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An economic observation of South Korea's manufacturing and service sectors through the lens of Input Output, Theil index, and Employment analyses

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Abstract

Using the data from the World Input Output Database, this paper attempts to further the understanding of recent economics performance of South Korea and contribute to the existing literature regarding the distributive effects of trade. By analyzing the interconnectedness of South Korea industrial sectors, applying wage and employment analysis, calculating employment change Due to Trade, the paper determine that South Korea possesses developed and interconnected manufacturing sectors. Moreover, the modern economy of Korea is facing increasing wage inequality between manufacturing and service workers and wage stagnation of some service sectors. The service sectors of the country are also characterized by increasing in the amount of working population and highly sensitive to employment change due to trade. As such, the paper suggests South Korea implements policies increasing productivity, by eliminating low skill jobs, combining with invested and qualified education and retraining programs in order to diversify new employment and improving wage inequality in the economy.

I, Introduction

After the Korean War (1950-1953) and until the Asia Financial Crisis (1997-1998)[2], The Republic of Korea (South Korea), by implementing an export-oriented economic model, has experienced a period of rapid economic development, transformed itself from an agrarian society to nowadays Asian Tiger. The incredible growth period, which is divided into 4 generalized phases: State Building (1948-1959), Export promotion and Industrialization (1960-1979), Stabilization and Liberalization (1980-1997)[3], is often cited as The Miracle on The Han River. It is a miracle in the sense that in a span of three decades the country achieve the kind of structural transformation, with a degree of relatively equitable income distribution that took today's industrialized countries almost a century to accomplish. However, after the Asia Financial Crisis until the modern day, the economy of South Korea has observed slow and decreasing economic growth. Which begs the question: why the slowdown of economics performance during the last 20 years?

Figure 1 shows that the real monetary values of exports of goods and services has been experiencing continuous increasing trend. Though not visible from the graph, from 1960 to 1980, the quantity of exports has increased by approximately 100 folds to around 20,000 billion Wons. The amount of goods and services exports also has expanded by 10 times to approximately 220,000 billion Wons and more than 3 times to 800,000 billion Wons from 1980 to 2000 and 2000 to 2018, respectively. Figure 2 shows that the average growth rate of real gross domestic product (GDP) during the 1960-1980 and 1980-2000 periods are incredibly high (9.45 percent and 8.63 percent on average, respectively). In contrast, the growth rate of South Korea after 2000 (average 3.85 percent) is less than half the figure for previous periods and possesses a decreasing

trend. Figure 1 and 2 can be said to partially show the disconnection of increasing exports and economy growth.

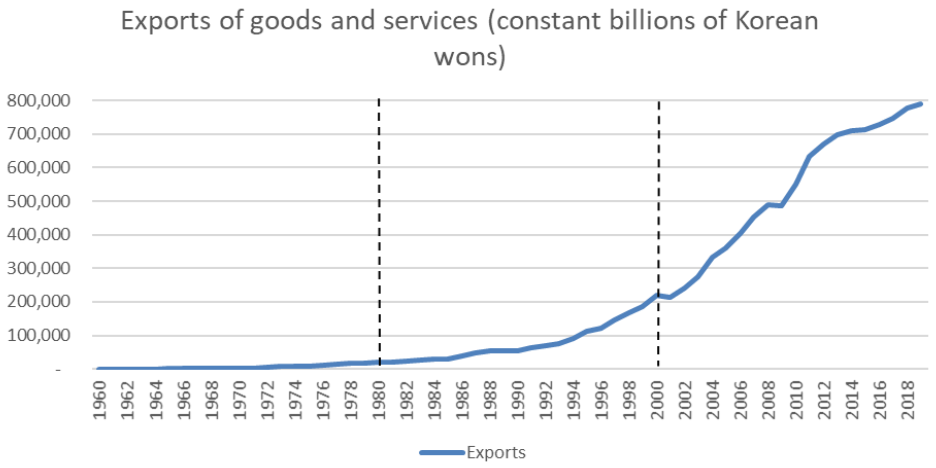
Throughout the years there have been much literature attempting to explain the success of the Korea economy. To begin with, Kwan S. Kim (1991) has provided a general explanation of the rapid growth and a critical examination of the nation industrial policies, and these policies consequences in development. The author also analyzed the framework of the export driven development model by focus on sector targeted and macroeconomics policies in the field of foreign trade and investment, financing and credits, public and private sectors, and technological development.

Park JD. (2019), in his view, expressed the essence of the Korean export led model of economics development can be broken down into 4 fundamental cornerstones: land reform, empowerment of the people, revolution in education, and governmental reform. He also stressed the important of the formation and evolution of social mindset and action-oriented campaigns, playing a critical role in Korea's overall development.

Chowdhury & Islam (1993) and Vogel (1991) have also pointed out that the Confucius influences on South Korea acts as contributory factors to economic improvement, which can be seen in its strong ethical and moral basis of government, its justification of hierarchical political systems, its demand for consensus and conformity, its community-like industrial organization and its co-operation between government and corporate interests.

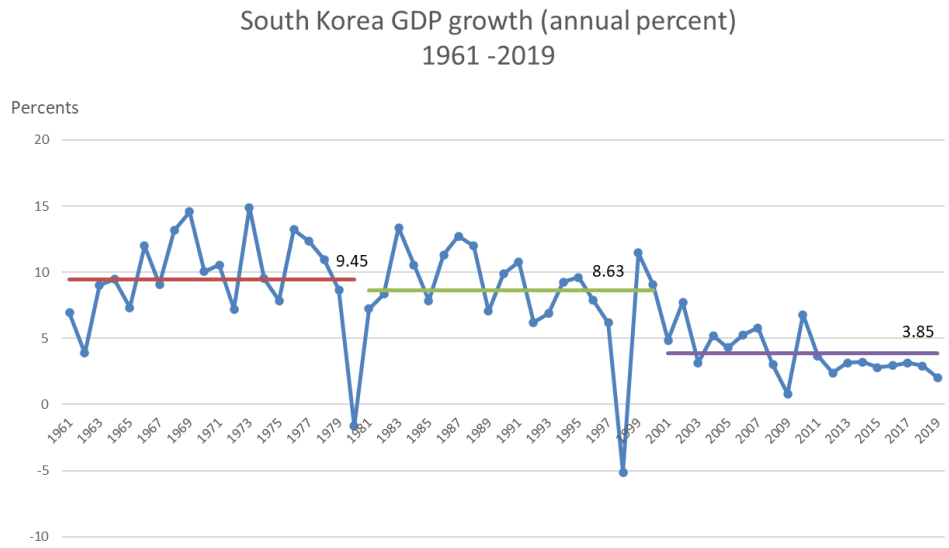
Moreover, other authors like Chang (1993) and Amsden (1989) emphasizes the strong state in Korea, with highly respected and qualified bureaucrats having the ability to discipline firms, played a central role in economic expansion.

Figure 1. Exports of goods and services (constant billions of Korean wons)



Source: Author's construction using data from the World Bank (World Development Indicator)

Figure 2. South Korea GDP Growth (annual percent) 1961 - 2019



Source: Author's construction using data from the World Bank (World Development Indicator)

All these authors have tried to explain the economics advancement of South Korea, its ability to reach the rank of industrialized, developed countries within such short period of time. This study, however, is not involved itself within the miracle on The Han River period, but rather focusing on data analysis of the distributive dimension of trade to employment and workers earning for the period after rapid economic development or the period from 2000 to 2014. Hence, it attempts to contribute to the existing literature regarding the distributive dimension of trade and further understanding Korea's recent economic performance.

This paper focuses on manufacturing and service sectors for 3 reasons:

- The fact that manufacturing and service sectors employs the vast majority of South Korea's workers, with the number of people working for agriculture and mining sectors is miniscule.
- Manufacturing has been at the center of Korea export led economic development and is the spearhead of the South Korea economy. [4]
- Service sectors although do not possesses much trade expansion within the studied period, have been observed to have the most extreme trade expansion employment effects.

In academia, there have been various theories supporting a relationship between demand of exports with domestic production and employment. As pointed out by Gibson (2011), because total employment depends on aggregate demand multiplied with employment per unit of output (or labor coefficient), combine with the fact that export forms one of the factors of aggregate demand in Keynesian economics; thus, establishing a connection between total employment and exports. More interestingly, Gibson (2011) also shows that, though employment creation has an

inverse direct effect with productivity growth, productivity can compensate employment creation by indirectly increase rate of growth of output (a component of employment creation).

