Thesis for the Degree of Master of Arts

ESTIMATING THE TOTAL FACTOR PRODUCTIVITY OF KOREA

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ABSTRACT

There has been a constant debate for decades on to what extent technical progress contributes to the economic growth of an economy. This is thanks to World KLEMS initiative which has been set up to promote and facilitate the analysis of growth and productivity patterns around the world, based on a growth accounting framework. At the heart of the initiative is the gradually building up of new databases on output, inputs and productivity at a detailed industry level, having as its objective to incorporate KLEMS-type data sets into Official Systems of National Accounts. The growth of outputs, inputs, and productivity at the industry level is crucial for understanding the sources of economic growth and the nature of Structural change.

Total factor productivity according to Economists, is an important factor in the process of economic growth. The evolution of total factor productivity (TFP) is a key determinant of long-run economic growth of a country. However, just how important it is has been a matter of ongoing controversy. Part of this controversy is about methods and assumptions. Total factor productivity growth is estimated as residual, using index number techniques. A New Economy critique of productivity points to unmeasured gains in product quality, while an environmental critique points to the unmeasured costs of growth. This paper is intended to show what results can be expected from the

productivity framework and what cannot. The ultimate objective is to demonstrate the considerable utility of the idea, as a counter-weight to the criticism, often mistaken, to which it has been subjected. Despite its flaws, the residual has provided a simple and internally consistent intellectual framework for organizing data on economic growth, and has provided the theory to guide a considerable body of economic measurement.

The focal point of this study is about to what extent technical progress will contribute to the economic growth of Korea. This research is conducted with sample data for1970 to 2012 of Korea KLEMS Growth and Productivity database with all its 72 industries compiled by Korea Productivity Center (KPC). Besides Capital and Labor, Energy, Material and Services are used as separate inputs unlike previous researchers who group energy, material and service inputs under intermediate inputs.

This paper aims at quantifying the total factor productivity (TFP) of the Korean economy using Korean KLEMS database to see to what extent technical progress has contributed to output by sector from 1970-2012. In this paper, focus is placed on all the 72 industries as prescribed by EU KLEMS-March 2011 updated database. The 72 industries, after being examined at aggregate level, were then classified into five different subgroups, such as Agriculture, Mining, Manufacturing, Utilities, and Services. TFP was calculated for the aggregate level as a whole consisting of 72 sectors as well as for five different subgroups.

The empirical results show that the total factor productivity growth rate for agriculture, utilities and services is insignificant as compared to that of the mining and manufacturing sectors. This is due to the Korean government's policy to prioritize the manufacturing sector because of its global competitiveness, thus suggesting it has reached high productivity level and its scope for further productivity improvement is limited. Therefore, there is the need to liberalize the services sector which probably may increase the productivity of the manufacturing subsectors which use liberalized services as inputs. This will go a long way in boosting other sectors like the utilities and agricultural sectors. From the results obtained from my findings, some policy recommendations are given that will help the Korean government and its policy makers for future industrial adjustments.

Keywords: Aggregate level, Agriculture, Growth accounting model, Korea KLEMS, Korea Productivity Center (KPC), Mining, Manufacturing, Services, Total Factor Productivity (TFP), Utilities, World KLEMS

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LIST OF ACRONYMS

AGG: Aggregate

AGR: Agriculture

ΔY: Change in output

ΔK: Change in capital input

ΔL: Change in labor input

ΔE: Change in energy input

ΔM: Change in material input

ΔS: Change in services input

ΔA: Change in technology (technical progress) input

gY: Gross output (growth in output)

gK: Growth of capital input

gL: Growth of labor input

gE: Growth of energy input

gM: Growth of material input

gS: Growth of service input

gA: Growth of technological input (TFP)

KLEMS: Capital, labor, energy, material & services

MIN: Mining

MNF: Manufacturing

MPK: Marginal productivity of capital input

MPL: Marginal productivity of labor input

MPE: Marginal productivity of energy input

MPM: Marginal productivity of material input

MPS: Marginal productivity of services input

MPA: Marginal productivity of technology (technical progress) input

OECD: Organization for Economic Cooperation and Development

RDD&D: Research, Development, Demonstration and Deployment

SRV: Services

sK: Share of capital input

sL: Share of labor input

sE: Share of energy input

sM: Share of material input

sS: Share of service input

sA: Share of technology (technical progress) input

TFP: Total Factor Productivity

UTL: Utilities

CHAPTER I – INTRODUCTION

In line with a country's movement from early recovery to a more persistent development, one of the main procedure matters is to know whether more investment in technology will improve the growth rate of that country. This issue is of great importance because the development has been weak so far. Unsecured economic and monetary policies successfully motivated a renewal from the 2008–2009 recessions, but an expansion in the rate of technological advancement is vital to push the economy into a more lasting enlargement point.

Decision makers have of recent known the link that exists between technology and growth as U.S. president's speech elaborately cited it. Following records, many of the policy debates in Washington have been about taxes and regulation, and these debates have often been put in relation to the effects for growth. Regrettably, these debates have turned to avoid the more central issue. "The effect of taking away regulatory barriers and tax cuts that will end up in a one-time increase in the level of gross domestic product (GDP), but not necessarily influencing its long-term rate of change, which relies critically on the rate of technological progress", as cited in an article entitled "Stimulating Economic Growth through Technological Advance" (2011).

A good number of authors retrospect the origin of total factor productivity to Solow's 1957 empirical work. The concept of total factor productivity (TFP), which is well-defined in simple terms as the ratio between real product and real factor inputs, was first presented by Tinbergen (1942) in an article written in German. The then econometric models of Paul Douglas (1948) and Tinbergen were put together with data from the aggregate production accounts produced by Abramowitz (1956) and Kendrick (1956) in Solow's rightly celebrated 1957 article entitled, "Technical Change and the Aggregate

Production Function." In this article, Solow acknowledged "technical change" with changes in the production function. Like Abramowitz, Kendrick, and Kuznets, Solow attributed almost all of U.S. economic growth to "residual" growth in productivity. Contemporarily, both growth accounting and productivity analysis by sector have captivated renewed attention on a global scale. The breakdown of inputs into capital (K), labor (L), energy (E), and intermediate materials (M) for full industry-level analysis of productivity growth was first realistic to the post-war US Economy by Jorgenson, Gollop, and Fraumeni (1987). The simple KLEM-methodology has been prolonged to cover eight European countries by the European KLEM project as explained in Timmer (2000) and Canada-Japan-USA database. In adding, the number of decomposed inputs increased to include imported goods (I) and services (S) forming the framework of KLEMS methodology as done by Forsgerau and Sorenson (1999).

