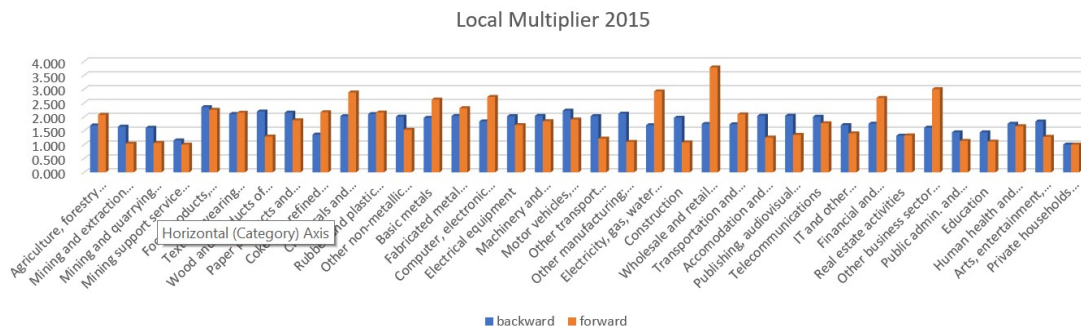
Figure 17. Domestic Backward and Forward Multipliers in 2011



Source : OECD

Backward and Forward multipliers of Korean sectors are calculated to show the relationship both domestic and international industries. Figure 17. shows domestic backward and forward linkage of local production sectors of Korea in 2011. Whereas, figure 18. shows domestic backward and forward linkage of production sectors of Korea in 2015. As you can see from the figure 17., In 2011 the sectors that have the highest local backward multipliers which imply a strong interconnection between that sectors and local suppliers are 1.Motor-vehicle trailers and semi- trailers 2.Food products, beverages and tobacco 3.Paper products and printing 4.Textiles,wearing apparel, leather and related products 5.Wood and products of wood and cork respectively. Whereas the sectors that have the highest local forward multiplier are 1. Wholesale and retail trade; repair of motor vehicles 2.Chemicals and pharmaceutical products 3.Basic metals 4.Electricity,gas,water supply, sewerage, waste and remediation services 5.Coke and refined petroleum products respectively.

Figure 18. Domestic Backward and Forward Multipliers in 2015

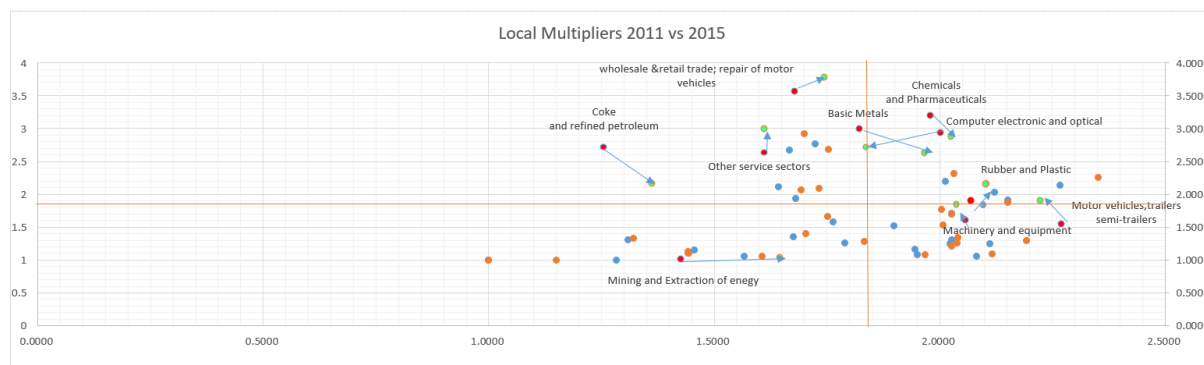


Source : OECD

Figure 18 shows the domestic backward and forward linkage of production sectors of Korea in 2015. It can be seen from the figure that the sectors that have highest backward multiplier are 1. Food products,

beverages and tobacco 2. Motor vehicle trailers and semi- trailers 3. Wood and products of wood and cork 4.Paper products and printing 5.Other manufacturing and installation of machinery and equipment respectively whereas among 36 sectors, the sectors that have the highest forward multiplier are 1.Wholesale and retail trade; repair of motor vehicles 2.Other business sector services 3.Electricity,gas,water supply, sewerage, waste and remediation services 4.Chemical and pharmaceutical products 5. Computer, electronic and optical products respectively.

Figure 19 Comparing the changes of sectors obtained from Domestic Backward and Forward Multipliers year 2011 and 2015



Source : OECD

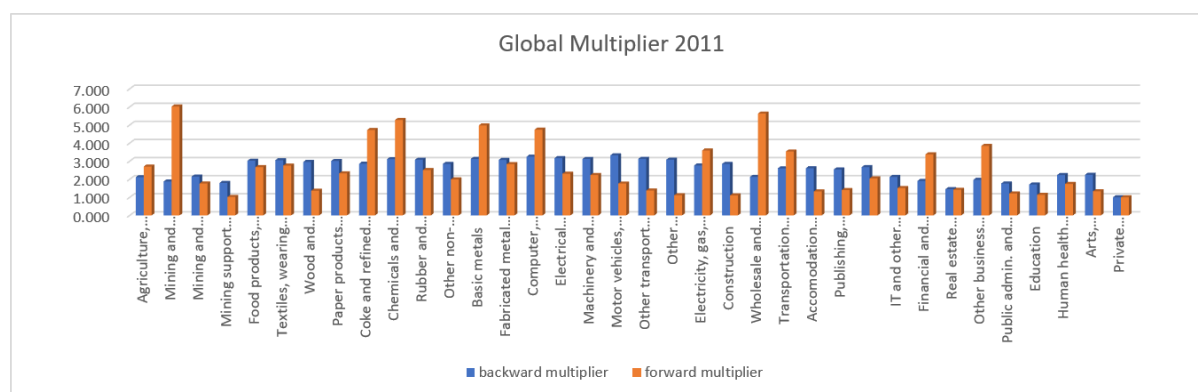
PS. The blue bubbles are the sectors in year 2011, the red bubbles are the focus sectors in year 2011, the orange bubbles are the sectors in year 2015, the green bubbles are the focus sectors in 2015

In conclusion, when comparing the domestic backward and forward multipliers of Korea in 2011 and 2015, we found that most of the sectors that have the highest local backward multipliers are soft industries which process mostly basic and raw material into intermediate goods that will be used by other industries to create more value added while the sectors that have the highest forward multiplier implied that they produced products that closely to finished goods which most industries are closely to the heavy industries that have sophistication processes. To be more concrete, we would like to introduce another criteria to compare the domestic multipliers of Korea that we used which is “the Pythagoras” to show the highest changing in multipliers the method that we used are firstly, find the difference between backward multiplier in both year as well as forward multiplier. Secondly, summation the square of both multipliers in each sector and selecting industries that has the summation higher than the average of all industries. Therefore, we got the largest changing industries which are 1.Mining and extraction of energy producing products, 2.Coke and refined petroleum products, 3.Chemicals and pharmaceutical products, 4.Rubber and plastic products, 5.Basic metals, 6.Computer electronic and optical products, 7.Machinery and equipment,8. Motor vehicles, trailers and semi-trailers, 9.Wholesale and retail trade; repair of motor vehicles, 10. Other business sector services. Furthermore, when we classify the relative change of these sector we can group them into 3 groups. Firstly, the relative highest changes in backward multiplier which are Mining and extraction of energy producing products meaning that this industry heavily extends backward supply chain therefore it will be used as a raw material. Secondly, the relative changing in forward multiplier consists of 1.Coke and refined petroleum products 2.Chemicals and pharmaceutical products 3.Basic Metals 4.Rubber

and plastic products 5.Machinery and equipment 6.Motor vehicles, trailers and semi-trailers 7.Other business sector services which means that these industries make forward length to be increased. Lastly, the relative changing in both multipliers which are 1.Wholesale & retail trade; repair of motor vehicles 2. Computer electronic and optical products which these sectors have extended both backward and forward chains.