As trade can affect employment through labor productivity and aggregate demand. The labor productivity effects from trade can be caused by the economy sectorial transitioning from labor to capital intensive sectors (or vice-versa). Moreover, because productivity is closely related to investment, growth, and technical change (improve in technology happens closely with sectorial expansion), hence, trade through affecting investment, growth, and technological advancement opportunities, can influence the rate of change of productivity and employment. (Gibson, 2011)

Moreover, with Keynesian economics, economic prosperity and aggregate demand can be driven up by the increasing in purchasing power of domestic consumers (through increase in wages, etc.). From Heckscher–Ohlin–Samuelson (HOS) model, trade can only influence wage rate of workers. Therefore, trade can effectively hold up wage and there after increase consumers purchasing powers.

The organization of the rest of the paper is as followed: section 2 determines the relationships between manufacturing and service sectors with the rest of the economy, identifies "key" and "disconnected" sectors in term of Forward or Backward linkages; section 3 uses Theil analysis to assess South Korea average wage trends and inspects wage inequality between manufacturing and service workers; section 4 evaluates the employment figures of Korea economy; section 5 studied the employment effects of manufacturing and service sectors; section 6 presents the paper conclusion and policies implications.

It is important to note that each sector is assigned a number. Agriculture and mining sectors are sectors 1 to 4, Manufacturing sectors are sectors 5 to 22, Service sectors are sectors 23 to 56. The name of each sector is listed in note 1.

II, Key manufacturing and service sectors

This section employs Hirschman's (1958) framework, or input output analysis to identify key manufacturing and service sectors and their connections with the rest of South Korea economy.

In the Hirschman's framework[5] of input output analysis, production by a particular industry (sector) has 2 kinds of economics effects on other sectors in the economy. The first concerns the connection of the industry to its suppliers. If industry j increases its output, it will increase its demands on others sectors whose goods are used as inputs to production in j. This effect is known as Backward linkage (BW) and shows the direction of causation in the usual demand side model. The second refers to the connection of the industry to its clients. The increased output in industry j means that additional amounts of its products are available to be used as inputs to other sectors for their own production – there will be increased supply from sector j for the sectors that use its goods in their production. The term Forward linkage (FW) is used to indicate this kind of interconnection and is used to show the direction of causation in the supply side model. Therefore, the study of FW and BW linkages provides us with a picture of the fundamental changes in the structure of production within manufacturing and service sectors. Hence, this section is particularly important as it identifies key sectors (sectors with high connections with the rest of the economy) within South Korea economy and put into context the results and analysis obtained in the remaining sections. The mathematical details behind FW and BW linkages computation used in this paper is in Appendix 2.

The paper computes the normalized direct BW and FW linkages of all manufacturing and service sectors by using data from South Korea's annual national input-output (I-O) tables from 2000 to 2014 published by World Input-Output Database (WIOD)[6]. The national (I-O) table are reported at basic prices of the corresponding year and are presented in millions of US dollars. These table contain the transaction (flows) table from which Matrix A (the technical coefficients matrix) and Matrix B (the value of total intermediate sales by sector as a proportion of the value of i's total output) are obtained. The I-O tables of South Korea are aggregated in 56 sectors, 4 of agriculture and mining, 18 of manufacturing, and 34 of service. This paper will focus on data of 52 manufacturing and service sectors. Figures 3 and 4 show the results for manufacturing, and figures 5 and 6 show the results for service.

The computation of normalized direct backward linkages for manufacturing sectors of the South Korea economy shows that most manufacturing sectors have strong backward linkages (values larger than 1), except for sector 10: manufacturing of coke and refined petroleum. This means that, except for sector 10, all manufacturing sectors have

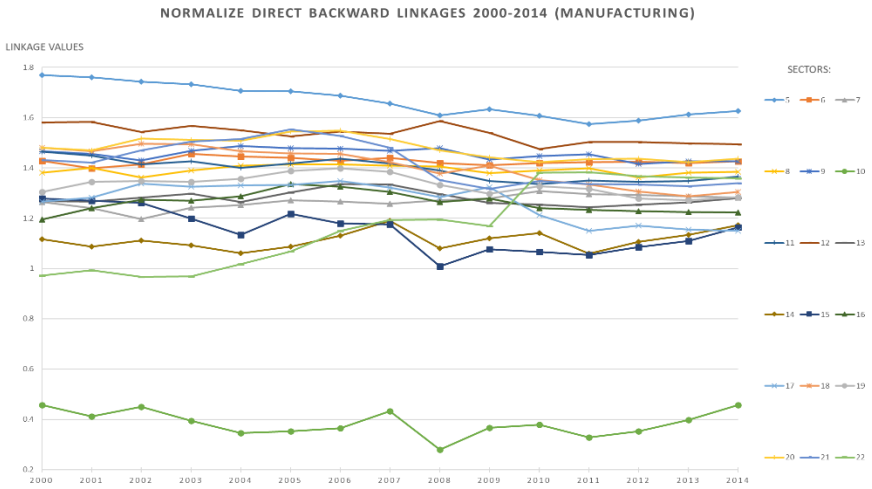
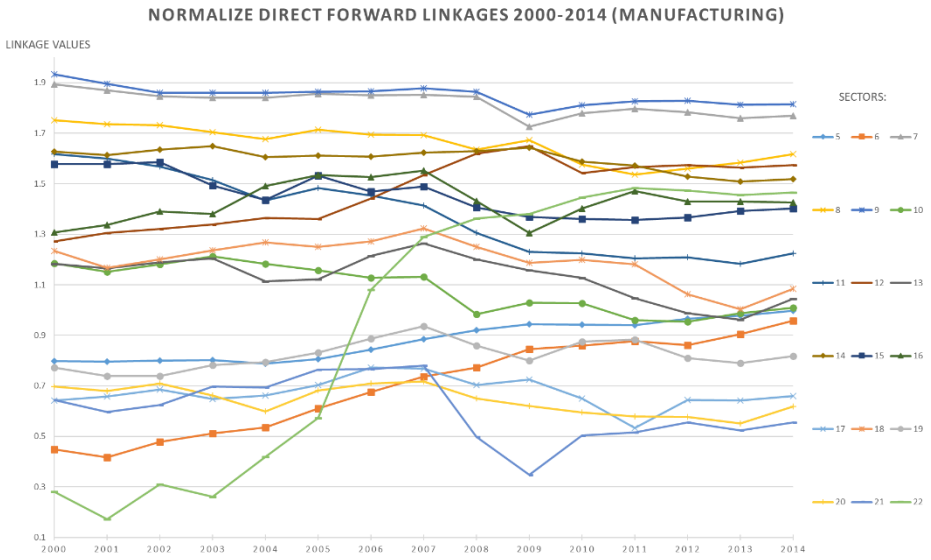


Figure 3. Normalized Direct Backward Linkages 2000 – 2014 (Manufacturing)

Source: Author's construction using data from WIOD

Figure 4. Normalized Direct Forward Linkages 2000 – 2014 (Manufacturing)



Source: Author's construction using data from WIOD

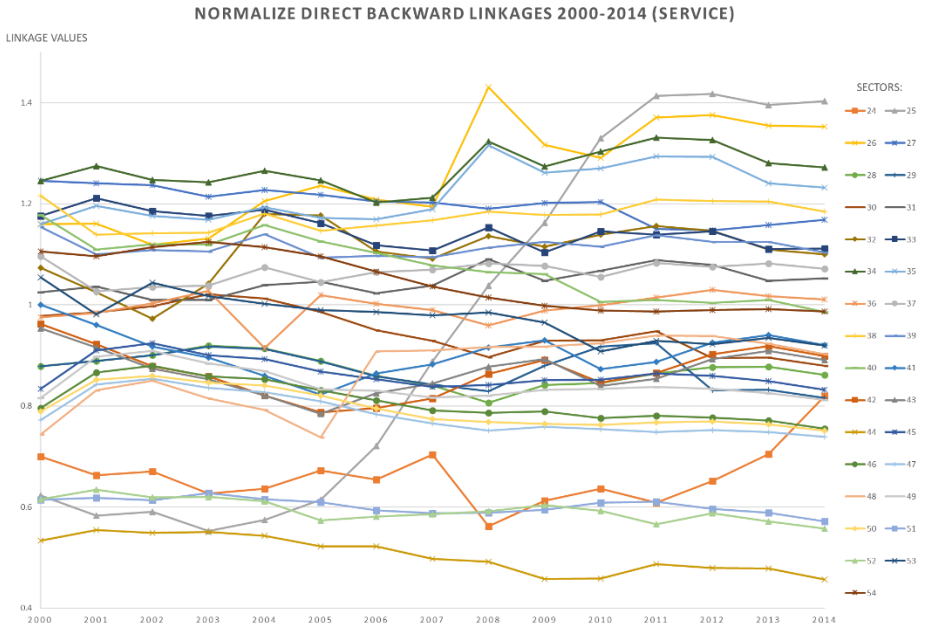
received most of their input domestically, with most manufacturing sectors cluster around normalized direct backward linkages values of 1.2 and 1.5. Moreover, with sector 10 is the exception, sectors 5, 12, 20, 9 have the highest values and sectors 15, 14, 7, 16 have the lowest in term of normalized direct BW linkages.