Previous studies along the line of the KLEM approach in Korea such as Kwon and Yuhn (1990), of which main concerns were restricted to estimating elasticity of substitution and productivity growth, with the help of data in manufacturing sector only or value-added accounting. More current empirical works such as Kim and Hong (1997), Pyo (2001), Timmer and van Ark (2000), and Rhee (2001) have also made use of value-added accounting. The earlier exception of applying gross-output accounting was Kim and Park (1985) but it was also limited to manufacturing sector.

The drive of this paper is to proof as to what extend does technical progress contributes to the economic growth of Korea and present the results obtained.

After a review of data availability, our time ranges between the years 1970-2012 and the source of our data is Korea Productivity Center (KPC)[1].

The awareness of efficiency or "total factor productivity" was presented unconventionally (individually) by George Stigler (1947) from where it became the starting point for a major research program at the National Bureau of Economic Research. This program involved data on output of the U.S. economy from earlier studies by the National Bureau, especially the original estimates of the national product by Kuznets (1961). The input side employed data on capital from Raymond Goldsmith's (1962) system of national wealth accounts. However, much of the data was produced by John Kendrick (1956, 1961) who employed an obvious system of national production accounts, including measures of output, input, and productivity for national aggregates and individual industries.

Worth noting is the fact that from Griliches' "R&D, Education, and Productivity" (2000, p10), Solow was not aware of Tinbergen's work when he wrote his 1957 article. A series of other authors like Johnson (1950), Schmookler (1952), Kendrick (1956), Abramowitz (1956), and Rutton (1956) had improved on the TFP concept and measured TFP before Solow (1957). That clarifies the comments by Griliches (1996: 1328) when he says that Solow's 1957 paper was not so original, "not the question, nor the data, nor the conclusion... the 'new wrinkle' was the clear incorporation of economic theory into such a calculation and the use of calculus". In general, there are two ways of measuring total factor productivity (TFP): the first being the clear use of an aggregate production function for econometric estimations, while the second being the national income or growth accounting approach which uses discrete data and adopts an aggregate production function perfectly.

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1 See website: www.kpc.or.kr

Amongst the most important findings in the last 50 years is that, a large share of economic growth is driven by technological advancement. This was founded with a 1957 seminal paper by Robert Solow titled "Technical Change and the Aggregate Production Function" that was published in a paper entitled *Review of Economics and Statistics*. Solow, in this paper, established that capital and labor constituted less than two-thirds of growth while the remainder was technology. While Solow on his part discovered that the accumulation of physical capital accounts for approximately 12% of output growth per hour worked in the U.S between the years 1900-1949 with the remainder 88% attributed to growth of TFP, Abramovitz (1956) discovered that only 10% of output growth per head in the United States is associated with growth of factors of production between the years 1869-78 to 1944-53, while 90% of output growth is linked with growth of TFP.

Latest estimates are also indicative of the fact that since the late 1940s, about two-fifths of growth can be credited to technology. The usual measure of technological advancement is total factor productivity (TFP), which is the residual calculated by deducting the contributions of labor and physical capital from GDP. In the short run, TFP is unstable, but the fluctuations (rise and fall) average out over long periods of time. Using the Bureau of Labor Statistics' estimates, statistics show that technical progress has assisted with approximately 38 percent of growth since 1948 while when frequencies are lower or over longer periods, the trend in total factor productivity measures the rate of technical improvement.

According to Brian Snowdown (2002) in "Conversations on Growth, Stability and Trade: A historical perspective", there were clear problems with the Solow model. TFP is, by structure, a residual, rather than a direct measure of technology. TFP can in theory cover everything from new products or better products to course improvements, reallocation of resources, and increases in efficiency. So, since the 1950s, there has been a huge mass of empirical work—much of it done by economic statisticians, linking TFP to pragmatic measures of technology. These studies have established the fact that TFP is highly correlated with patents and indexes of scientific knowledge.

In the 1980s, a new major theoretical development occurred, when Paul Romer of Stanford claimed that technological advancement depended on investments in research, or human capital. Romer's model was in effect implying that rates of technical advancements could fluctuate over longer periods, which was also confirmed by Romer and other statisticians like George Evans and Seppo Honkapohja in "Growth Cycles", which was published in the *American Economic Review*. The 1960s and 1990s were well-off because they enjoyed faster rates of technological progress. As cited in a paper entitled "Stimulating Economic Growth through Technological Advance".

The exceptional economic enactment of East Asian countries has been researched at length. Common factors that contribute to high economic growth rates include stable macroeconomic conditions [2] (an economy with fairly constant output growth and low and stable inflation) and active investment in human capital[3] .According to Dale Weldeau Jorgenson, Masahiro Kuroda and Kazuyuki Motohashi, in a book entitled "Productivity in Asia: Economic Growth and Competitiveness", there are certain studies centered on the question of whether a high economic growth rate is as a result of factor inputs or total factor productivity growth. Generally, results on growth accounting at a macroeconomic level show that the Asian economic miracle has been realized by factor accumulation rather than by productivity growth as cited by Young(1995), Kim and Lau (1994), and Bosworth and Collins (1999).. The factor accumulation theory is reliable with the human capital explanation of the economic growth of Asian countries, if labor quality is properly measured.

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2 See https://en.wikipedia.org/wiki/Economic_stability

3 World Bank (1993)

However, these studies are conducted at a macro level, or fairly aggregated level, and the role of structural factors (a particularly useful tool in the interpretation of interference patterns obtained in X-ray, electron and neutron diffraction experiments) is flouted in the process of economic development. In the process of economic improvement, substantial changes in industrial organization from agriculture to manufacturing can be found in Japan, Korea, china and other countries. Comparable industry-level data is required to scrutinize such trends. Moreover, the significance of export in economic development is from time to time stressed in literature, according to Motohashi (2003). In this respect, industry-level productivity examination is useful to evaluate the effect of exporting sectors on the aggregated economic growth of East Asian countries.