Global Backward and Forward multipliers

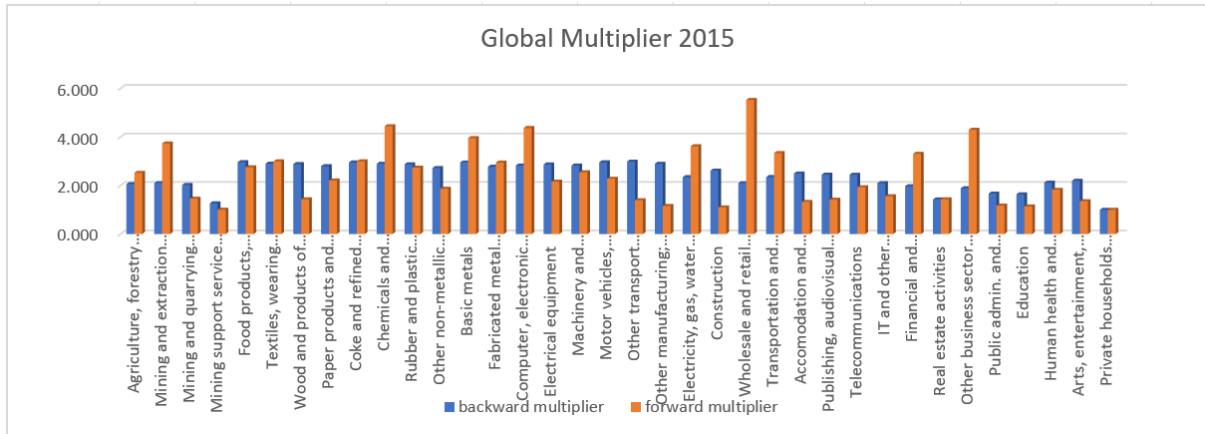
Figure 20. Global Backward and Forward Multipliers in 2011



Source : OECD

In 2011 for global backward and forward multipliers, we found that the sectors that have the highest internationally backward multiplier are 1. Motor vehicles. trailers and semi-trailers 2.Computer,electronic and optical products 3.Electrical equipment 4.Others transport equipment 5.Basic metals respectively whereas the sectors that have the highest forward multiplier are 1.Mining and extraction of energy producing products 2.Wholesale and retail trade; repair of motor vehicle 3.Chemical and pharmaceutical products 4.Basic metals 5. Computer, electronic and optical products respectively

Figure 21. Global Backward and Forward Multipliers in 2015

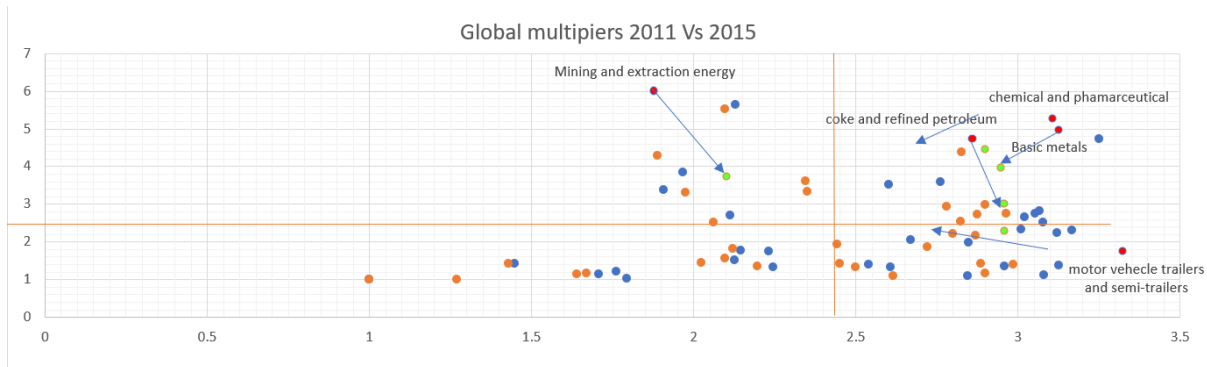


Source : OECD

In 2015, the sectors that have the highest global backward multiplier are 1.Other transport equipment 2. Food products, beverages and tobacco 3.Motor vehicles, trailers and semi-trailers 4.Coke and refined petroleum products 5.Basic metals. Whereas the sectors that have the highest global forward multiplier are 1.Wholesale and retail trade; repair of motor vehicles 2.Chemicals and pharmaceutical products 3.Basic Metals 4.Mining and extraction of energy producing products 5. Electricity, gas water supply, sewerage, waste and remediation services respectively.

To be more precise, we used the same strategy that was mentioned above to show the highest changing sectors in global multipliers which are 1.Mining and extraction of energy producing products 2.Coke and refined petroleum products 3.Chemicals and pharmaceutical products 4.Basic Metals 5.Motor vehicles, trailers and semi-trailers. Showing the relative changes of both multipliers observing from the chart, we categorized the relative changing of global multipliers into 2 groups which are 1. the relative changing in forward multiplier consists of 1.Mining and extraction of energy producing products 2.Coke and refined petroleum products 3.Chemical and pharmaceutical products 4.Basic metals which all these sectors have negative trend meaning that the forward length has been decreased therefore these sectors move closely to upstream. 2.The relative changing in both multipliers which is only Motor vehicles trailers and semi-trailers that is decreased in backward chain but increased in forward chain.

Figure 22. Comparing the changes of sectors obtained from Global Backward and Forward Multipliers in year 2011 and 2015



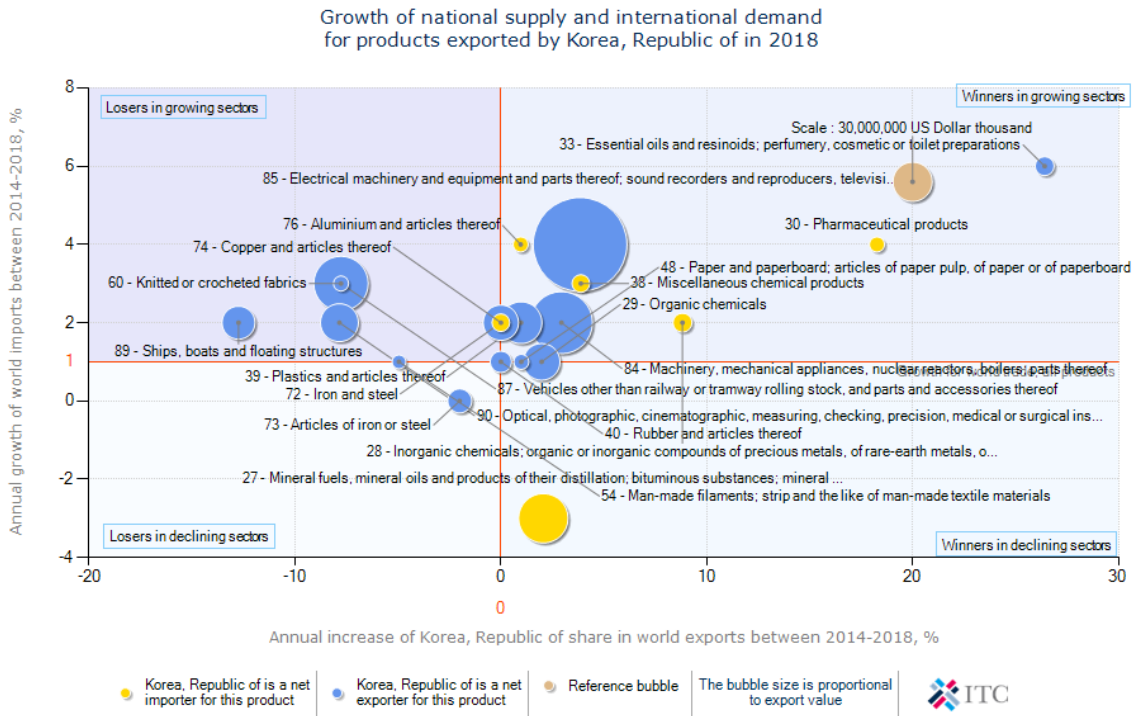
Source : OECD

PS. The blue bubbles are the sectors in year 2011, the red bubbles are the focus sectors in year 2011, the orange bubbles are the sectors in year 2015, the green bubbles are the focus sectors in 2015

In conclusion, from backward and forward multipliers, we found that global multipliers have high value than domestic multipliers from both years since they have strong interconnection to global suppliers. Moreover, from both local and global multipliers of both years, we found that 1. Mining and extraction of energy producing products 2. Coke and refined petroleum products 3. Chemical and pharmaceutical products 4. Basic metals 5. Motor vehicles, trailers and semi-trailers always ranked in the highest changing sectors therefore Korean government should focus more on these sectors especially making these sectors have a higher domestic multipliers, especially backward, because these sectors will contribute to local economy and it will create more job available and increase Korean economy.

Quadrant Analysis

Figure 23. Quadrant Analysis of Korea in 2018



Source : TradeMap

From Quadrant Analysis between 2014-2018, the horizontal axis is the annual growth in Korea while the vertical axis is annual growth of world import, we can divide into 4 boxes which are 1st quadrant (top right) that has both increased in growth of Korean export and in growth of world import which Korean government should focus on sectors that placed within this quadrant. 2nd quadrant (top left) that has increased in world import but decreased in Korea export which is a loser in growing sector. 3rd quadrant (bottom left) which has both decreased in Korea export and world import, we can call it as the loser in declining sectors. Lastly, 4th quadrant that has increased in Korea export but decreased in world import or “Winners in declining sector”. The blue bubble means the net exporter of products whereas the bright yellow bubble is the net importer of each products

Starting with the 1st quadrant, we found that the biggest blue bubble that represents electrical machinery and equipment and part e.g. sound recorder and reproducer, following by Machinery, mechanical appliances e.g. nuclear reactors boilers, Iron and steel. All sectors are heavy industries which are required sophisticated process. Since they are needed in the world market as the input therefore we would recommend Korea government to keep expanding these sectors because they still have potential to grow. Moreover, these three sectors are the main export of Korea which contribute a lot to Korean economy since we had found an evidence to support from the other criteria supporting that these sectors

are upstream business. Thus, If Korea pay more attention on these sectors, it will expand backward length which is good for economy. For three small bubbles ,relatively comparing with the reference dark yellow bubble, in this quadrant which are 1.Aluminium and articles 2.Pharmaceuticals products and 3.Organic chemicals 4.Copper and articles thereof all these sectors are imported to produce the other products as well as using as intermediate inputs to exporting sectors therefore we suggest the Korean government to pay more attention in these sectors because all these three sectors require a massive investment to gain economy of scale. Once Korea gain the “EOS” therefore it will reduce dependence in importing and gain more profit.