From Figure 4, it can be said that sectors 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18 have strong normalized direct forward linkages (value larger than 1). Thus, these sectors are used to produce other goods in the economy. Other sectors 5, 6, 17, 19, 20, 21, 22 (sector 22 has a drastic increase of forward linkage value after 2005, showing an increase in domestic demand for intermediate furniture goods) have a value of normalized direct forward linkage lower than 1. Therefore, it's safe to assume that these sectors produce products for final demand consumption or exports.

About the values of Korea service sectors normalized direct backward linkages resulted from figure 5, there are 10 sectors that have a value larger than 1, including sectors: 26, 27, 32, 33, 34,

35, 38, 39, 40, and 54. Sectors 24, 25, 28, 29, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, and 52 have value smaller than 1. The rest of the economy have normalized backward linkage values approximate 1. In general, normalized direct backward linkage values of the service sectors do not show fluctuation throughout the years. Except for sector 25, being 1 of the lowest in term of backward linkage before 2005 and then slowly increase to the highest value sector after 2009.

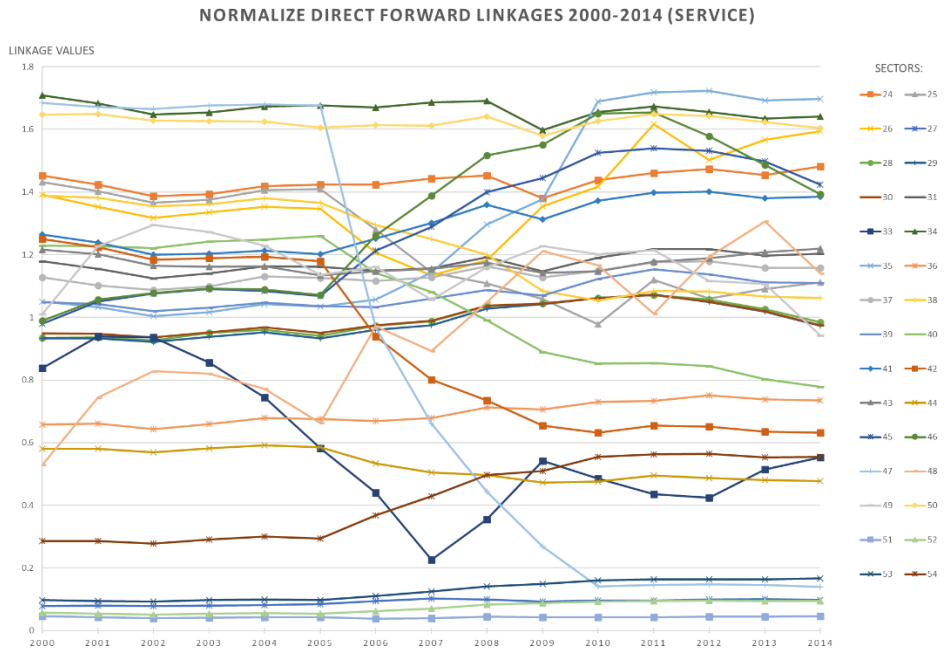
Figure 5. Normalized Direct Backward Linkages 2000 - 2014 (Service)



Source: Author's construction using data from WIOD

From figure 6, regarding normalized direct forward linkage values of the service sectors, there are sectors 24, 25, 26, 31, 34, 35, 37, 38, 39, 41, 43, 45, 46, 49, 50 that have forward linkage values larger than 1, also sector 28, 29, 30, 40, 42, 48 have values approximate 1. The rest of the service sectors have normalized direct forward linkage values less than 1. Compare with backward linkage, normalized direct forward linkage of service sectors have more variety and sectors' fluctuation, especially sector 47 from the top 1 highest sector to one of the lowest in term of direct forward value.

Figure 6. Normalized Direct Forward Linkages 2000 – 2014 (Service)



Source: Author's construction using data from WIOD

After the calculation of direct backward and forward linkages of manufacturing and service sectors, the paper identifies that there are 3 exception sectors and 16 "key" or "leading" (sectors with both BW and FW linkages values larger than 1) sectors within the Korea economy, with 11 of manufacturing and 5 of service. The 3 exception sectors are: manufacturing of coke and refined petroleum (the result of heavy reliance of imported gas and fuel); water collection, treatment, and supply; and scientific research and development. "Key" sectors within the Korea economy consists mostly of manufacturing sectors, to be more specific are sectors 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 26, 34, 35, 38, and 39. Also, exist 4 service sectors that are "disconnected" (sectors with both BW and FW linkages smaller than 1) from the economy, which are: sectors 44, 47, 51, and 52. Other non "key" sectors within manufacturing can be said to be export sectors, because of their nature to have strong backward linkages but weak forward linkages.

Economics interpretation for non “key” sectors of service sectors are harder to determine because of the nature of service sectors.

There are fundamental ideas to retain from this section:

1. Not all the manufacturing or service sectors have the same interactions (BW and FW linkages) with the rest of the economy. Hence, the relevance of each sector varies and needs to be considered in the analysis carried out in the next section.
2. There is a cluster of manufacturing sectors that have low forward linkages, which are: Sectors 5, 6, 17, 19, 20, 21, 22; within these sectors: sectors 6, 17, 19, 20, 21, 22 produces for the external markets and final consumption.
3. There are in total 16 “key” sectors within the Korea economy, with 11 belongs to the manufacturing sectors.
4. There are 4 “disconnected” service sectors: 44, 47, 51, and 52 that have both weak forward and backward linkages. [11]
5. The heavy reliance of Korea economy to imported fuel.

The following section studies the wage inequality of manufacturing and service sectors, with special attention to “key” and “disconnected” sectors.

III, Wage analysis

This section uses Theil indexes[7] to analyze the distribution of wages throughout the manufacturing, service, and previously identified “key” sectors of the Korea economy. First, each sector Theil index is calculated using sectorial employment and wage data. Using the information given in the WIOD, we can retrieve the average annual wage per sector (in thousands of Korean wons) by using the vector of total employee compensation (in millions of

Korean wons) then divide by the number of employed workers (in thousands). We then calculate the total Theil index from 2000 – 2014:

$$T = \sum_{i=1}^{n} \left(\frac{P_i}{P_T}\right) * \left(\frac{y}{\bar{y}}\right) * \ln\left(\frac{y}{\bar{y}}\right)$$

Where $\frac{P_i}{P_T}$ is the ratio of employed people of sector i over total number of employed people in the economy. $\frac{y}{\bar{y}}$ is the ratio of income of sector i over the average wage in the economy. We compute sectorial Theil index by the multiplication of 3 following steps:

1. For each sector, we obtain the share of population with respect to total population in the economy. $\left(\frac{P_i}{P_T}\right)$
2. We obtain the share of income of each sector with respect to the average wage in the economy. $\left(\frac{y_i}{\bar{y}}\right)$
3. Take the natural logarithm of each ratio obtained in Step 2. $\ln\left(\frac{y_i}{\bar{y}}\right)$

The results from the multiplication of 3 above steps give Theil index contribution of each sector. The sum of all sectorial Theil indexes equals the total Theil index of manufacturing and service sectors. [8]

The Theil index results are shown in figures 7 and 8, where the contribution of each sector to total Theil index of the manufacturing and service sectors are presented. Figure 9 shows the total Theil index of manufacturing and service sectors combine.