Contemporarily, specifically since the 1997 financial crisis in the East Asian countries with Korea, significant changes such as in investment stagnation as seen in Pyo and Ha (2005) and changes in production input designs have taken place. One of the most essential changes is the demand for high productivity, which would recompense the current go-slows of growth rates in capital and labor inputs. As Krugman (1994), Lau and Kim (1994), and Young (1994) presented, the East Asian economic miracle could be concise as 'input-led' growth. Korea can't be left out in this respect of growth pattern as stated by Pyo and Rhee (2008).

From the paper written by Chun and Hyunbae entitled *''Multifactor Productivity in Korea and an International Comparison: Data and Productivity Estimates of the Korea Industrial Productivity Database''* the authors however conclude by saying that both the stagnation in investment and the decrease in average working hours require a productivity rush for long-term growth in Korea. In addition, a sharp decrease in the fertility rate in Korea's youthful population necessitates productivity increase in order to get better the present income level and ease the support of the large elderly population by the small numbers of working age adults. For these reasons, ‘productivity-driven’ growth is essential for Korea. Lewis (2004), on his part attributes the fast economic growth in Korea to both large labor input and capital accumulation.

Perversely, TFP plays a significant role on economic fluctuations, economic growth and cross-country per capita income differences. Nevertheless, just how important it is has been a matter of ongoing controversy. Part of this is about methods and assumptions. Total factor productivity growth is estimated as residual, using index number techniques. It is therefore a measure of our ignorance,' with ample scope for measurement error[4]. (Difference between the actual value of a quantity and the value obtained by a measurement. Repeating the measurement will improve (reduce) the random error (caused by the accuracy limit of the measuring instrument) but not the systemic error (caused by incorrect calibration of the measuring instrument). Another source of controversy arises from sins of omission, rather than commission. A New Economy critique of productivity points to unmeasured gains in product quality, while an environmental critique points to the unmeasured costs of growth.

This paper aims to explain the data structure of the Korea Industrial Productivity (KIP) database using EU KLEMS guidelines and to present estimates of multifactor productivity (MFP). A 72-industry classification was used according to EU KLEMS guideline; did the calculation thereof at the aggregate level, thereafter classifying them under the following five sub-sectors; agriculture, mining, manufacturing, utilities and finally the service sector, calculated total factor productivity. The different industry sectors in the Korean economy have shown different productivity trends and growth patterns

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4 See http://www.businessdictionary.com/definition/measurement-error.html#ixzz3Kh5UpM4B

according to their various characteristics of production, competition policies, and other economic and non-economic circumstances.

The results arrived at show the role played by total factor productivity (TFP) in both the aggregate level and the different industrial sectors in the economic growth of Korea. More to that, it also shows the contribution of TFP more specifically when put together with the other factor inputs vis-à-vis the Korean economy. The results obtained will go a long way in helping policy makers in particular and the government of Korea in general in their decision making as regards the future of its economy.

This study comprises five remaining chapters. The second chapter presents the literature review while chapter three is on the theory of economic growth. Chapter four presents the methodology and data used on measuring gross output, capital inputs, quantity of labor, energy input, material and service inputs, Chapter five presents the empirical results while chapter six concludes the paper with some policy recommendations.

CHAPTER II - LITERATURE REVIEW

From the mid-1980s, research awareness in economic growth has been reawakened and relieved by the accessibility of the Summers-Heston dataset [5]and stirred by the work of Baumol (1986), Romer (1986) and Lucas (1988) though somewhat more complicated than in the past. The questions asked are still options of what inspired Adam Smith's masterpiece entitled: "why do countries grow richer?" hypothetically, the study was freed from the pure neoclassical example that long-term per capita growth relied only on the rate of an exogenously determined technological progress. Subsequently, endogenous growth theories (an economic theory which argues that economic growth is generated from within a system as a direct result of internal processes. More specifically, the theory notes that the enhancement of a nation's human capital will lead to economic growth by means of the development of new forms of technology and efficient and effective means of production) have been advanced that permit for policy to effect long-run growth (e.g. Barro and Sala-i-Martin, 1995, and Aghion and Howitt, 1998) and empirical work has reinforced this inference. It is also revealed that capital factor accumulation in particular does not justify for the greater share of *constant* cross-country changes in per capita growth and that industrial countries seem to have noticed a slowdown in total factor productivity (TFP) growth.

This paper examines the role played by total factor productivity (TFP) in the tradable and non-tradable sectors (areas) of the Korean economy From authors like Pietro Cova, Massimiliano Pisani, Nicoletta Batini, and Alessandro

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[5]The Summers-Heston data set, or Penn World Table, has been the foundation of most empirical growth research since the mid-1980. The data set has been discussed in Heston and Summers (1996), and is described in more detail in Summers and Heston (1988, 1991). See also Nuxoll (1994)

Rebucci (2009), simulation results centered on a dynamic general equilibrium model of the world economy, and using the EU KLEMS database show that TFP growths in some economies can account for a substantial portion of the total worsening in an economy's trade balance. Dissimilarities in TFP growths through sectors can also partly explain the evolution of the real effective value of the Korean currency during this period.

In his 2002 paper, Caesar B. Cororaton presents estimates of total factor productivity (TFP) in the Philippines from 1967 to 2000. From the paper, it was observed that while TFP growth was mostly negative in the last thirty-five years, its contribution to economic growth developed from –4.26 percentage points in the mid of 1980s to +0.93 in 1998-2000. It is remarkable to note that this matches with the period in which major economic policy reforms were trailed enthusiastically. In spite of the increasing share of skilled labor to the total, its contribution to TFP growth is detected to have dropped in the passage of time. This may suggest a number of things, among which include: (a) a decline in the quality of education essential for productivity development in particular the marginal productivity of workers with higher education, as well as the efficiency of education itself, has dropped; and (b) negative brain drain influence on productivity of massive Filipinos working abroad. Efficiency improvements appear to have been gained from the movement of labor out of the sector (agriculture).