Following by the 2nd quadrant which is the top left box, it can be seen that 1.Vehicles other than railway or tramway rolling stock, parts and accessories sector 2. Optical, Photographic, cinematographic sector 3.Ships, boats and floating structures fell in this quadrant meaning that all of those growing sectors still having potential to grow but unfortunately Korea has lost their competitive advantages for producing them therefore we recommend them to look more closely on them by developing research and development or improving the engineering skills to bring them back into 1st quadrant because they used to be the top export sector of Korea. Another small blue bubble that located in 2nd quadrant is Knitted and crocheted fabrics which is textile industry which is the old targeted S-curve that is the reason why it located here since Korea already success in this sector and other countries try to catch up. Therefore, they decided to shift to the new S-curve which is the heavy industry therefore Korea might not currently invest a lot to improve R&D in this sector. Thus, it makes them loss in growing sectors.

The 3rd quadrant which is bottom left box that we considered as “Losers in declining sectors”. From the top 20 products, Korea didn’t have any products located in this quadrant meaning that it is good for them since they didn’t invest in the declining sectors so their capital was not used up in extravagant sectors.

Lastly, the 4th quadrant which is winner in declining sector that located in the bottom right. we found that the small blue bubbles are 1. Man-made staple fibers 2. Paper and Paper board 3. Tools, implements, cutlery, spoons and forks of base metals. We recommend Korea to focus a little because they are declining sectors which contribute a little to the Korea economy. The obvious yellow bubble that located is Mineral fuels, mineral oils and products of their distillation which are imported from abroad because Korea does not have plenty of resources and the reason that it is declining sector might be because of the clean energy that reduce less toxic that the world is now taking seriously concern.

To sum up from the quadrant analysis, Sectors that need to be more focus are sectors that located in the top right box which is the winner in the expanding sector. And Korea need to change the imported products to become the exported products to gain a higher competitiveness in the world market. Furthermore, Korea need to move all sectors that located in top left box to the 1st quadrant by heavily supporting R&D since they are the growing sectors which can positively contribute to Korea GDP.

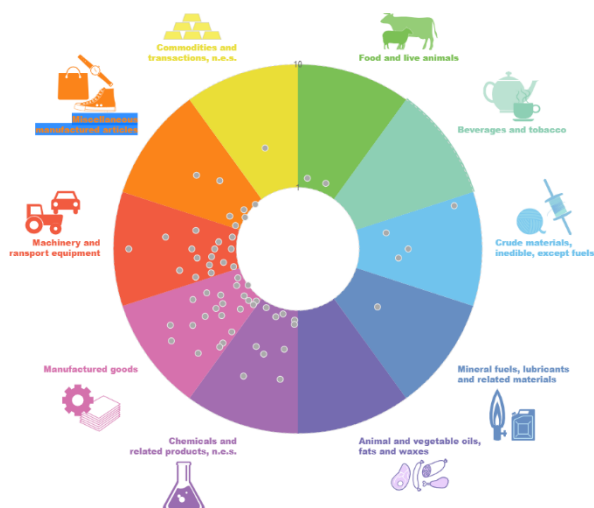
Revealed Comparative Advantage (RCA) is used to measure advantage or disadvantage in certain country and in certain class of goods and services that evidenced by trade flows.

When RCA is ≥ 1 meaning that country is inferred to be a competitive producer to export goods than the world average did. The more value of RCA, the higher strength of exporting in each product.

In this section, we got visualization that easily to understand from UNCTAD that it provided the RCA radar plots. They divided into 10 sectors which are 1. Food and live animals 2. Beverage and tobacco 3. Crude materials, inedible, except fuel 4. Mineral fuels, lubricants and related materials 5. Animal and vegetable oils, fats and waxes 6. Chemicals and related products, n.e.s. 7. Manufactured goods 8. Machinery and transport equipment 9. Miscellaneous manufactured articles 10. Commodities and transactions, n.e.s. based on SITC Rev.3

We would like to show Korea's comparative advantages for each sector in year 2000, 2010 and 2017 to show the trend that had been changed.

Figure 24. Revealed Comparative Advantage in 2000

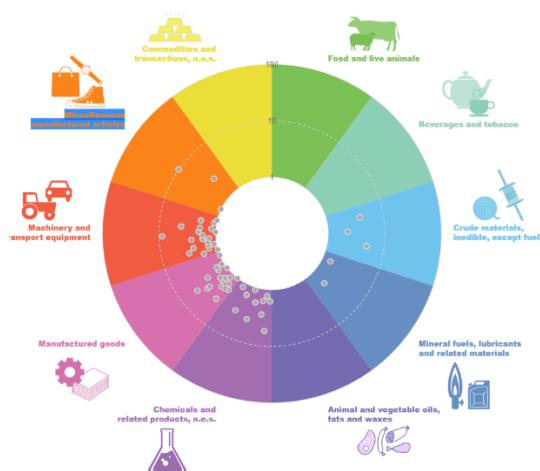


Source : UNCTADSTAT

Starting with year 2000 in figure24, showing that the highest clustering area is around Machinery and transport equipment sector and Manufactured goods to be more detailed, the highest radar plot in Machinery sector has RCA = 7.5 which is ships boats and floating structure which is the targeted S-curve at that time. Therefore, Korea is well-knows for the shipbuilding industry due to their high comparative advantage. Moving inward to the central of the circle in this sector, we found that RCA = 1.1 are 1. Radio-broadcasts receivers 2. Civil engineering and contractors' plant and equipment 3. Road motor vehicles which still had a higher comparative advantage compare to the world average. For the manufactured goods, we found that knitted or crochet fabrics had the highest RCA = 6.1 following by fabrics woven of man-made fabrics (RCA = 5.1) whereas the heavy industries had the lower RCA which are Tube, pipes (RCA = 1.2), Iron and steel bars (RCA = 1.2), structure and parts of Iron, Steel, Aluminium (RCA = 1.2) and Metal container for storage or transport had RCA =1. For the chemicals sector, The polymer of Styrene in primary form had RCA = 4.2, Hydrocarbons had RCA = 3.7 In agriculture sector, RCA was 1.2 for the frozen foods. Overall, in

2000 we found that the high RCA were in the heavy industries such as manufactured goods, chemicals and machinery and transport equipment.

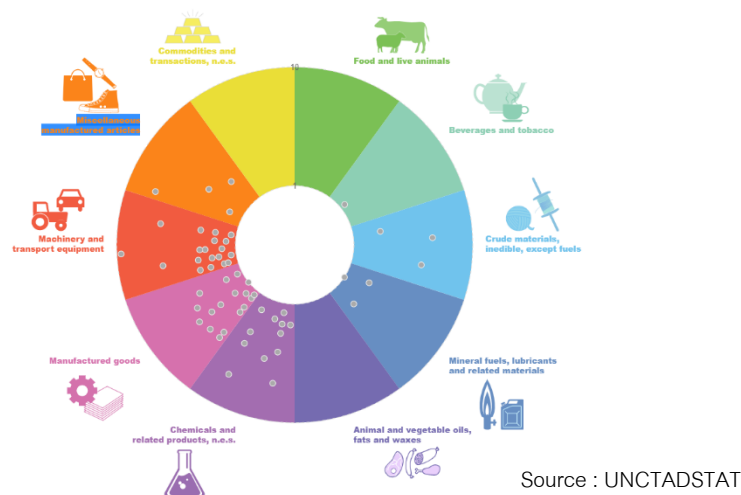
Figure 25 Revealed Comparative Advantage in 2010



Source : UNCTADSTAT

In 2010, The trends still were the same since the clustering areas of the higher RCA were around Machinery and transport sector, Manufactured goods sector and Chemicals sector. The highest RCA = 9.6 was the shipbuilding product (which improved from 2000 that RCA = 7.5) the civil engineering and contractor's plants and equipment kept increasing in RCA (from 1.1 to 2.1) as well as the machinery and transport equipment. Unfortunately, in knitted or crochet in manufactured goods the RCA decreased to 4.4 while Iron and Steel bars still were at the same. Also, the trend still was the same in chemicals sector, Polymers of styrene in primary forms still had the highest RCA = 5.1 which increased from 2000. The other chemicals product also improved but not significant. For the soft industries, agriculture and beverage, tobacco products, Korea had lost their comparative advantages in this sector since there was none of products that had RCA = 1. as well as in commodities product and animals, vegetable, oils, fats and waxes.