From Figure 7, the manufacturing sectors have seen half of the number of sectors with no contribution to Theil index throughout the given period, to be more specify, they are: sectors 5, 7, 8, 9, 11, 12, 13, and 22. The rest of the manufacturing sectors, except for sector 6

(manufacture of textiles, wearing apparel and leather products), has shown signs of continuous increasing positive value contributing to the Theil index. Notably, sectors 15, 17, 11, and 20 illustrates noticeable signs of better wage within the manufacturing sectors. Thus, compared to workers from the rest of the economy, manufacturing sectors' workers consistently at least have the national average wages. Especially, workers from sectors 11, 15, 17, 20 have increased and high wages throughout the studied period.

From Figure 8, within the service sectors, there exists 8 sectors having negative contribution to total Theil index (sectors 29, 30, 36, 42, 45, 49, 50, 53, and 54), in which only sectors 29, 30, 36, 42 have increasing Theil index values throughout the period. Other sectors: 24, 27, 38, 40, 41, 43, 44, 46, 47, 51, 52, despite having positively contributed to total Theil index, indicates a general decreasing in Theil values, except for sectors 41 and 46 which sectorial Theil indices remain approximately unchanged. The rest of the service sectors have approximately 0 contribution to the total Theil index. Another observation is that, compared with manufacturing

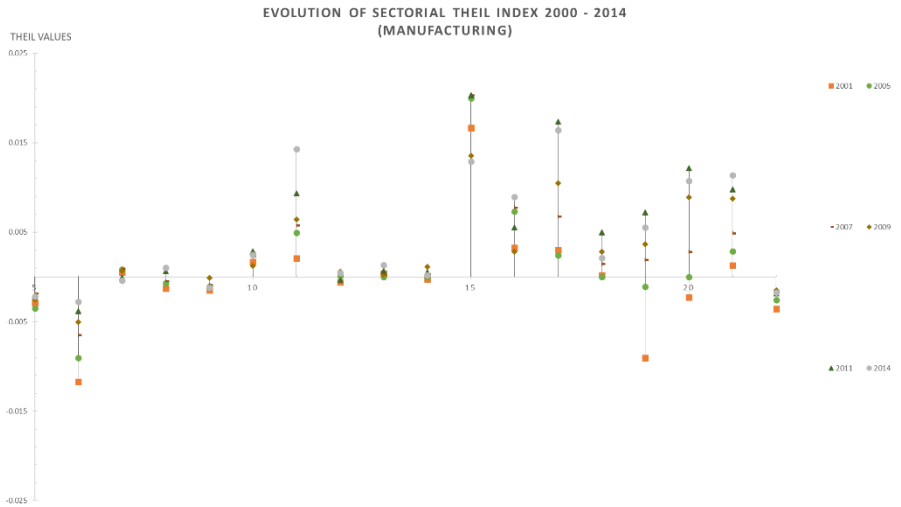


Figure 7. Evolution of Sectorial Theil Index 2000 – 2014 (Manufacturing)

Source: Author's construction using data from WIOD

sectors, service sectors Theil index values show more volatility. Hence, wages within service sectors are more dispersion with 9 sectors (sectors 29, 30, 36, 42, 45, 49, 50, 53, and 54) having lower than average wages, 11 sectors (sectors 24, 27, 38, 40, 41, 43, 44, 46, 47, 51, 52) having higher than average wages.

In term of "key" and "disconnected" sectors (being sectors with BW and FW linkages larger and smaller than 1, respectively), there are 6 sectors that have an increase worker's wage from 2000 – 2014 (which are sectors 10, 15, 16, 18, 35, and 38). Other sectors like 44 and 51 have decreasing trends of worker compensation. The rest of "key" and "disconnected" sectors have an unchanged workers' wage. From these results, all "key" sectors within manufacturing have unchanged or increase worker's wage. Regarding "key" service sectors, there is sector 38 which have increase wage, sectors 35, 34, 39, 26 wages have not changed. Lastly, all 4 "disconnected" sectors did not observe any increase in wage, with sectors 47 and 52 have unchanged wage trends and sectors 44 and 51 have decreased wage trends.

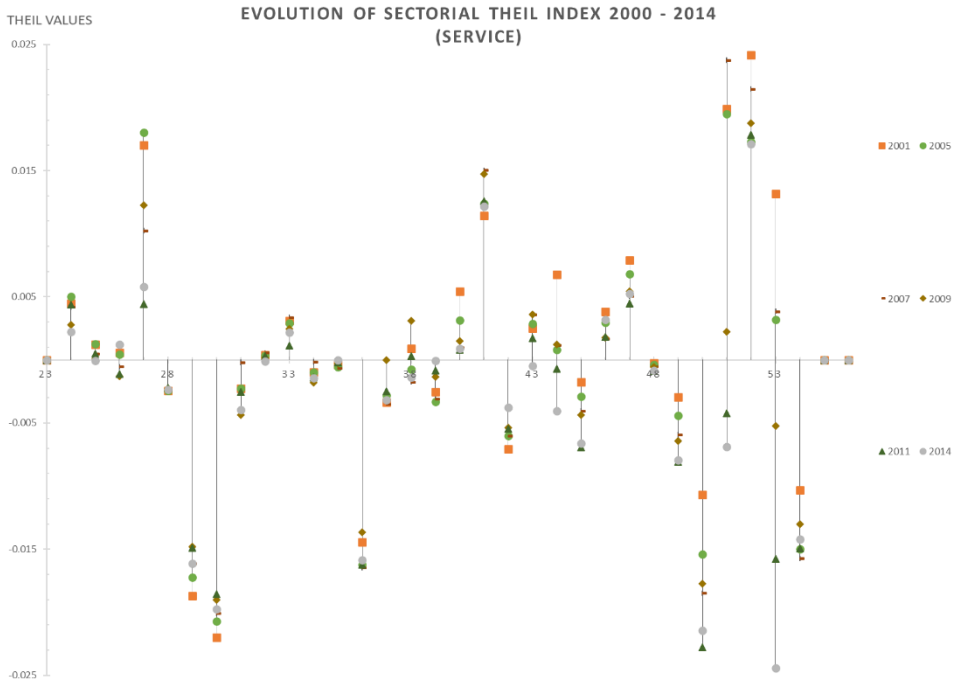


Figure 8. Evolution of Sectorial Theil Index 2000 – 2014 (Service)

Source: Author's construction using data from WIOD

From Figure 9, the South Korea economy total Theil index for manufacturing and service sectors had been in relatively stable positive throughout the 2000s. Therefore, South Korea manufacturing and service sectors' workers in the 2000s had observed constant increasing average wage. Until after 2009, when the country manufacturing and service sectors total Theil index value starts becoming negative, showing signs of decreasing overall workers' wage. The source of constant decreasing average wages after 2009 can be partially explained from figure 7 and 8. From 2009 to 2014, most sectors of the Korea economy observe general decreasing in Theil values, making the total Theil value decreasing below 0.

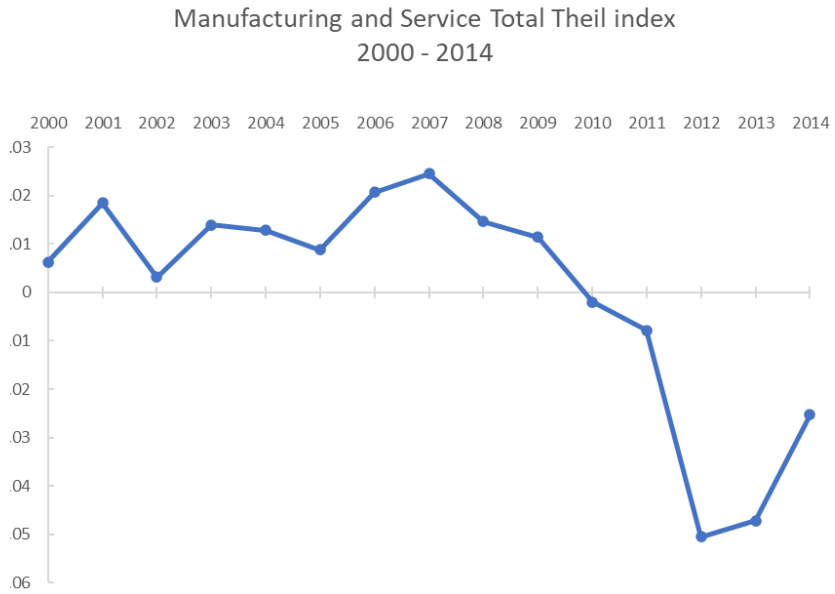


Figure 9. Total Theil index for manufacturing and service sectors [9]

Source: Author's construction using data from WIOD

From the Theil indices results of this section, although the average South Korean working for manufacturing and service sectors has had increasing wages until 2009, in more details, the

sectorial Theil indices of manufacturing and service sectors differ. Manufacturing sectorial Theil indices, except for sector 6's, have all remained approximately 0 or positive with a general increasing trend. Whereas service sectors' Theil indices mostly unchanged or increased with less magnitude. This acts as a factor contribute to wage inequality between service and manufacturing sector workers. The situation worsens after 2009, when the average South Korea manufacturing and service worker wages started decreasing, workers within manufacturing still have positive Theil values, indicate that, wages within manufacturing remained unchanged or still increasing. However, many sectorial Theil indices of service sectors decreases to negative values, therefore wages within service sectors have decreasing trends after 2009. The bulk of the decreasing in Theil values also comes from labor intensive service sectors, with sectors 49, 50, 51, 52, 53, and 54 employed approximately 30 percent of the working population. To fully graphs the drivers of wage inequality of South Korea economy, the next section will study the employment figure of each sector.