Favorable macroeconomic fundamentals, price stability and opening up to foreign trade and investment are critical factors affecting TFP growth. Spillover effects are detected to be far important from the growth in manufacturing than in agriculture and service sectors. Among the studies which estimate TFP using a value added measure are Dollar et al. (1988), Markus (1991), Dollar and Wolff (1993), Van Ark and Pilat (1993), and Harrigan (1997, 1999). The first three references use overall GDP price levels and as a consequence this causes alterations to the magnitude that relative prices differ across countries. Harrigan shows that this alteration is large enough to practically change the results of TFP comparisons. The two closely related studies by Van Ark (1993) and Van Ark and Pilat (1993) decrease value added by a price index which is constructed by direct comparisons of output prices at the wholesale level rather than using GDP price levels. Unfortunately, this theoretically superior procedure is exchanged by the very small number of matches across countries for specific products (Jorgensen, 1990). In addition to this, Ark (1993) and Ark and Pilat (1993) studies include only a small number of countries and years.

The second class of studies uses data on GDP, and decreases all factors (capital, labor, materials, energy, etc.) in an asymmetric (unequal) way. This procedure was pioneered (founded) by Jorgenson and various authors, and is undoubtedly the most theoretically appropriate and least restrictive method of making TFP comparisons. Jorgenson has comprehensively introduced this methodology. Because of tough data requirements needed for Jorgenson's procedure, however, there have been only two studies applying this method and comparing only two countries, the United States and Japan (Jorgensen et al. 1987; Jorgensen and Kuroda, 1990).

According to Hak K. Pyo, Keun Hee Rhee and Bongchan Ha's publication of 2006, same as Krugman, Young, and Lau and Kim's studies revealed that the East Asian economic miracle may be categorized as `input-led' growth. Nevertheless, both the stagnation in investment and the decline in average working hours joined with a fall in the fertility rate call for a productivity rush for a transformed sustainable growth in East Asia. "The purpose of our study is to identify the role played by TFP growth in the economic growth of Korea. This is based on a KLEMS model for the Republic of Korea which experienced a financial crisis in 1997 after joining OECD. We report estimates of KLEMS inputs and gross output in Korea based on 72-industry classification following EU KLEMS project guidelines. Estimates of 72 industry - level labor productivity and total factor productivity was also provided. It was revealed that Korea's catch-up procedure with industrial nations in its late industrialization has been principally input-led and manufacturing based", as specified by Hyunbae Chun, Hak K. Pyo and Keun Hee Rhee's paper titled "total factor productivity in Korea and international comparison" and as acknowledged in Timmer (1999) and Pyo (2001). Chun et al. went further to say "We have also established that TFP growth has been positively affected by the growth of labor productivity and output growth. Nevertheless, since its financial crisis in December 1997, the sources of growth seem to have swapped to TFP-growth centered and IT-intensive Service centered. But lesser productivity in service industries due to regulations and absence of competition appears to work against finding renewed sustainable growth path".

In Jesus Felipe and John Mccombie's (2006) "the tyranny of the identity: Growth accounting revisited" , there are claims that growth accounting may be carried out by directly differentiating the national income and product accounts individuality where total income equals labor's total compensation and total profits. Reasonably these researchers show that this is merely an exercise in the manipulation of an accounting identity without unavoidably having any theoretical foundation. To Felipe et al, simulations demonstrate that estimates of total factor productivity growth resulting from growth accounting performed with aggregate monetary data are not equal to the true rate of technological progress implied by the micro-data. This suggests that results from the traditional growth accounting approach may be very confusing.

It is of great importance to attach to this notion of total productivity the normal interpretation of the neoclassical theory of production and not to be satisfied with a conventional definition resulting from the application of an 'index calculation' type of formula, which leads to the introduction of the assumptions of a production function homogeneous of degree one and a structure of distribution according to marginal productivities. But Jorgenson and Griliches themselves recall that constant returns to scale may result from the agreement of measuring inputs in terms of efficiency units. In this way, writers such as Jorgenson and others attempt to show that the residuals of Solow and Denison echo a series of errors in measurement, which have led in particular to an underestimation of the role of capital. The principal modifications they make are as follows: firstly, capital is measured as a flow of productive services rather than as a stock; secondly, capital price series are rebuilt in terms of Divisia indices [6]of basic series supposed to be more consistent; thirdly, the use of capital is taken into thought and measured from the consumption of electricity; and finally, the weighting for capital services is calculated on the basis of user cost and includes interest rates, tax rates, capital gains and rates of decline. This set of rectifications authorized Jorgensen and Griliches to gain empirical endorsement of their theory.

Review of Korea

Among the key issues in the series of TFP studies on the Korean manufacturing sector from Jene K. Kwon's view point is the thoughtfulness of capital utilization rate. After integrating the capital utilization rate in the growth accounting framework, Kim and Kwon (1977) proved that the role of TFP growth to output growth in the Korean manufacturing sector fell

[6] A Divisia index is a theoretical construct to create index number series for continuous-time data on prices and quantities of goods exchanged. It is designed to incorporate quantity and price changes over time from subcomponents which are measured in different units -- e.g. labor hours and equipment investment and materials purchases -and to summarize these in a time series which summarizes the changes in quantities and/or prices.

meaningfully from 36 percent to 8 percent during the period 1962-71. Though, the thorough estimate of TFP growth wasn't accessible in their study.

In his 1986 paper, Kwon disintegrated TFP growth into technical change, non-constant returns to scale and change in capital utilization by connecting growth accounting to a cost function. The empirical result displayed that during the 1961-80 periods the TFP of the Korean manufacturing sector developed by 2.95 percent yearly and contributed 15.16 percent to output growth. To be more precise, the shares credited to TFP growth by technical change, non-constant returns to scale and change in capital utilization stood at 44.6 percent, 38.1 percent and 17.3 percent respectively.