Figure 26 Revealed Comparative Advantage in 2017



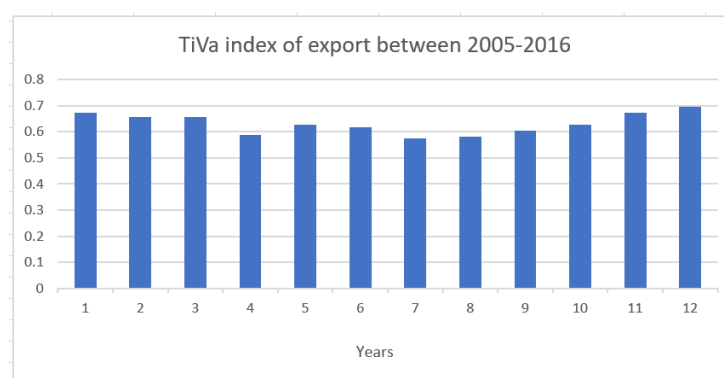
In 2017, the trend still was the same that the highest RCA was clustering around machinery and transport equipment, manufactured goods and chemicals products. For the machinery and transport equipment, the ships, boats and floating structures had RCA = 9.7 following by vapor generating boilers, the electronic equipment, parts and accessories of vehicles, sound recorders. But, the manufactured goods had been changed since knitted or crocheted fabric was no longer had the highest RCA in this sector (RCA = 2.7). Changing to flat-rolled product (RCA = 3.4), Zinc (RCA = 3.3) so they kept increasing in more heavy manufactured goods. In Chemicals sector, polymer of styrene in primary form still has the highest RCA = 5.2 followed by hydrocarbons (RCA = 4.9) and they kept innovating the chemicals products. For the soft industries, Korea still had the low comparative advantage since they didn't focus much in these sectors because they already move to the heavy industries which contributed for a higher GDP.

To sum up from the RCA, we found that the trend of Korea is a pattern because they deeply expert in shipbuilding industries, machinery and transport equipment, electronic parts, manufactured goods and chemicals products which are the main export goods of Korea since they massively invest in human capital for acquiring an engineering skills accompanied by the conglomerates of Chaebol group which most of them are in heavy industries therefore the reveal comparative advantages in those sectors are higher than the world average.

Trade in Value Added index (Tiva) is used to measure the value added by each country in the production of goods and services that are consumed by worldwide.

In this section, we would like to show Tiva of Korea from year 2005 to year 2016 to demonstrate the contribution that Korea add the domestic value to the total export. The method that we used to calculate Tiva index is using domestic valued added content of gross export divided by gross export each year. The reason why that we use this method instead of just looking the value of gross export is because the value of gross export might contain the foreign value added therefore we want to measure the “real contribution” of Korea towards export of goods and services.

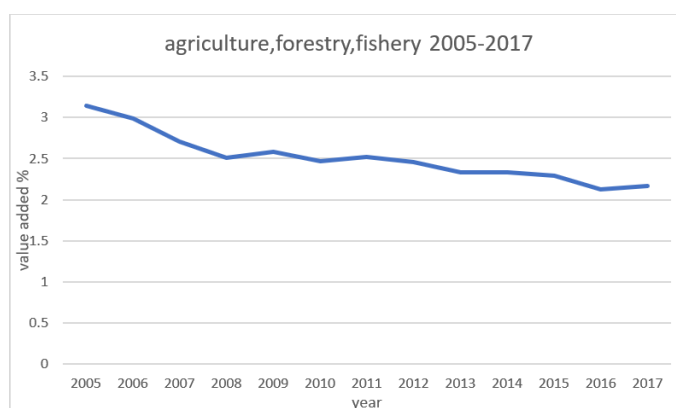
Figure 27. Trade in Value Added of export (TiVA index) between 2005-2016



Source : OECD

As you can see from the figure that from 2005 to 2016, Tiva index of Korea has surpassed 50% and the highest were around 70% in year 2016 (the latest available data) meaning that Korea has contributed effort in adding value towards the export.

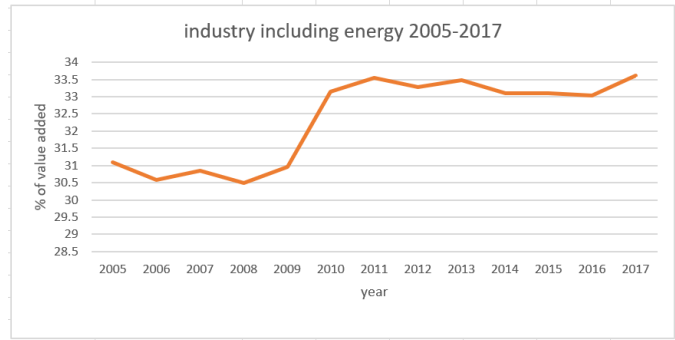
Figure 28. TiVA index of Agriculture, forestry and fishery between 2005-2017



Source : OECD

To be more specific, we would like to show the value-added trend of each sector from 2005 to 2017, starting with agriculture, forestry and fishery we found that Korea had less and less contribution of adding value to the gross export. The highest part is just around 3%

Figure 29. TiVA index of Industry including energy between 2005-2017

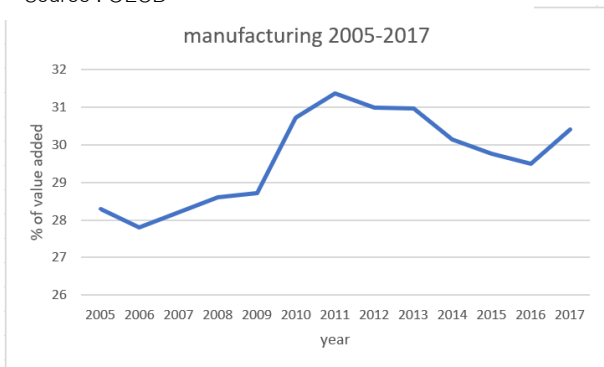


Source : OECD

Next, industrial sector including energy, we can witness that from 2005 -2009 it fluctuated around 31% and it start increasing to 33.5% through 2010-2017 comparing with agricultural sector, we found that it higher than 11 folds because Korea revolutionized their economy by starting with the industrial sector therefore, we witnessed a high value added of this sector.

Figure 30. TiVA index of Manufacturing between 2005-2017

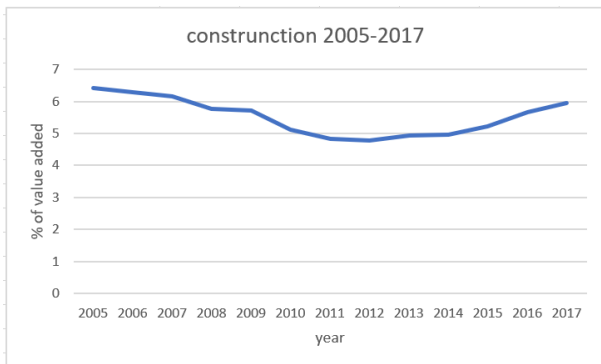
Source : OECD



Following by manufacturing sector, we found that it started increasing since 2006-2011 then it experienced declining from 2011 to 2015 (around 1%-2%) and then resumed to increase again. Overall, we witnessed the fluctuation in value added of manufacturing sector because manufacturing sector consisted of many products therefore in some period of time Korea might focus

a lot on that product but when the time passed by, other countries can capture their competitiveness therefore Korea need to switch to new products but the overall of this sector still contributed a lot of value added to the export.

Figure 31. TiVA index of Construction between 2005-2017



In construction, Korea didn't show a huge improvement, the rate was stable around 5% to 7%

Source : OECD

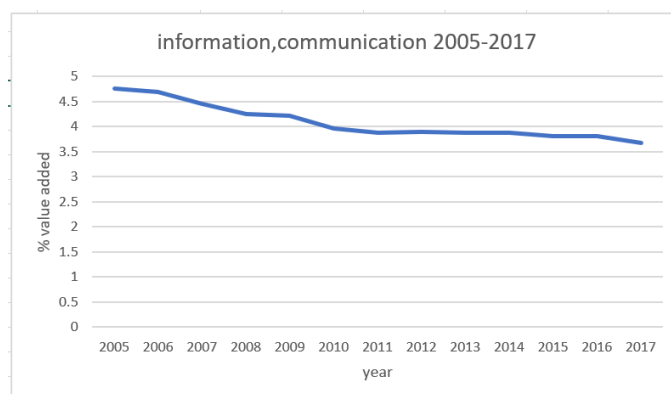
Figure 32. TIVA index of Wholesale, retail trade and repair between 2005-2017



Source : OECD

Wholesale, retail trade, repairs, transportation, accommodation, food services with all these services, Korea experienced a declining trend but still around 14% - 15% it might be because the broad category of sector that OECD computed together therefore we saw a fluctuated graph since Korea contributed just a little value added in the food services sector. Moreover, the transportation which was in between the period that Korea targeted the new industry therefore we might see a dropped valued added from them.