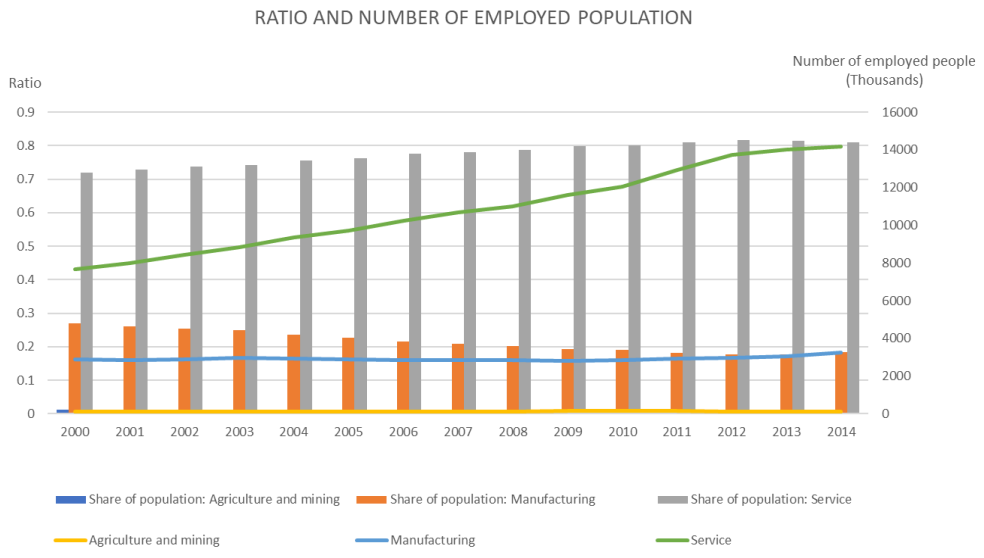
IV, Employment

This section involves the study of the evolution of employed workers in the Korea economy. Figure 10 shows the evolution of employed workers in 3 general economic categories: Agriculture and mining, Manufacturing, Service. The graph shows that during the period from 2000 to 2014, manufacturing sectors number of employed people have had little change, stable around 3 to 4 million working people. On the other hand, the only sectors that show signs of increasing in number of working people are service sectors, which number increases from around 7 million to approximately 14 million workers. Consequently, the population share of service sectors has a 10 percent increase to around 80 percent of the total population and manufacturing sectors share of employed population reduces to less than 20 percent in 2014 from 30 percent in

2000. Lastly, throughout the period, agriculture and mining sectors have consistently employed a minuscule number of workers.

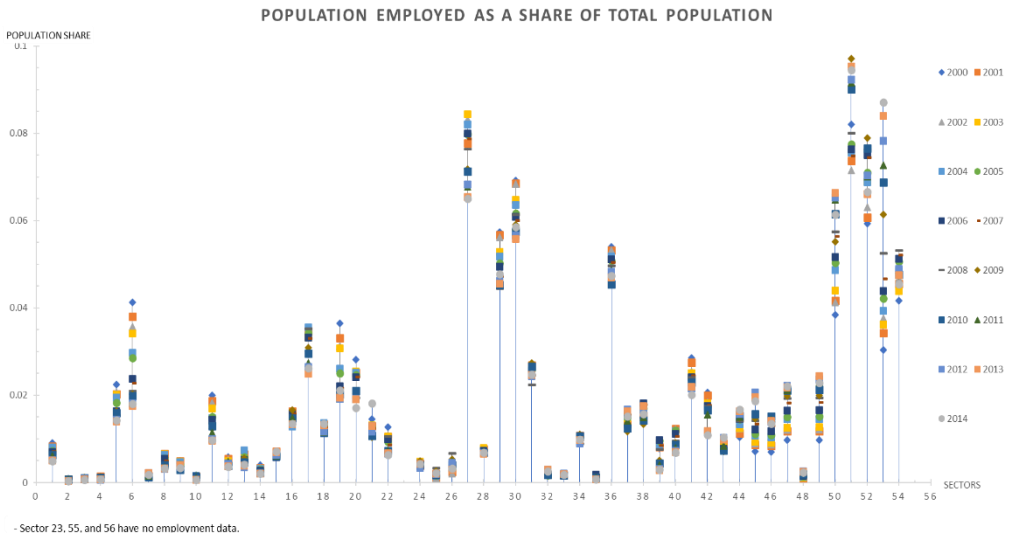
Figure 11 shows the sectorial ratio of employed population. It is shown that most labor-intensive industries fall into service category. Among these sectors, the largest in term of population share are sectors 51, 52, 53, and 27. Whereas sectors like 2, 3, 4, 35, 48 are the smallest. More importantly, throughout the economy there are only 10 sectors within the service sectors that gaining working population share, which are: sectors 44, 45, 46, 47, 49, 50, 51, 52, 53, 54. Within these sectors, sectors 49, 47, 45, 44, and 46 have consistently less than 2.5 percent of the employed population. Only sectors 52, 53, 51, 50, and 54 shows any signs of significant increase in number of workers share. Interestingly, out of these 5 sectors, only sector 52 workers get paid continuously above the average wages according to Figure 8. On the contrast, the other 4 sectors have stagnant and low worker salaries, with sectors 50, 53, and 54 pay among the lowest in the economy. [10]

Figure 10. Ratio and amount of employed population.



Source: Author's construction using data from WIOD

Figure 11. Sectorial employed population share.



Source: Author's construction using data from WIOD

More significantly, from figure 11, most "key" sectors have low population share, with only sector 38 has more than 2 percent of the total working population. More noticeable is that only "disconnected" sector 44 has a population share less than 2 percent, other "disconnected" sector have more than 2 percent of the total working population, with sectors 51 and 52 both have more than 6 percent of the employed population.

There are 3 ideas to retain from this section:

(1) The increase in number of employed workers in South Korea focuses on the service sectors, with much of the increase happens within sectors 50, 51, 52, 53, and 54. The manufacturing and agriculture sectors observe general decrease in the share of employed population.

(2) All "key" sectors (sectors with FW and BW linkages values larger than 1) have little share of employed worker population (around and less than 2 percent), sectors characterized as "disconnected" (sectors with FW and BW

linkages values smaller than 1) have in total approximately 17 percent of the population.

(3) Sectors having increase employed population face stagnant and less than average increase in wages. Sectors 50, 53, and 54 also have low wages compare to the rest of the economy.

(4) Around 10-15 percent of the population earns among the lowest wages, whereas around 2.5 percent of the population have the highest wages.

V, Employment Creation Due to Trade

Using similar methodology as Kucera and Milberg (2003) and Jiang (2013), whose papers have identified the degree of influence upon employment from changes in pattern of trade of OECD countries and China in the period from 1978 to 1995 and 2002 to 2007 respectively, this paper attempts to determine the influences of trade structure in 18 manufacturing and 34 service sectors of South Korea have on employment. We can analyze these influences by using:

$$L = \hat{E}[(I - A)^{-1}T]$$

In which: A is the input coefficient matrix, each element in Matrix A is the sum of all required intermediate goods values of sector j as a share of j 's total output. I is the identity matrix and $(I - A)^{-1}$ is the Leontief inverse matrix, each element of Leontief matrix shows the change in input requirements of sector j if there is a unit increase in final demand for jth sector. $\hat{E}$ is the diagonal labor coefficient matrix, which shows the employment per unit of output. L is a vector showing employment generated due to changes in patterns of trade. T is the trade expansion vector and for the period t = 0 to t = 1 is computed as:

$$T = (X^1 - M^1) - (X^0 - M^0)(\frac{D^1}{D^0})$$

In Which: X shows a vector export values, M shows a vector import values, and D show a vector of domestic demand or the sum of total production and imports. Hence, T is the net exports adjusted for domestic demand changes from period t = 0 to t = 1. Figure 12 shows the sectorial trade expansion of 56 South Korea economy from 2000 to 2014.