In engaging growth accounting, Dollar and Sokoloff (1990) divided labor productivity growth into capital deepening and improvements in total factor productivity and scrutinized their relative contributions to labor productivity growth in 25 Korean manufacturing industries. It was evident that capital deepening accounted for over 70 percent of labor productivity growth in heavy industries, involving iron and steel, industrial chemicals and others. In divergence, a quick development in total factor productivity in light, medium and natural resource industries on average clarified about two-thirds of labor productivity growth. The maximum TFP growth was established in the leather (12.7 percent) and other chemical (12.6 percent) industries but the glass industry underwent a negative TFP growth rate of 4.1 percent. In the midst of TFP studies on Korean manufacturing industries, Dollar and Sokoloff (1990) stated the top annual TFP growth average of 6.1 percent for the whole manufacturing sector over the period 1963-79.

Kang and Kwon's (1993) measurement of the TFP growth of 22 Korean manufacturing industries, by means of growth accounting connected with translog cost function [7]same as taking account of the capital consumption rate. They proposed that TFP for the whole manufacturing sector on average developed at annual report rates of 3.43 percent and 0.16 percent for the period 1963-73 and 1973-83 respectively. Input growth accounted for 84 percent and 99 percent of the output growth for the two conforming periods, proposing that the output growth in Korean manufacturing industries was principally input-driven. Meanwhile, the disintegration of TFP growth into technical change returns to scale and capital consumption indicated that returns to scale accounted for half of the TFP growth and technical change paid 45 percent during the 1963-83 period.

Applying a Cobb-Douglas production function and value added as a measure of output, Pilat (1995) first equated the level of TFP in the Korean manufacturing industry with that of the United States founded on specific industry-of-origin purchasing power parities. He brought into being that the Korean manufacturing sector's TFP had increased from 9 percent of the US level in 1967 to over 18 percent in 1987. By means of growth accounting, Pilat established that the TFP growth of the overall manufacturing sector revealed an average annual report rate of 4.3 per cent between 1967 and 1987. In the midst of 13 Korean manufacturing industries, the maximum average annual TFP growth rate of 10.4 percent happened in the electrical machinery and equipment industry.

By means of the short-run generalized Leontief cost function, Park and Kwon (1995) probed the TFP growth of 28 Korean manufacturing industries, assembled as heavy and light industries, coupled with the effects of markups (market power) scale economies and capacity utilization. The empirical results presented that there was a significant difference between conventional TFP

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[7] A *cost function*, such as the *Translog* (Transcendental Logarithmic) production *function*, can be used to model how a firm combines inputs to produce outputs

growth (2.0 percent) and generalized TFP growth (-1.6 percent) for Korean manufacturing as a whole over the period 1967-89. This signified that due to the failure to differentiate the consequences of scale economies and capacity utilization in the measurement of TFP growth, the conventional TFP estimates were theoretically biased. Therefore, it was disputed that the negative TFP growth obtained from the generalized TFP measure replicated the true degree of technology deterioration in the Korean manufacturing sector.

On adding to examine the effect of government interventions (tariff, tax incentives and so on) on the TFP growth of the manufacturing sector in Korea, Lee (1996) also made available TFP growth estimates for 38 manufacturing industries over four isolated periods: 1962-67, 1968-72, 1973-76 and 1979-83. As there was no aggregate (collective) TFP growth estimate for the whole manufacturing sector and no estimates for 38 industries over the whole period, the outcomes for individual industries are not accessible here but are presented in Lee (1996, p.408).

In a comparative study relating to Korea and Taiwan, Okuda (1997) delivered TFP growth estimates for Korean manufacturing industries by means of the growth accounting framework. The Korean manufacturing sector as a whole had an average annual TFP growth rate of 3.2 per cent for the period 1970- 93. In relations of relative contribution to output growth, 22.7 percent of output growth was credited to TFP growth throughout the sample period. Furthermore, the first and second highest annual TFP growth rates were realized in the metals (8.4 percent) and machinery (7.6 percent) industries; in contrast, the oil refinery industry did not record any improvement in TFP.

Lee et al. (1998) applied the non-parametric Malmquist productivity index for 36 Korean manufacturing industries over the period 1967-93. Generally, the TFP of the whole manufacturing sector rose by an annual report rate of 0.286 percent. The disintegration (breakdown) of TFP growth revealed that technological progress (1.141 percent per annum) was the major source of TFP progress. Nonetheless, the adequate technological progress joined with low TFP growth implied that there was a deterioration (decline) in technical efficiency (-0.855 percent per annum) over time, which was the case in many Korean manufacturing industries.

Hwang (1998) differed with the views of Young (1995) and others who argued that TFP performance in the East Asian manufacturing sectors was similar with that of developed countries. Applying two different approaches (the conventional growth accounting and augmented Solow models), Hwang revealed that TFP for Korea's whole manufacturing sector augmented by average annual report rates of 2.06 percent and 2.46 percent between 1973 and 1993 respectively. Additionally applying Johansen's co-integration investigation, Hwang proposed that the Korean manufacturing sector could be characterized by an endogenous growth model due to increasing returns to scale in production technology or a learning-by-doing effect.

In line with Hall (1988) and Harrison (1994), Kim (2000) differentiated between 'standard' TFP growth and 'true' TFP growth for 36 Korean manufacturing industries over the period 1966-88 due to the prevalence of imperfect competition and non-constant returns to scale. With Korea's *Input Output Tables* and regulating the growth in labor input for variations in hours worked and education level, the product derived from traditional growth accounting exposed that the un- weighted average TFP growth of Korean manufacturing industries was 1.9 percent per annum. After excluding the effects of imperfect competition and non-returns to scale, the true un-weighted TFP growth estimate for the whole manufacturing sector was about 0.5 percent per annum throughout the sample period, accounting for only 3 percent of output growth in the Korean manufacturing sector (Kim, 2000).

Kwack (2000) measured the TFP growth of Korean manufacturing industries over the period 1971-93. Using the growth accounting approach, the outcomes showed annual TFP growth rates of 3 percent, 4.5 percent and 1.1 percent in the total, heavy and light manufacturing industries respectively. The input of TFP growth to value added growth for the whole manufacturing sector was 21.6 percent for the sample period but fell to 9.4 percent in the more recent period 1989-93.

Yuhn and Kwon (2000) extended their work of 1990 and censured the use of value added as a measure of manufacturing output in any productivity analysis due to its failure to gratify the separability hypotheses. They then used the growth accounting approach to estimate the TFP growth of the Korean manufacturing sector as a whole. The outcome advocated that TFP developed by an average annual rate of 1.52 percent between 1962 and 1981 and the support of TFP growth to output growth was 7.6 percent.