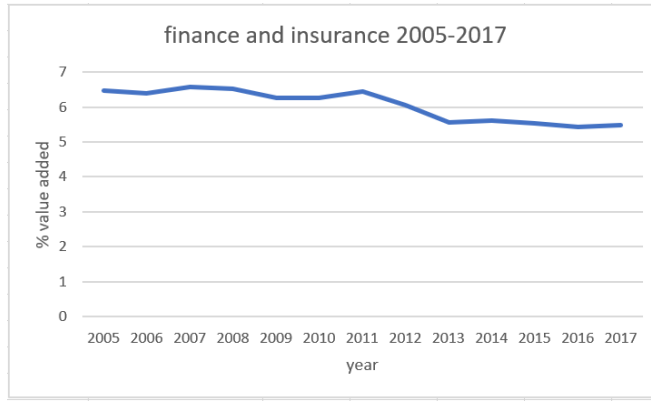
Figure 33. TIVA index of Information, Communication between 2005-2017



Source : OECD

Information, communication, Korea experienced a declining trend of value added around 3.5%-5% which surprisingly showed low value added since there are many corporates that do communication business. But if OECD provided the latest value added, we believed the figure will massively change since Korea reached that has the highest subscription on 5G accounted around 82.4% of the global total at 2 Million according to GSMA. Their process started acquiring 5G since February 2018 by getting support from Korean government through heavily subsidy for attracting 5G subscriber, more attractive tariff than 4G and compelling 5G contents that can add more value through 5G especially related to VR and AR.

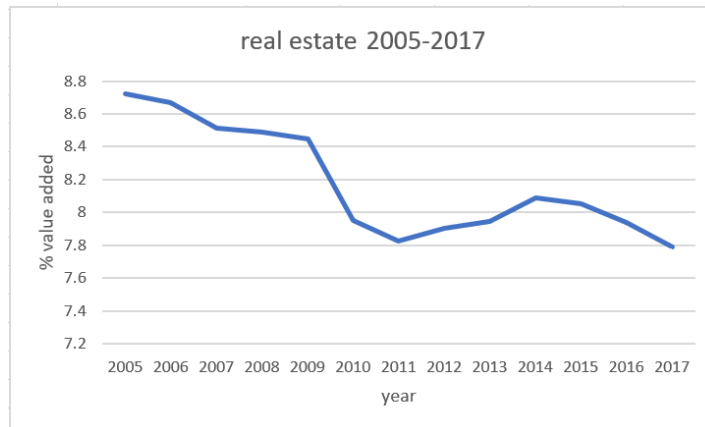
Figure 34. TIVA index of Finance and Insurance between 2005-2017



Source : OECD

Finance and insurance sector, Korea experienced the stable valued added around 5%-7% through 2005-2016.

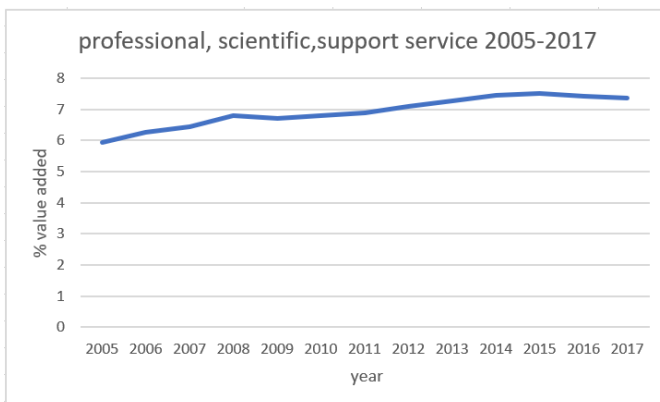
Figure 35. Tiva index of Real estate between 2005-2017



Source : OECD

Real estate, Korea experienced a declining trend but still acceptable because the valued added was around 7.8%-8.8%

Figure 36. Tiva index of Professional, scientific, support service between 2005-2017

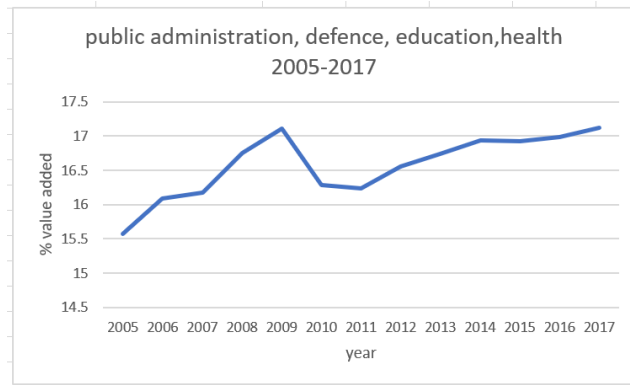


Source : OECD

Professional, scientific, support services, Korea experienced an increasing trend but just a little which was around 6%-8%. From our point of view, it gave a surprising figure to us because they had KDI and KIST which is the research and development center that is a national lab to create the new product. Moreover, Korea also have training program to the employee as an inplant-training therefore it might enhance

more value added. But this figure may be focus on the products not the value added that invest in human capita.

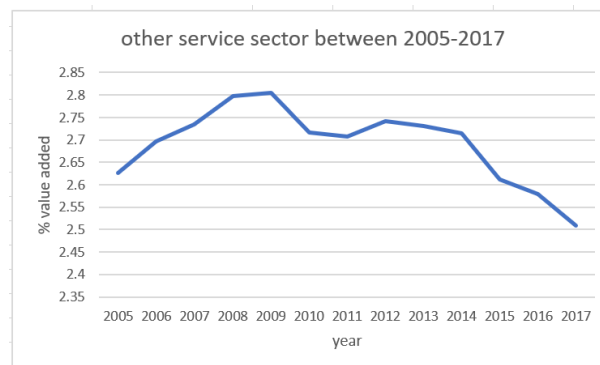
Figure 37. TIVA index of Public administration, defence, education and health between 2005-2017



Source : OECD

Public administration, defence, education, health, social work, Korea experienced an increasing trend around 15.5%-17% which was impressive for the value added in soft infrastructure since Korea government subsidized on education by providing primary school and secondary school therefore the rate of literacy labor was good.

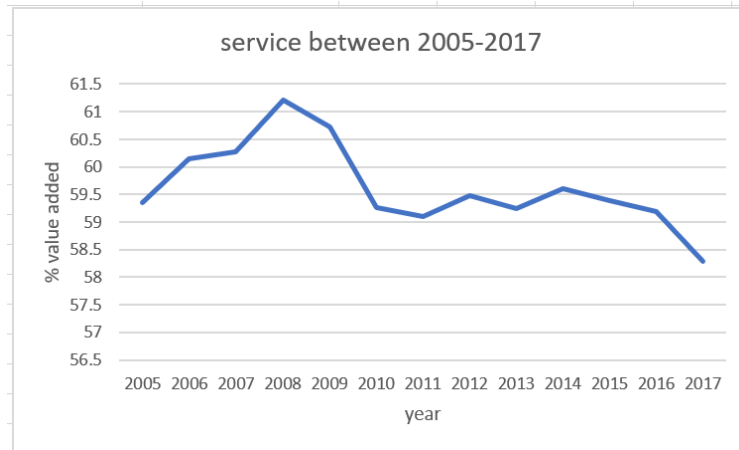
Figure 38. TIVA index of Other services between 2005-2017



Source : OECD

Other service activities, for these sections the OECD doesn't provide the definition of other service activities, but the figure gave us a declining trend and the value added fluctuated around 2.5%-2.6% each year.

Figure 39. TiVA index of Service between 2005-2017

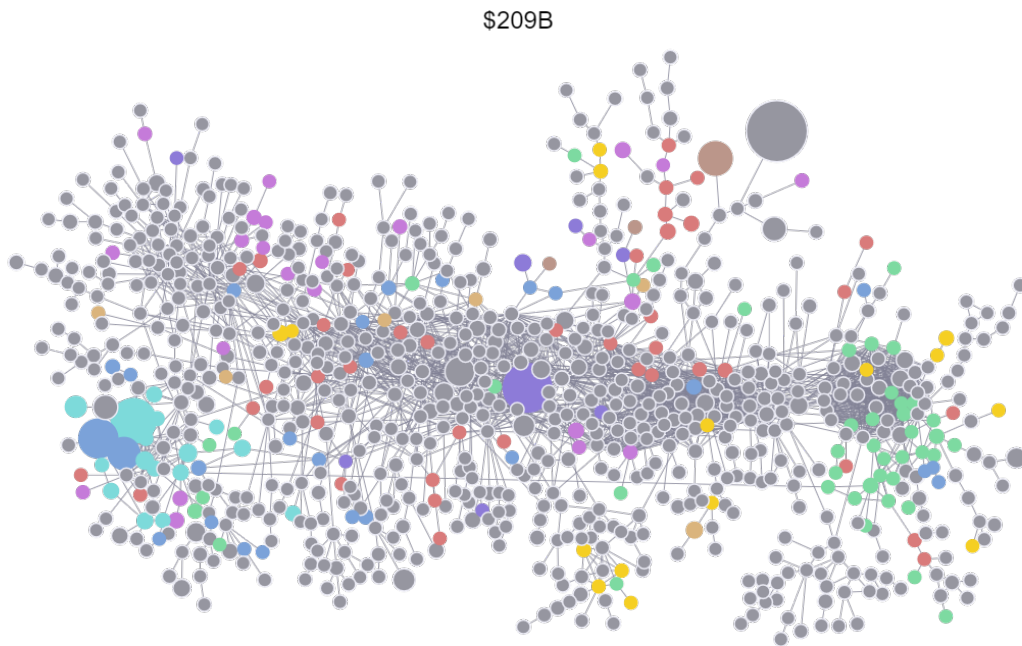


Source : OECD

Service sector, comparing to all sectors that mentioned before, this sector got the highest valued added around 58.5%-61% between 2005- 2017 and it reached a peak in 2008 which they started exporting the entertainment sector which included music, drama, movie, etc, to global therefore the major driver to force this sector to have high value added was the “entertainment industry”.