Because T is the domestically adjusted net export, therefore, matrix $(I - A)^{-1}T$ is a column vector showing the sectorial change in total outputs due to the change in the pattern of trade. The pre-multiplication with the $\hat{E}$ matrix gives the employment outcomes of these changes.

To compute the employment effects of change in trade, we use the data from the socioeconomics accounts and national I-O tables of the WIOD from 2000 to 2014. Firstly, we obtain matrix A, the vectors of import, export, and total outputs by using the transaction table containing 56 South Korea economic sectors from the national I-O tables. Secondly, we create the diagonal labor coefficient matrix by divide the vector of employed workers per sector by the total outputs vector.

In this paper, the labor coefficients are the numbers of workers required to produce 1 million of USD worth of output for each sector in every year. The multiplication of this matrix with total outputs resulted from change in pattern of trade matrix gives us the change in employment effects of trade, the result of this multiplication is presented in Figure 13. This plot shows employment creation in 18 manufacturing and 34 service sectors. The points locate around 0 shows no employment effect, positive points show employment creation, and negative points show employment destruction.

Figures 12 and 13 show the trade expansion adjusted for domestic demand and its employment effect of manufacturing and service sectors. From figure 12, manufacturing sectors are highly fluctuated in term of trade expansion, most noticeable are sectors 17, 21, and 6. These sectors and sectors 10, 11, 15, 16, 18, 19, 20, making up half of the manufacturing sectors, all can be characterized to have apparent trade expansion. This correctly reflects the Korea economy foundation focusing on manufacturing as the economy driving forces. Combine the results of figures 12 and 13, the employment effects due to trade of manufacturing sectors follows the same patterns as trade expansion. Sectors with little to no trade expansion (sectors 5, 7, 8, 9, 12, 13, 14, 22) have little to no trade employment effects. Other sectors like 11, 15, 16, 18, 19, and 20 having highly fluctuated trade expansion, these sectors employment effects are magnified. The only exception is sector 10, having fluctuated trade expansion but little to no employment effects.

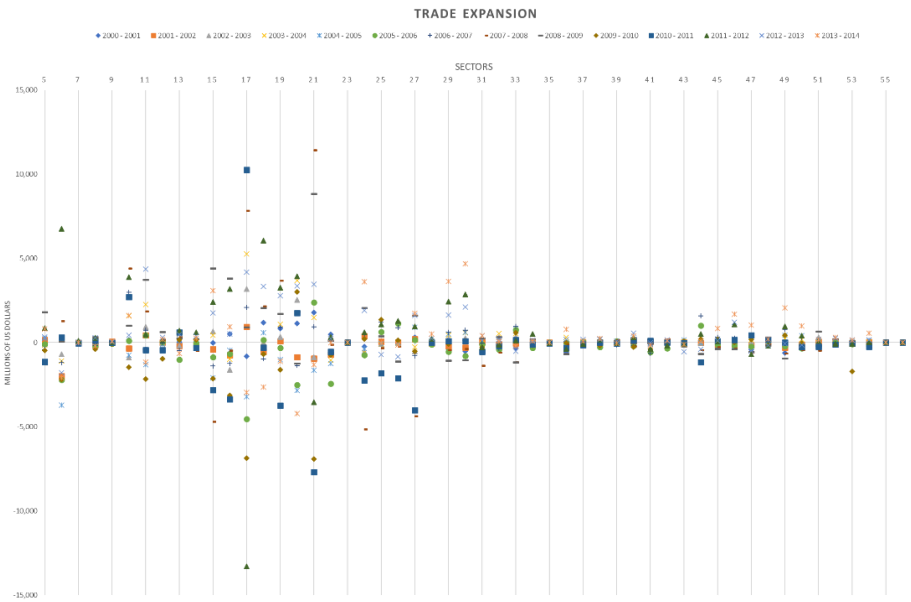
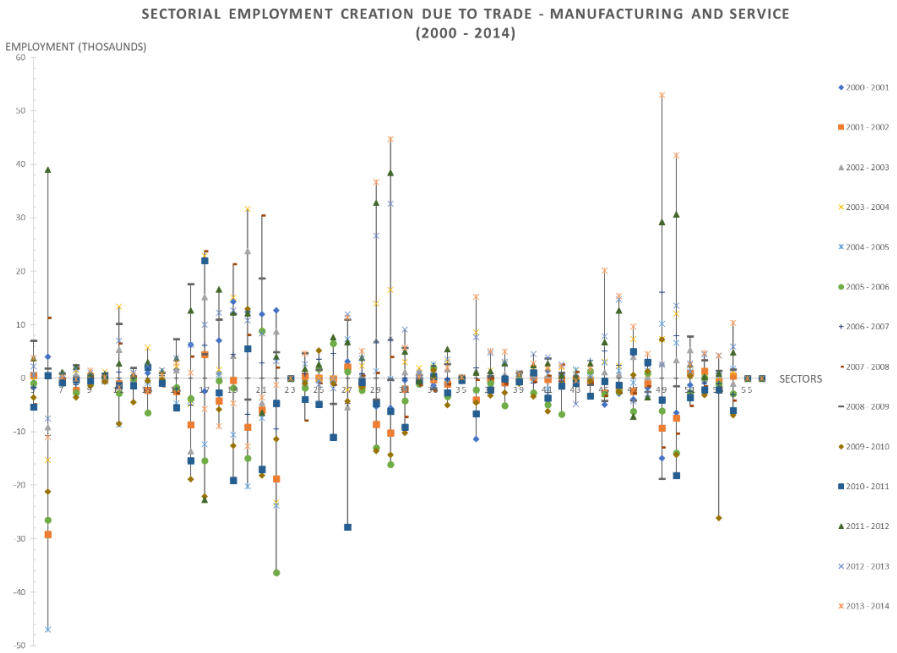


Figure 12. Trade Expansion – Manufacturing and Service (2000 – 2014)

Source: Author's construction using data from WIOD

Figure 13. Employment Creation Due to Trade – Manufacturing and Service (2000 – 2014)



Source: Author's construction using data from WIOD

Also from figure 12, the service sectors are observed to be dominated by sectors with little to no trade expansion during the studied period, with a few exceptions (sectors 24, 25, 26, 27, 29, 30). Thus, most service sectors have little adjusted export. However, from 2000 to 2014, the overall trade expansion of service sectors observes a slight increase, indicates increase in export values of service sectors. Interestingly, from figure 13, though trade expansion and its employment effects have the same patterns, the employment due to trade are highly magnified. Most noticeably, sectors 45 (Legal and accounting activities; activities of head offices), 46 (Architectural and engineering activities; technical testing and analysis), 47 (Scientific research and development), 49 (Other professional, scientific and technical activities; veterinary activities), 50 (Administrative and support service activities) have little trade expansion compare with the rest of the economy but possess the most fluctuated employment effects.

Thus, South Korea adjusted net export from 2000 to 2014 is dominated with apparent fluctuations from manufacturing sectors. During the period, the most extreme cases of fluctuation in term of trade expansion are sectors 6, 10, 11, 15, 16, 17, 18, 19, 20, 21 (making up half of manufacturing sectors), 24, 29, 30. The rest of the economy have insignificant trade expansion. This is evidence for manufactured good export-oriented economy of the country. Interestingly, trade employment effect is more apparent on a wide range of sectors. Most contradictory, despite manufacturing leading in trade expansion, trade expansion effect is more visible within service sectors. The employment effect of trade is most apparent within service sectors 29, 30, 49, 50. This may be due to the sheer number of people employed from these sectors, contributing to the employment effects.