The examination of Kim and Han (2001) on the TFP growth of Korean manufacturing industries by using a stochastic production frontier approach. In line with Kumbhakar et al (2000), TFP growth was disintegrated into four components: technical progress, changes in technical efficiency, changes in allocating efficiency and scale effects. Using the annual data for 508 manufacturing firms itemized on the Korean Stock Exchange from 1980 to 1994, Kim and Han established that technical progress was a key contributor to TFP growth and that technical efficiency development also had an important effect. The average annual TFP growth rate of the entire manufacturing sector was 7.3 percent despite the decreasing trend. Among the individual industries, the fabrication industry (fabricated metal products, machinery and equipment) enjoyed the highest average annual TFP growth of 9.4 percent during the same period, followed by textiles (7.7 percent) and food (7.1 percent).

Recently Mahadevan and Kim (2003) used the random coefficients model and firm-level data from 135 firms listed on the Korean Stock Exchange to estimate the TFP growth for four industries at the 2-digit level during 1980-94. Their study disclosed that output growth in the four manufacturing industries was increasingly productivity-driven from the mid- 1980s. Note that because the sample size was relatively small and probably based on large firms, their results may not be comparable with the present study and other studies deliberated above.

CHAPTER III - ECONOMIC GROWTH THEORY

From the view point of Neri Salvadori, interest in the study of economic growth has experienced outstanding ups and downs in the history of economics. It was dominant in classical political economy from Adam smith to David Ricardo, and then in its ‘critique’ by Karl Marx, but moved to the edge during the so-called ‘marginal revolution’.

Classical economists like Adam smith’s approach is of the view that production involves labor, produced means of production and natural resources. In contrast to some contributions to modern growth theory none of these factors – labor, capital and land – were considered negligible other than in theoretical experiments intended ‘to illustrate a principle’ (Ricardo). To understand real growth processes one had to come to grips with the interconnected laws governing the growth of population, the pace of accumulation and the rate and bias of technical innovation in an environment characterized by the scarcity of natural resources.

From Adam smith’s point of view, there is no upper limit to labor productivity. This is why smith sustained that an investigation of the growth of income per capita is first and foremost an inquiry into ‘the causes of this improvement, in the productive powers of labor, and the other, according to which its produce is naturally distributed among the different ranks and conditions of men in the society’.

Smith’s analysis foreshadows or prefigures the concepts of *induced* and *embodied* technical progress, *learning by doing*, and *learning by using*. The invention of new machines and the improvement of known ones is said to be originally due to the workers in the production process and ‘those who had occasion to use machines’. At a more advanced stage of society making machines’ became the business of a peculiar trade’, engaging ‘philosophers or men of speculation, whose trade it is, not to do anything, but to observe everything; and who, upon that account, are often capable of combining together the powers of the most distant and dissimilar objects’. Research and development of new industrial designs becomes ‘the principal or sole trade and occupation of a particular class of citizens’. New technical knowledge is systematically created and economically used, with the sciences becoming more and more involved in that process. The accumulation of capital propels (pushes) this process forward, opens up new markets and enlarges existing ones, increases effectual demand and is thus the main force behind economic and social development.

From Adam smith’s point of view, improvement was seen from the aspect of the growth of national wealth. Hence, the principle of national advantage was considered as an essential criterion of economic policy. Improvement was conceived also within the framework of a need to preserve private property and hence the interests of the property-owning class. From this perspective, they tried to show that the exercise of individual initiative under freely competitive conditions to promote individual ends would produce results helpful to society as a whole. Conflicting economic interests of different groups could be reconciled or settled by the operation of competitive market forces and by the limited activity of ‘responsible government.

David Ricardo on his part set aside what may be called *statically and dynamically increasing returns.* The positive or valuable effects of capital accumulation on productivity arbitrated through the extension of the division of labor play hardly any role in his analysis. In modern parlance (phrasing), the problems of externalities which figured prominently in smith’s analysis are given only scant (slight or limited) attention. This does not mean that Ricardo was of the opinion that they are of negligible interest. One has to recall that Ricardo explicitly subscribed (contributed) too much of smith's analysis and set himself the moderate task of correcting views of the Scotsman that he deemed wrong. These concerned especially smith's view of the long-term trend of profitability as capital accumulates. Ricardo was keen to show that, given the real wage rate, the rate of profits cannot fall as a consequence of the 'competition of capital', as smith had argued, but only because of diminishing returns due to scarcity of land. Much of Ricardo's argument was therefore developed (improved) in terms of the implicit assumption that the set of (constant returns to scale) methods of production from which cost-minimizing producers can choose, is given and constant. In such a framework the question then is how scarce natural resources affect profitability as capital accumulates. The resulting vision is reflected in what Ricardo called the 'natural course' of events.

For both smith and Ricardo the required size of the workforce is essentially generated by the accumulation process itself. In other words, labor power is treated as a kind of producible commodity. It differs from other commodities in that it is not produced in a capitalistic way in a special industry on a par (balance) with other industries, but is the result of the interplay between the growth of the working population and the socioeconomic conditions. In the most simple and abstract conceptualization possible, labor power is seen to be in elastic supply at a given real wage basket. Increasing the number of baskets available in the support of workers involves a proportional increase of the workforce. In this view the rate of growth of labor supply to any given rate of growth of labor demand without necessitating a variation in the real wage rate. As a result of their work in economic analysis, the classical economists were able to provide an account of the broad forces that influence economic growth and of the mechanisms underlying the growth process. An important achievement (accomplishment) was their recognition that the accumulation and productive investment of a part of the social product is the main (central) driving force behind economic growth and that, under capitalism, this takes the form mainly of the reinvestment of profits. Armed with this recognition, their critique of feudal society was based on the observation among others that a large part of the social product was not so invested but was consumed unproductively or fruitlessly.