The Economic Complexity Index measures a location’s ability to enter a specific product. A product’s distance which is from 0 to 1 using to capture the network of an existing location’s capabilities to make the product as measured by how adjacently related a product is to its current export. From this section, we would like to compare 4 years which are 2000, 2011,2015 and 2017 (the latest available data) to show how closely each product was related when the time passed by. The pictures depicted the product space to show “product space” that illustrated the connection between product based on the similarities of process to produce them. The circle is a product node which represented the size of world trade which each color represented each sector. The bigger the node is, the more value of export that Korea contribute to GDP each year.

Figure 40. Complexity Index in 2000



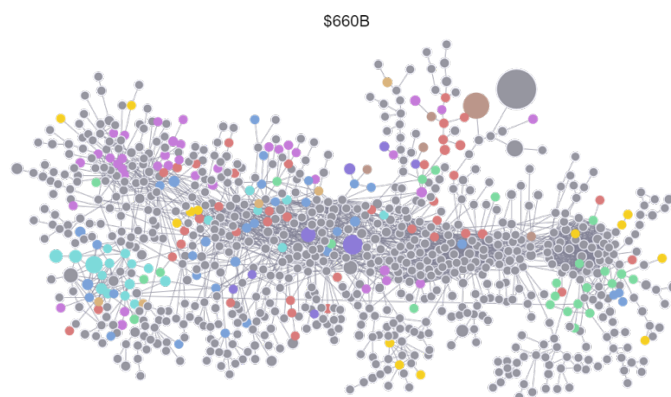
Source : ATLAS

Starting with year 2000, as we can see from the figure40, beginning with the top right of the chart. We found that the biggest node was Petroleum oils which pretty isolated since there had only one line connect with the other bubble meaning that it shared less know-how techniques that contribute to other products. The 2nd largest circle was colored by brown which is Petroleum oils, refined which was categorized in minerals product sector. But still had only one line connected to a bubble. Overall from this figure, the most concentrated area was located in the middle and pretty inclined towards to the right which meant each product shared the technique of production towards each other. At the center, obviously showed the 2 big dark purple nodes which were cars and parts of motor vehicles which had many lines connected with showing the complexity that Vehicle sector had been contributed to Korea economic. Moving towards the right of the picture, it showed how messy of nodes that connected with others, mostly are “clothing products” which is the old targeted s-curved e.g. women active wears, T-shirts and pants, socks, suits, etc.

We can see that purple and light blue bubbles spread around the picture which were chemical sector and electronics sector respectively. Mostly top left bubbles were chemical sector since those products shared the closely process of acquisition and some were used as input to produce others e.g. Petroleum rasins, Acrylics polymers, Silicones in primary forms.

For the light blue bubble spread around the bottom left of the picture which were electronics sectors e.g. Parts and accessories for video or sound equipment, Batteries, Telephone, Electronic integrated circuits. We hardly observed the green and yellow bubbles which were categorized as textiles and agriculture sectors which were soft industries that required a little sophisticated process.

Figure 41. Complexity Index in 2011



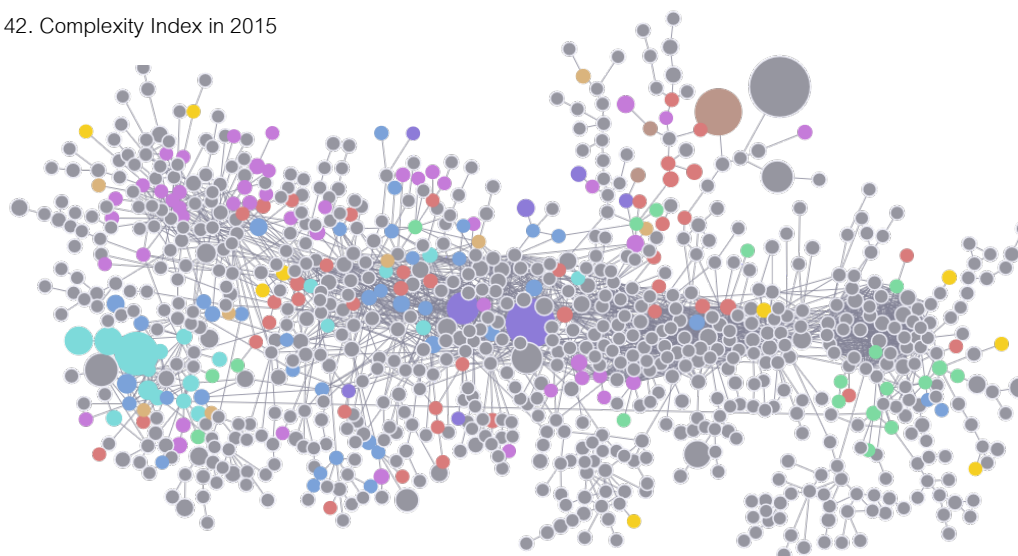
Source : ATLAS

Comparing with year 2011, it still had the same trend as year 2000 that Petroleum oils, crude were the biggest bubble but still had only one line to link with the other products.

The connection of bubbles was almost the same when comparing with year 2000 but the most obvious important point was the increasing in the metals sectors. The evidence that we could witness was the increasing of the red bubbles that spread around the picture. Although, the bottom left area was dominated by the light blue bubbles ,electronics, but the size of bubbles decreased.

\$633B

Figure 42. Complexity Index in 2015

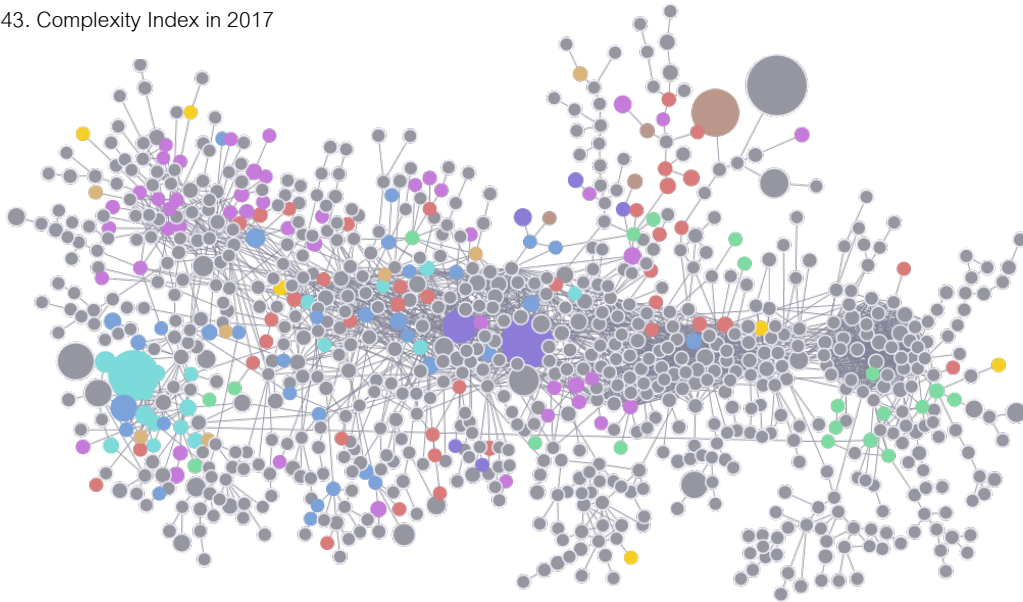


Source : ATLAS

Comparing with year 2015, the trend still almost the same but at the center of picture we could see that the vehicles sectors had been linked with many products moreover the size of cars and part of motors increased which also heavily connected with the steel and iron and Aluminium which were the main component of automotive. For the bottom left, we witnessed that the size of light blue bubbles massively increased therefore it showed the importance of electronics sectors that linked with other products which were the main export goods of Korea because of the well-known brand and good qualities.

\$689B

Figure 43. Complexity Index in 2017

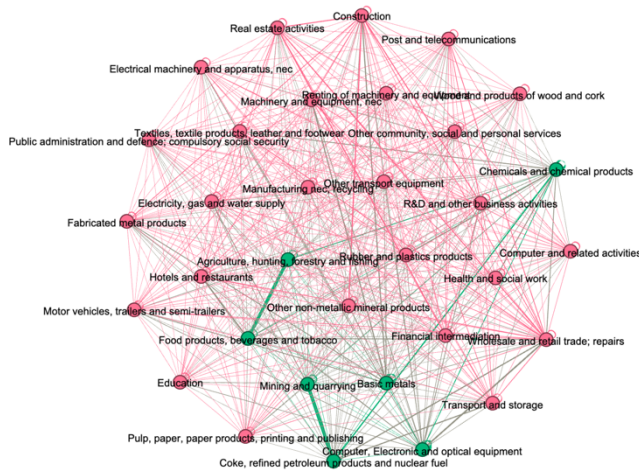


Source : ATLAS

In 2017, The trend of lines connection was still almost the same but the dark blue bubble increased meaning that the machinery sectors had been increased in terms of the connection that they had towards the others products. Moreover, we rarely found the yellow and green bubbles which were the agriculture sectors and textiles sectors respectively which were the old soft industries, old s-curve, therefore these two sectors contributed a little technique in terms of know-how sharing with other products.