VI, Conclusion and policies implications

Using Hirschman concept of Input – Output Analysis to study the South Korea economy, this paper has identified 16 "key" or "leading" manufacturing and service sectors, which are: manufacturing sectors 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18 and service sectors 26, 34, 35, 38, 39. These sectors and the rest of the manufacturing sectors except for sector 6 can be said to have excellent connectivity with the rest of the economy. This means that if manufacturing sectors expands, the rest of the economy will benefit. Therefore, the high figures in term of normalized direct FW and BW linkages of manufacturing sectors act as evidence for the historical focus of the country pursuing manufactured export led development strategy. However, there are sectors: 6, 17, 19, 20, 21, 22, having FW linkage values comparably lower than other manufacturing sectors, hence, these sectors produce for final consumption or external markets. It is also noted that service sectors have experienced stable BW and FW linkages throughout the studied period. Moreover, service sectors show more variety in term of linkages values. Thus, service sectors of

South Korea economy have had little change to structural of require intermediates goods for inputs, additionally, service sectors do not possess comparable interconnectedness between industries that possessed in manufacturing sectors.

Afterward, this study focuses on wage analysis of the Korea manufacturing and service industries through the values of total and sectorial Theil indices. To begin with, apart from sector 6 having continuously not contributed to the total Theil index, all manufacturing sectors have added into the values of the total Theil index, with each sectorial Theil values remains positive or approximately 0. Or in other word, most manufacturing sectors workers' wages have consistently increased throughout the period, being equal to or more than the national average wage. For service sectors, workers compensation seems to be stagnant or have slower increase compared to the whole economy. Most service sectors have wage around the economy average or decreasing rate of increase. This is supported by the fact that most service sectors have no contribution to the total Theil index or possess a negative or decreasing Theil index value. More importantly, from the results of figures 7, 8, and 9, there is an increase in wage inequality between manufacturing and service sectors workers throughout 2000 to 2014, with wage inequality worsening especially after 2009. The results also point out a problematic situation where around 12 percent of the employed population are paid the lowest wages.

Lastly, this paper attempts to analyze the employment figure, trade expansion and its employment effects upon the economy. The study points out that from 2000 to 2014, only service sectors have gained in term of number of employments, double its employed population during the period, with the figure for the rest of the economy stagnant or decrease. More interestingly, the bulk of employment figures increase within service sectors is mainly results of sectors 50, 51, 52, 53, 54. Thus, because most newly created jobs resigned in these 5 sectors, this

makes new workers try to compete to get a profession within these sectors, putting pressure on wage to remains low and worsening wage inequality. Furthermore, the employment share of "key" sectors remains low, whereas "disconnected" sectors have in total 17 percent of the population. Therefore, 17 percent of the working population are currently working in sectors with least connections to the rest of the economy. It is important to note that, from Appendix 3, the reason behinds increase in employment figures stem mainly from the increase of the labor force in Korea from 2000 to 2014. About trade expansion and its employment effect to manufacturing sectors, half of manufacturing sectors are characterized with highly fluctuated trade expansion (sectors 6, 10, 11, 15, 16, 17, 18, 19, 20, 21), combine with low FW linkages of sectors 6, 17, 19, 20, 21, thus making sectors 6, 17, 19, 20, 21 produce products for external markets or final consumption. For service sectors, there are only 6 service sectors with high trade expansion fluctuation (sectors 24, 25, 26, 27, 29, 30), the rest of the service sectors have insignificant trade expansion. Moreover, the employment effect due to trade follows the same pattern as trade expansion with figures for service sectors are extremely magnified. Most importantly, the worst employment effects fluctuation of service sectors are sectors 27, 29, 30, 36, 45, 46, 47, 49, 50, 54, sectors 27, 29, 30 already have high trade expansion, hence high trade expansion effects on employment. Thus, other sectors like 36, 45, 46, 47, 49, 50, 54 employment figures are extremely sensitive to trade. This phenomenon combines with the fact that service sectors production structure mostly remains unchanged (because of stable FW and BW linkages values of most service sectors) means that sensitivity to trade of some sectors partly are the results of large amount of people required to produce a unit of product (or large $\hat{E}$ value).

The paper results suggest that South Korea economy possessed interconnected and developed manufacturing sectors. Workers working within manufacturing have better wages and

a consistent wage increase. Though the number of manufacturing employment has been stable and stagnant around 3 to 4 million jobs. On the other hand, South Korea service sectors has less connections to the rest of the economy compared with the manufacturing sectors, based on the number of sectors with weak FW and BW linkages. Moreover, wages of service workers have had slower increase compared to that of manufacturing workers, there are also period where service wages decrease. Despite slow growth in term of wage, service sectors have been the main sectors with increase in employment opportunities for Koreans, especially in sectors: Administrative and support service activities (sector 50), Public administration and defense, compulsory social security (sector 51), Education (sector 52), Human health and social work activities (sector 53). The fact that new employment focus on service sectors also put pressure on wages and contribute to the employment sensitivity of some sectors. Hence, increasing wages and limited employment opportunities within manufacturing sectors, low wages and increasing in employment number within service sectors, results to wage gaps between manufacturing and service workers.

As such, though South Korea has achieved developed country status, according to this paper, the nation is facing increasing wage inequality between manufacturing and service workers, wage stagnation of some sectors, concentration of new employment on specifies sectors, employment sensitivity to trade of service sectors. Therefore, to combat these problems, the paper suggests South Korea creates incentives to increase labor productivity of service sectors, especially labor-intensive sectors, by eliminating low skill jobs (f.e encourage technology adaption, automation, upgrade labors' skillsets by improving education and retraining programs, etc) in order to increase the average wage within service sectors[12]. Increase in labor productivity by eliminating low skill jobs also reduces the fluctuation of employment effects due

to trade (because labor coefficient decreases) and put pressure on diversify new employment (because low skill job of labor-intensive sectors disappearing)[13]. Thus, it is critically important to improve and create education and retraining programs as well as other types of social safety nets for low skill and new workers when they are learning new or advance skills. More importantly, an invested higher education can diverse new employment back into developed manufacturing sectors helping to put low wage pressure off service sectors, hence, increase in wage equality. An increasing average wage created from productive workers, higher education, and government policies also increase final consumption, therefore, reduce trade expansion and its employment effects.

All in all, South Korea possesses developed and interconnected manufacturing sectors, whereas its service sectors are volatile in term of trade expansion, trade employment effects, and connectivity to the rest of the economy. The nation, despite being a developed country, is having increasing wage inequality and stagnation, concentrated new employment, and unpredicted trade expansion employment effects of service sectors. By eliminating low skills jobs and diversify workers throughout the economy, South Korea may regain its growth figure during the miracle on the Han River period.

Note:

1. South Korea economy sectors:

1) Crop and animal production, hunting and related service activities; 2) Forestry and logging; 3) Fishing and aquaculture; 4) Mining and quarrying; 5) Manufacture of food products, beverages and tobacco products; 6) Manufacture of textiles, wearing apparel and leather products; 7)

Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; 8) Manufacture of paper and paper products; 9) Printing and reproduction of recorded media; 10) Manufacture of coke and refined petroleum products ; 11) Manufacture of chemicals and chemical products ; 12) Manufacture of basic pharmaceutical products and pharmaceutical preparations; 13) Manufacture of rubber and plastic products; 14) Manufacture of other non-metallic mineral products; 15) Manufacture of basic metals; 16) Manufacture of fabricated metal products, except machinery and equipment; 17) Manufacture of computer, electronic and optical products; 18) Manufacture of electrical equipment; 19) Manufacture of machinery and equipment n.e.c.; 20) Manufacture of motor vehicles, trailers and semi-trailers; 21) Manufacture of other transport equipment; 22) Manufacture of furniture; other manufacturing; 23) Repair and installation of machinery and equipment; 24) Electricity, gas, steam and air conditioning supply; 25) Water collection, treatment and supply; 26) Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services ; 27) Construction; 28) Wholesale and retail trade and repair of motor vehicles and motorcycles; 29) Wholesale trade, except of motor vehicles and motorcycles; 30) Retail trade, except of motor vehicles and motorcycles; 31) Land transport and transport via pipelines; 32) Water transport; 33) Air transport; 34) Warehousing and support activities for transportation; 35) Postal and courier activities; 36) Accommodation and food service activities; 37) Publishing activities; 38) Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities; 39) Telecommunications; 40) Computer programming, consultancy and related activities; information service activities; 41) Financial service activities, except insurance and pension funding; 42) Insurance, reinsurance and pension funding, except compulsory social security; 43)

Activities auxiliary to financial services and insurance activities; 44) Real estate activities; 45) Legal and accounting activities; activities of head offices; management consultancy activities; 46) Architectural and engineering activities; technical testing and analysis; 47) Scientific research and development; 48) Advertising and market research; 49) Other professional, scientific and technical activities; veterinary activities; 50) Administrative and support service activities; 51) Public administration and defence; compulsory social security; 52) Education; 53) Human health and social work activities; 54) Other service activities; 55) Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; 56) Activities of extraterritorial organizations and bodies.