The basic problem of growth theory is to describe the behavior of an expanding economy over time. The more traditional or customary way to conceive growth is to consider it as due to the accumulation of capital. In its attempt to construct a theory of growth (e.g. Solow, 1956), neoclassical economics sought to extend its static theory of distribution to a dynamic context, and in order to succeed in this attempt, it had to assume decreasing returns with respect to the accumulated factor as seen in the example of Bertola's 1993, 1994 papers. This assumption results in the accumulation process having only transitory effects on the rate of growth, whose long-run behavior therefore remains unexplained within the model and is characterized by the constancy of the capital/labor and product/labor ratios. As a consequence, empirically relevant examples of permanent growth like sustained increase in the per capita stock of capital are attributed (credited) to the 'compensating influence of residual factors that have been assumed away in the model'(Kaldor, 1961).

The properties of the neoclassical growth theory have always been questioned not only on empirical but also on theoretical grounds. One of the main criticisms has been that the rate of growth of economies should depend upon the thriftiness of the economy and that technical change should be the outcome of intentional decisions of economic agents. The recent literature on the endogenous growth theory has been successful in dealing with such criticisms and has been able to construct a variety of models in which the rate of growth depends upon the saving decision of households and/or in which technological change is the intentional or unintentional outcome of the maximizing behavior of agents.

In search for a growth theory which explains (elucidates) the real dynamics of economies, Kaldor criticizes Harrod-Domar's model on the grounds that it explains only the growth of a non-recurring economy with full employment of savings rather than the *actual* rate of growth of a system that does not maintain a shifting equilibrium. Indeed, he held that in a system in which growth results from successive booms and slumps, the actual trend is determined by the 'natural rate' of growth (Kaldor, 1954).

The great or large increase in material well-being that has taken place in advanced (developed) economies since the industrial revolution has been categorized by change and innovation. We do not just have more of the same goods and services; we also have new ones that would have been unimaginable to someone in the 18th century. People then knew nothing of such modern marvels (prodigies/ wonders) as personal computers, jet airplanes, satellite communication, microwave ovens, and laser surgery. The knowledge (acquaintance/ familiarity) of how to design, produce, and operate these products and processes had to be discovered, through a succession (sequence/series/chain) of countless innovations. More than anything else, it is these innovations that have created the affluence (material comfort/ prosperity) of modern times. Beyond making us richer, they have changed (altered) the way we live and work.

Innovations (improvements) do not fall like manna from heaven. Instead, they are created by human beings, operating under the normal range of human motivations, in the process of trying to solve production problems, to learn from experience, to find new and better ways of doing things, to profit from opening up new markets, and sometimes just to satisfy their curiosity. Innovation is thus a social process; for the intensity and direction of people's innovative activities are conditioned by the laws, institutions, customs, and regulations that affect their incentive and their ability to appropriate rents from newly created knowledge, to learn from each other's experience, to organize and finance R&D, to pursue scientific careers, to enter markets currently dominated by powerful incumbents, to accept working with new technologies, and so forth.

"Thus economic growth involves a two-way interaction between technology and economic life: technological progress transforms the very economic system that creates it. The purpose of endogenous growth theory is to seek some understanding of this interplay between technological knowledge and various structural characteristics of the economy and the society, and how such interplay results in economic growth", as stated by Philippe Aghion, Peter Howitt and Cecilia García-Peñalosa in a paper entitled "Endogenous Growth Theory".

Joseph Schumpeter's notion of creative destruction is based on the competitive process by which entrepreneurs are constantly looking for new ideas that will make their rivals' ideas outdated. By focusing explicitly on innovation as a separate economic activity with distinct economic causes and effects, this approach opens the door to a deeper understanding of how organizations, institutions, market structure, market imperfections, trade, government policy, and the legal framework in many domains affect (and are affected by) long-run growth through their effects on economic agent's motivations to engage in innovative (or more generally knowledge-producing) activities.

An earlier element to endogenous growth theory is the so-called AK approach, by which technological knowledge is intellectual capital, which can be taken together with computers, crankshafts, and other forms of capital into a single aggregate K. This point of view eradicates the distinction between technological progress and capital accumulation. And it depicts economic growth as basically a private activity; economies become richer in the same way Robinson Crusoe might- by saving at a rate determined by inter-temporal preferences. In spite of its reduced- form representation of the process of knowledge accumulation, the AK formulation appears to be quite useful, especially when discussing government policies from an aggregate perspective. There exist several excellent surveys of endogenous growth theory, such as the books by Grossman and Helpman (1991a), Barro and Sala-I-martin (1995), the survey articles by Dinopoulos (1993) and Stern (1989), and the symposium in the journal of economic perspectives.

Understanding "the nature and causes of the wealth of nations," the reasons why some countries are rich and others poor, was the main purpose of inquiry for economic science in the early days of its existence. But with the passing of time, that aim was slowly abandoned in favor of other subjects. To the economists' disclaimer, this was partly the result of a serious lack of data on which to ground their theories (and "theory without measurement" doesn't really do). The publication in recent years of two major data banks for a large number of countries has eased the situation; hence the "main questions" are back. In fact, they have become once again the center of economic research.

There is no doubt, therefore, that more time will have to pass before we can separate robust results from "intellectual white noise" in this new flow of research. However, on some very important issues a consensus has been reached that new ideas (such as the importance of human capital accumulation, the process of "learning-by-doing," and the existence of externalities from technical innovation) will remain with us and are likely to be fruitful.

We thus have "the facts" and the methodology. What we need now is the theory capable of accommodating the facts, and the first problem to be addressed is where to start because the theory of economic growth is as old as economics itself. Since it is not our intention to write a story of the ideas on the topic, most practitioners of our discipline will agree that the proper place to start is the neoclassical model. This was originally developed by Solow (1956) and Swan (1956). The same year then, but independently of each other and published in different journals: one (Solow's version) American, the other (Swan's) Australian. This may explain why for many years the neoclassical model was popularly known as "the Solow model." In truth, and justice is being done lately, it is now known as "the Solow-Swan model."

CHAPTER IV - METHODOLOGY AND DATA

In this chapter we constructed gross output and inputs of capital, labor, energy, materials, and services (KLEMS) variables using Korea KLEMS. Our data is taken from Korea productivity center (KPC) and it is between the years 1970 to 2012. The data constitutes of gross output (measured in millions of Korean won), real capital stock, quantity of labor (millions of total working hours), real energy, material and service inputs (all measured in millions of Korean won.