In conclusion, from 2000 to 2017 the trends have been changed especially, the machinery sectors and electronics sectors that having many lines to connect with the other products meaning that they share the techniques of know-how, process of production. Which contribute a lot to Korean GDP since they are the main export goods. And another important point is that the soft industries which are textiles sectors and agriculture sectors have been decreasing in terms of value, that it contributes from trading with the world since sizes of them are getting smaller and smaller, and also decreased in the connection to

Figure 44. Network analysis in 2000



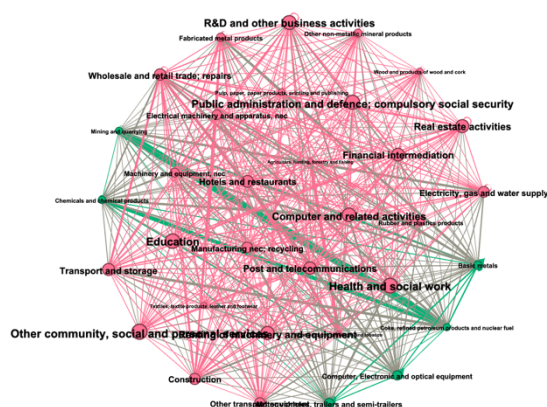
Source : world input-output database

Network analysis

For the Network analysis part, we obtain the result from Gephi that reveal patterns and trends of the data in our report, we would like to compare the trend of year 2000 and 2011 to show the trend and which sector has potential to become a new targeted industry.

Starting with year 2000, when we use degree as a criteria, we found that 1.chemicals sector, 2.Basic metals and 3.Computer, Electronic and optical equipment have the degree equal to 2 which is the highest degree meaning that they had the highest connections that each industry has towards the others industries following by 1.Agriculture,hunting, forestry and fishing 2.Food products, beverage and tobacco 3.Mining and quarrying and 4.Coke, refined petroleum products and nuclear fuel which all of these had the degree equal to 1. And the rest of the industries in data had the degree equal to 0 meaning that they had less important than the 2 subgroups that we mentioned before. When using Eigenvector centrality, we found that 1.Agriculture, hunting, forestry and fishery 2.Mining and quarrying 3. Food products, beverages and tobacco 4.Chemicals and chemical products and 5. Basic Metals get Eigenvector centrality equal to 1 meaning that these industries are the most important industries in a network based on the industry’s connections whereas the rest of industries got Eigenvector centrality equal to zero. Using Pagerank as an indicator, the more value of pagerank show how central industry within the network is , from the result we got 1. Agriculture, hunting, forestry and fishing 2.Mining and quarrying 3. Food products, beverages and tobacco got 0.091593 these industries are central within this network while the other industries got 0.013082

Figure45 : Network analysis in 2011



Source : world input-output database

In year 2011, the result from degree we got 1. Chemicals and chemical products 2. Basic metals 3. Computer, Electronic and optical equipment 4. Motor vehicles, trailers and semi-trailers got the degree equal to 2 meaning that these industries had the highest connections that each industry has towards the others industries following by 1. Mining and quarrying, 2. Coke, refined petroleum products and nuclear that got degree equal to 1 while the rest got zero degree. From Eigenvector, we found that 1. Chemicals sectors 2. Basic Metals 3. Computer, Electronic and optical equipment 4. Motor vehicles, trailers and semi-trailers 5. Mining and quarrying 6. Coke, refined petroleum products and nuclears got Eigenvector equal to 1 while the rest got 0 therefore the former groups had more important because they had a high network compare to the rest industries. When using Pagerank, we found that 1. Mining and quarrying 2. Coke, refined petroleum products and nuclear got 0.099295 meaning that these two industries are more central sectors when comparing with the other industries that got 0.014971

By comparing year 2000 and 2011, we found that the trend of a network still the same. The sector that were the central of the network are 1. Chemicals sector 2. Motor vehicles, trailers and semi-trailers and Basic metals which has many links to other industries therefore Korea government did a right way because they still targeted in these sectors since they still had potential to grow and generate the linkage which spillovers effect to other industries.

Conclusion table

Industry/indication	Electronics	Automobile	Petrochemical	Basic Metal	Retail
Sectors' share on GDP	+	+	+	+	+
Global Backward Multiplier	+ (-)	+ (-)	+ (+)	+ (-)	+ (-)
Global Forward Multiplier	+ (-)	+ (+)	+ (-)	+ (-)	+ (+)
Local Backward Multiplier	+ (-)	+ (-)	+ (+)	+ (+)	+ (0)
Local Forward Multiplier	+ (-)	+ (+)	+ (+)	+ (+)	+ (+)
TiVA	+	+	+	+	+
Quadrant Analysis	+ (++++++) Winner in growing sector	- (+) loser in growing sector	+ (+) Winner in growing sector	- (-) loser in losing sector	+ (+) Winner in growing sector
Centrality indices (Eigen vector)	+	+++	+	+	0
Modularity index	++	++	+	+	+++
Complexity analysis	+++	+ +++++	+	++	++

+ (+) : increase in faster

+ (-) : increase in slower growth rate

Policy Recommendation

From this analysis, we would like to recommend Korea to keep continuing support these major industries since the evident that we obtained indicating these major industries still have potential to grow. The criteria that we would like Korean government to take a deeply focus on is the domestic backward multiplier since it will contribute to Korean economy, especially basic metal and mineral sector which currently close to the upstream business and they will involve many stakeholders. Not only benefit for them but still benefit for the intermediaries participants since they used it as the intermediaries input to produce their product therefore it increased the valued added of products. From Quadrant analysis, we found that automobile industry located in the second quadrant which mean Korea automobile industry are losing in the growing sector that still has potential to grow and massively generate the spillover effects since to produce one car it combined around 5000 parts which can confirm by complexity analysis implying that automobile sector have high level of technical sharing which can be used and adapted with other sectors. To kill 2 birds with one stone, supporting automobile industry also support basic metals industry especially steel sector which is the main component to produce cars and also being the sector that Korea has a competitiveness over time.

For the next S-curves that Korea would like to target consisting of 5 industries which are firstly, electric self-driving vehicle. Secondly, Internet and telecommunication. Thirdly, Bio-health. Fourth, New engines/semi-conductors and displays. In our point of views, we suggest Korea to start with the Internet and telecommunication and new engines/semi-conductors because Korea are currently doing well on that sectors since the government promised to roll out the free public WIFI in the public places including public transportation as well as they got the highest subscription users on 5G among the world. Moreover, Korea is the first country that reached 100% coverage of LTE therefore, the nationwide LTE coverage ensures to connect with a high speed anywhere. Furthermore, these sector also has spillover effects that generate to many services which related with 5G such as video game, social application in new formats especially VR and AR, enhancing professional broadcasting services and being partnership with global game developers and content creator to develop the content such as e-sport industry therefore this internet and telecommunication plays the important roles as a central sectors to create many jobs. The next step that we would like to suggest Korea government is the electric self-driving vehicle since automobile sector is our major export product and we also have competitiveness in electronic sector due to the high capabilities of engineering , therefore, to produce a new self-driving vehicle might not be the things that impossible. But before going to that stage, we would like Korea to start step by step to produce fully electronic vehicle first, since Korea also got the competitive in Basic metals sector which Lithium is required to produce battery which is a main component of electric vehicles. Then, following by the self-driving and robotic since we got stronger and stable internet and telecommunication . From the president Park's speech that he would like to boost the service sectors which contributed a large amount to GDP so the President would like to massively invest in the area such as medical care, tourism. Thus, it would be the challenges for

Korea to enhancing their capabilities in Bio-health sector due to the advance of technology and the well-known of telecommunication sector and medical care products, Korea might start from inventing robotic medical machine to increase the accuracy rate in the treatment and Korea can increase their GDP by becoming a hub of medical tourist.