2. Asia Financial Crisis (1997 – 1998)

The Asia Financial Crisis started on July of 1997 when the country devalued its currency relative to the US dollar. The crisis has caused havoc throughout East Asia economies and affected the economy of Latin America and Eastern Europe. Deeper investigation into the causes of the financial crisis can be found at (Kwack, 2000) and (Chang & Velasco, 1998).

3. The division of South Korea's economy history into 4 generalized phases are taken from Park J.-D (2019).

4. Figure a and b of Appendix 1 shows that manufacturing are the biggest import and export merchandies. Thus, the manufacturing sectors has been at the center of South Korea export led economic development.

5. For detail information about classical linkages liteture of Hirshman, readers should review Hirschman (1958).

6. The World Input – Output Database (WIOD) released in 2016 contains the Socio – economic accounts and the World Input – Output tables (WIOT) of 43 nations. For more information regarding the WIOD, readers should refer to Timmer, Dietzenbacher, Los, Stehrer, & J. de Vries (2015).

7. The Theil index is a statistic measuring economic inequality. The index shows the "distance" between the sectorial population and the "idea" equality state that everyone having the same average national wage. The Theil index provides an accurate picture of sectorial average wages relative to the national average wage. Moreover, the total of sectorial Theil indices gives the general trend of the national average wage. Thus, the Theil index can be used to measure inequality.

8. Given the mathematic formula to calculate Theil index, we can see that if the average wage or income of a sector is equal to the economy average wage then $\frac{y_i}{\overline{y}} = 1$ and $\ln\left(\frac{y_i}{\overline{y}}\right) = 0$. Thus, if the average wage of sector i is bigger than the economy average wage then sector i's Theil index will be positive and contribute the the total Theil index. In constrast, if the average wage of sector i is smaller than the economy average wage then sector i's Theil index will be negative and there is a negative contribution to total Theil index. Hence, the sum of all sectorial Theil indices or total Theil index will show the trend of the economy average wage throughout the studied period.

9. Because of its mathematical formula:

$$T = \sum_{i=1}^{n} \left(\frac{P_i}{P_T}\right) * \left(\frac{y}{\overline{y}}\right) * \ln\left(\frac{y}{\overline{y}}\right)$$

The agriculture and mining sectors' Theil indices are miniscule because the population working within agriculture and mining always less than 2 percents throughout the studied period. Thus, making total Theil index of the economy and total Theil index of manufacturing and service sectors approximately equal.

10. This oberservation shows that the extreme positive or negative contributions toward total Theil index of sectors 50, 51, 52, 53, and 54 are caused by the sheer amount of people working for these sectors, and are not the resulted of extremely high or low wage. This amount of working population within these sectors are also the main driver of extreme fluctuation whenever there are slight changes of wage relative to the naitonal average wage.

11. One of the reason these sectors being "disconnected" relates the the nature of these 4 sectors requires little inputs to produce outputs and little outputs used as inputs for other sectors.

12. There are examples of modern developed economics that have facing increasing productivity and pay gap. The most famous example is that of the United State where productivity and average wage have been diverge since the 1980s.

13. This is assuming that the discoragement of low skill jobs within these sectors means that workers will and have the ability to find jobs in another sectors, or engage in retraining programs to work in higher paying industries. Whether or not workers actually engages finding another jobs or going to higher paying industries through retraining programs is outside the scope of this paper.

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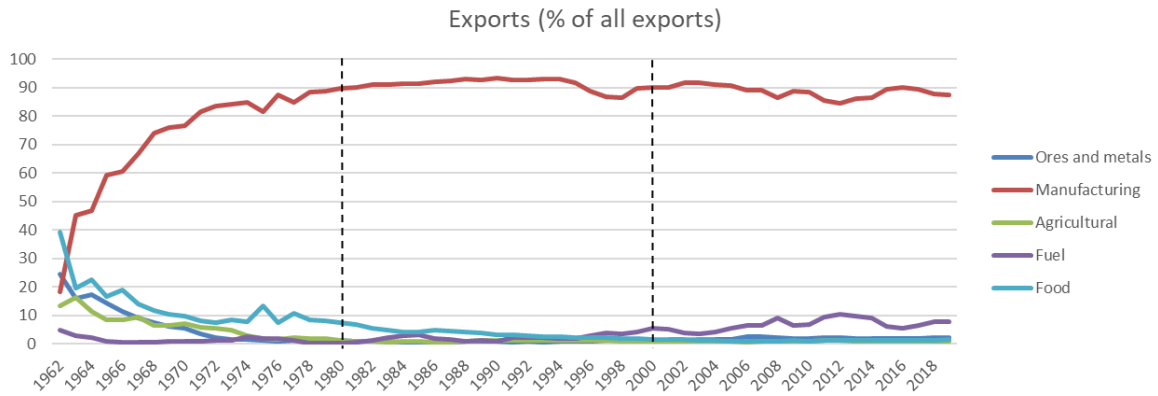
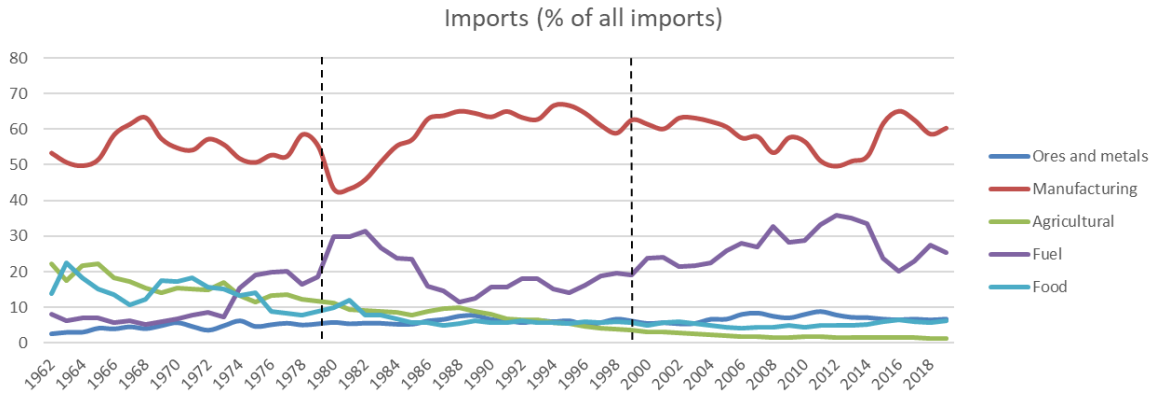
Appendix 1:



(a)



(b)

Source: Author's construction using data from the World Bank (World Development Indicators)

Figure A1: Korea export and import by type of merchandise (1962 – 2019)

Appendix 2

Computation of linkages

We calculate normalized direct input output linkages of manufacturing and service sector of South Korea economy using techniques provided by Miller and Blair (2009).

Direct backward linkages measure how sector j depends on inputs from other industries and is the sum of the elements of the jth column of matrix A. Hence the direct backward linkage for sector j is: $BL(d)_j = \sum_{i=1}^{n} a_{ij}$. The row vector containing the backward linkages of all sectors is given by: $b(d) = i'A$, where i is a column vector of 1's.

Thus, we can normalize direct backward linkages as: $\overline{b}(d) = i'A/i'Ai\ /n$,

Direct forward linkages measure the effect of sector i in the total production and is the row sum of matrix B. Hence the direct forward linkage for sector i is computed as: $L(d)_i = \sum_{j=1}^{n} b_{ij}$, the column vector containing the forward linkages of all sectors is given by: $j(d) = Bi$, where i is a column vector of 1's.

Thus, we can normalize direct forward linkages as: $\overline{f}(d) = Bi/i'Bi/n$.

Consequently, we can use forward and backward linkages analysis as a method to identify "key" or "leading" sectors in each economy by comparing the normalized direct and total forward and backward linkages to 1.

Appendix 3:

South Korea Labor Force

population in thousands

(2000 – 2020)