Appendix 3: Table shows domestic valued added of gross export and total value of gross export

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
domestic valued added of gross exports	216,361.4	240,631.6	280,622.0	285,813.3	260,726.3	325,686.8	374,499.3	388,412.9	414,279.7	433,035.1	413,178.2	402,770.8
gross exports	321,539.7	365,614.9	427,496.3	485,982.9	414,824.2	526,915.2	650,411.3	669,623.5	684,539.2	691,070.2	612,884.8	578,440.6

Source : OECD

Appendix4: Trad in value added by each sector

sector/year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
agriculture,forestry,fishery	3.147	2.989	2.709	2.508	2.588	2.471	2.517	2.459	2.336	2.329	2.291	2.123	2.163
industry including energy	31.09	30.57	30.85	30.49	30.97	33.15	33.54	33.28	33.48	33.1	33.1	33.03	33.62
manufacturing	28.28	27.81	28.2	28.6	28.72	30.72	31.37	31	30.97	30.15	29.76	29.49	30.41
construction	6.41	6.29	6.16	5.78	5.71	5.12	4.84	4.79	4.93	4.96	5.23	5.66	5.94
wholesale, retail trade, repairs, information,communication	15.25	15.35	15.38	15.6	15.19	15.27	15.14	15.21	15.12	14.95	14.93	15	14.37
finance and insurance	4.75	4.684	4.455	4.252	4.211	3.962	3.87	3.897	3.882	3.876	3.811	3.804	3.67
real estate	6.48	6.4	6.57	6.52	6.26	6.26	6.44	6.06	5.56	5.6	5.53	5.44	5.47
professional, scientific,support service	8.721	8.667	8.516	8.49	8.445	7.95	7.828	7.905	7.944	8.086	8.051	7.939	7.792
public administration, defence, edu,health	5.952	6.286	6.452	6.801	6.719	6.807	6.883	7.098	7.271	7.45	7.512	7.438	7.356
other service sector	15.57	16.09	16.17	16.75	17.11	16.29	16.24	16.56	16.74	16.94	16.93	16.99	17.12
service	2.626	2.697	2.735	2.798	2.804	2.717	2.707	2.742	2.73	2.715	2.612	2.58	2.508
	59.36	60.15	60.28	61.21	60.73	59.26	59.1	59.47	59.25	59.61	59.38	59.19	58.28

Source :OECD

Appendix 4: Gephi table of year 2000

Sector	Degree	Weighted Degr	Eccentricity	closeness	central	harmonic	closeness	Authority	Hub	modularity	clustering	pageranks	component	hub	centrality
Agriculture, hunting, forestry and fishing	1	23302.09912	1	1	1	1	1	0.5	0.5	1	0.091593	0	1		
Mining and quarrying	1	24752.90078	1	1	1	1	0.5	0.5	0.5	0	0.091593	1	1		
Food products, beverages and tobacco	1	23302.09912	1	1	1	1	0.5	0.5	0.5	1	0.091593	0	1		
Textiles, textile products, leather and footwear	0	0	0	0	0	0	0	0	0	2	0.013802	2	0		
Wood and products of wood and cork	0	0	0	0	0	0	0	0	0	3	0.013802	3	0		
Pulp, paper, paper products, printing and publish	0	0	0	0	0	0	0	0	0	4	0.013802	4	0		
Coke, refined petroleum products and nuclear fu	1	24752.90078	1	1	1	1	0.5	0.5	0.5	0	0.091593	1	1		
Chemicals and chemical products	2	42273	0	0	0	0	0	0	0	5	0.013802	5	1		
Rubber and plastics products	0	0	0	0	0	0	0	0	0	6	0.013802	6	0		
Other non-metallic mineral products	0	0	0	0	0	0	0	0	0	7	0.013802	7	0		
Basic metals	2	66328	0	0	0	0	0	0	0	8	0.013802	8	1		
Fabricated metal products	0	0	0	0	0	0	0	0	0	9	0.013802	9	0		
Machinery and equipment, nec	0	0	0	0	0	0	0	0	0	10	0.013802	10	0		
Computer, Electronic and optical equipment	2	86579.60156	0	0	0	0	0	0	0	11	0.013802	11	1		
Electrical machinery and apparatus, nec	0	0	0	0	0	0	0	0	0	12	0.013802	12	0		
Motor vehicles, trailers and semi-trailers	0	0	0	0	0	0	0	0	0	13	0.013802	13	0		
Other transport equipment	0	0	0	0	0	0	0	0	0	14	0.013802	14	0		
Manufacturing nec: recycling	0	0	0	0	0	0	0	0	0	15	0.013802	15	0		
Electricity, gas and water supply	0	0	0	0	0	0	0	0	0	16	0.013802	16	0		
Construction	0	0	0	0	0	0	0	0	0	17	0.013802	17	0		
Wholesale and retail trade; repairs	0	0	0	0	0	0	0	0	0	18	0.013802	18	0		
Hotels and restaurants	0	0	0	0	0	0	0	0	0	19	0.013802	19	0		
Transport and storage	0	0	0	0	0	0	0	0	0	20	0.013802	20	0		
Post and telecommunications	0	0	0	0	0	0	0	0	0	21	0.013802	21	0		
Financial intermediation	0	0	0	0	0	0	0	0	0	22	0.013802	22	0		
Real estate activities	0	0	0	0	0	0	0	0	0	23	0.013802	23	0		
Renting of machinery and equipment	0	0	0	0	0	0	0	0	0	24	0.013802	24	0		
Computer and related activities	0	0	0	0	0	0	0	0	0	25	0.013802	25	0		
R&D and other business activities	0	0	0	0	0	0	0	0	0	26	0.013802	26	0		
Public administration and defence; compulsory s	0	0	0	0	0	0	0	0	0	27	0.013802	27	0		
Education	0	0	0	0	0	0	0	0	0	28	0.013802	28	0		
Health and social work	0	0	0	0	0	0	0	0	0	29	0.013802	29	0		
Other community, social and personal services	0	0	0	0	0	0	0	0	0	30	0.013802	30	0		

Source : world input-output database

Appendix 5: Gephi table of year 2011

Sector	Degree	Weighted Degr	Eccentricity	closeness	centrality	harmonic	clustering	Authority	Hub	modularity	clustering	pageranks	component	thrust	centrality
Agriculture, hunting, forestry and fishing	0	0	0	0	0	0	0	0	0	0	0	0.014971	0	0	0
Mining and quarrying	1	89554.50156	1	1	1	1	0.707107	0	0.707107	5	0.099295	0.014971	1	1	1
Food products, beverages and tobacco	0	0	0	0	0	0	0	0	0	1	0.014971	0.014971	2	2	0
Textiles, textile products, leather and footwear	0	0	0	0	0	0	0	0	0	2	0.014971	0.014971	3	3	0
Wood and products of wood and cork	0	0	0	0	0	0	0	0	0	3	0.014971	0.014971	4	4	0
Pulp, paper, paper products, printing and publishing	0	0	0	0	0	0	0	0	0	4	0.014971	0.014971	5	5	0
Coke, refined petroleum products and nuclear fuel	1	89554.50156	1	1	1	1	0.707107	0	0.707107	5	0.099295	0.014971	1	1	1
Chemicals and chemical products	2	145323.5938	0	0	0	0	0	0	0	6	0.014971	0.014971	6	6	1
Rubber and plastics products	0	0	0	0	0	0	0	0	0	7	0.014971	0.014971	7	7	0
Other non-metallic mineral products	0	0	0	0	0	0	0	0	0	8	0.014971	0.014971	8	8	0
Basic metals	2	294858	0	0	0	0	0	0	0	9	0.014971	0.014971	9	9	1
Fabricated metal products	0	0	0	0	0	0	0	0	0	10	0.014971	0.014971	10	10	0
Machinery and equipment, nec	0	0	0	0	0	0	0	0	0	11	0.014971	0.014971	11	11	0
Computer, Electronic and optical equipment	2	218785.7969	0	0	0	0	0	0	0	12	0.014971	0.014971	12	12	1
Electrical machinery and apparatus, nec	0	0	0	0	0	0	0	0	0	13	0.014971	0.014971	13	13	0
Motor vehicles, trailers and semi-trailers	2	116832.2031	0	0	0	0	0	0	0	14	0.014971	0.014971	14	14	1
Other transport equipment	0	0	0	0	0	0	0	0	0	15	0.014971	0.014971	15	15	0
Manufacturing nec; recycling	0	0	0	0	0	0	0	0	0	16	0.014971	0.014971	16	16	0
Electricity, gas and water supply	0	0	0	0	0	0	0	0	0	17	0.014971	0.014971	17	17	0
Construction	0	0	0	0	0	0	0	0	0	18	0.014971	0.014971	18	18	0
Wholesale and retail trade; repairs	0	0	0	0	0	0	0	0	0	19	0.014971	0.014971	19	19	0
Hotels and restaurants	0	0	0	0	0	0	0	0	0	20	0.014971	0.014971	20	20	0
Transport and storage	0	0	0	0	0	0	0	0	0	21	0.014971	0.014971	21	21	0
Post and telecommunications	0	0	0	0	0	0	0	0	0	22	0.014971	0.014971	22	22	0
Financial intermediation	0	0	0	0	0	0	0	0	0	23	0.014971	0.014971	23	23	0
Real estate activities	0	0	0	0	0	0	0	0	0	24	0.014971	0.014971	24	24	0
Renting of machinery and equipment	0	0	0	0	0	0	0	0	0	25	0.014971	0.014971	25	25	0
Computer and related activities	0	0	0	0	0	0	0	0	0	26	0.014971	0.014971	26	26	0
R&D and other business activities	0	0	0	0	0	0	0	0	0	27	0.014971	0.014971	27	27	0
Public administration and defence; compulsory social security	0	0	0	0	0	0	0	0	0	28	0.014971	0.014971	28	28	0
Education	0	0	0	0	0	0	0	0	0	29	0.014971	0.014971	29	29	0
Health and social work	0	0	0	0	0	0	0	0	0	30	0.014971	0.014971	30	30	0
Other community, social and personal services	0	0	0	0	0	0	0	0	0	31	0.014971	0.014971	31	31	0

Source : World Input-output database

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