Generally speaking, there are two approaches to measuring TFP: the explicit use of an aggregate production function for econometric estimations, and the national income or growth accounting approach which uses discrete data and assumes an aggregate production function implicitly. The econometric approach begins with the specification of a production function, say of the Cobb-Douglas constant-returns-to-scale type**.**

4.1. Methodology

Growth accounting is a method which is used to determine the contribution of each factor input to the growth of output. Any unexplained growth by factor input growth is being attributed to technical progress. Commencing with the industry-level production function and showing how this allows us to quantify the sources of output growth. In general, we follow the growth accounting methodology as developed by Dale Jorgenson and associates as outlined in Jorgenson, Gollop and Fraumeni (1987) and more recently in Jorgenson, Ho and Stiroh (2005). We follow their notation as close as possible. It is based on production possibility frontiers where industry gross output is a function of capital, labor, energy, material and services inputs and technology, which is indexed by time, *t*. Each industry, indexed by *j*, can produce a set of products indexed by i indicated by the production possibility set g. Each industry has its own production function and purchases a number of distinct intermediate inputs (energy inputs indexed by E, material inputs indexed by M and services inputs indexed by S) capital service inputs indexed by K, and labor inputs indexed by L.

The production functions are assumed to be separable in these inputs, so that:

$Y_J = g_j(Y_{ij}) = f_j(K_j, L_j, E_j, M_j, S_j, A_j)$ ………………………………. (Eq. 1)

$P_j^Y Y_j = P_j^K K_j + P_j^L L_j + P_j^E E_j + P_j^M M_j + P_j^S S_j$………………….......... (Eq. 2)

where Y is output, K is an index of capital service flow, L is an index of labor service flows, with capital and labor as primary factors of production, while E is an index of energy input, M an index of material input and S, an index of services input, which constitute of the intermediate inputs purchased from the other domestic industries and imported products. Under the assumptions of constant returns to scale and competitive markets, the value of output is equal to the value of all inputs as found in equation 2 above.

All variables are also indexed by time, but the time subscript is suppressed in the remainder of this paper wherever possible for brevity.

Under the standard assumption of profit maximizing behavior, competitive markets, such that factors are paid their marginal product, and constant returns to scale, we can define TFP growth (ΔInA_j) as follows:

$\Delta InA_j = \Delta\, InY_{jt} - S_{jt}^K\, \Delta InK - S_{jt}^L\, \Delta InL - S_{jt}^E\, \Delta InE - S_{jt}^M\, \Delta InM -$

$S_{jt}^S\, \Delta InS$ ……………………………………………………………… (Eq.3)

Growth of TFP is derived as the real growth of output minus a weighted growth of inputs where

ΔK denotes the change between year t-1 and t, and S_{jt} denoting share of the input in the nominal value of output. The value share of each input is defined as follows:

$$S_{jt}^{K} = \frac{P_{jt}^{K} K_{jt}}{P_{jt}^{Y} Y_{jt}}\ ;\ S_{jt}^{L} = \frac{P_{jt}^{L} L_{jt}}{P_{jt}^{Y} Y_{jt}}\ ;\ S_{jt}^{E} = \frac{P_{jt}^{E} E_{jt}}{P_{jt}^{Y} Y_{jt}}\ ;\ S_{jt}^{M} = \frac{P_{jt}^{M} M_{jt}}{P_{jt}^{Y} Y_{jt}}\ ;\ S_{jt}^{S} = \frac{P_{jt}^{S} S_{jt}}{P_{jt}^{Y} Y_{jt}} \quad (Eq.4)$$

The assumption of constant returns to scale implies $S_{jt}^{K} + S_{jt}^{L} + S_{jt}^{E} + S_{jt}^{M} + S_{jt}^{S} = 1$ and allows the observed input shares to be used in the estimation of TFP growth in equation (3). This assumption is common in the growth accounting literature (see e.g. Schreyer 2001). Alternatively, one can perform growth accounting without the imposition of constant returns to scale and use cost shares, rather than revenue shares to weight input growth rates (Basu, Fernald, and Shapiro 2001).

Rearranging (4) yields the standard growth accounting decomposition of output growth into the contribution of each input and TFP (denoted by AY):

$$\Delta InY_{jt} = S_{jt}^{K}\,\Delta InK + S_{jt}^{L}\,\Delta InL + S_{jt}^{E}\,\Delta InE + S_{jt}^{M}\,\Delta InM + S_{jt}^{S}\,\Delta InS + \Delta\, InA_{jt}^{Y} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (Eq.5)$$

where the contribution of each input is defined as the product of the input's growth rate and its two period average revenue share.

To rearrange equation 5 above, we have;

$$\Delta InA_{jt}^{Y} = \Delta InY_{jt} - S_{jt}^{K}\,\Delta InK - S_{jt}^{L}\,\Delta InL - S_{jt}^{E}\,\Delta InE - S_{jt}^{M}\,\Delta InM - S_{jt}^{S}\,\Delta InS$$

……………………………………………………………………….. (Eq.6)

Where ΔInA_{jt}^{Y} denotes growth of A, ΔInY_{jt} for growth of Y, $S_{jt}^{K}\,\Delta InK$ for contribution of capital input, $S_{jt}^{L}\,\Delta InL$ for contribution of labor input, $S_{jt}^{E}\,\Delta InE$ for contribution of energy input, $S_{jt}^{M}\,\Delta InM$ for contribution of material input, and $S_{jt}^{S}\,\Delta InS$ for contribution of services input.

For simplicity, equation 6 can be decomposed into;

$$g_A\,(TFP) = g_Y - s_K g_K - s_L g_L - s_E g_E - s_M g_M - s_S g_S \quad \ldots\ldots\ldots\ldots\ (Eq.7)$$

where $g_A\,(TFP)$ denotes the growth rate of technical progress (A), g_Y denoting the growth rate of output (ΔInY_{jt}). Define;

$s_K = S_{jt}^{K};\ \ s_L = S_{jt}^{L};\ \ s_E = S_{jt}^{E};\ \ s_M = S_{jt}^{M};\ \ s_S = S_{jt}^{S}$ and

$$g_K = \Delta InK\ ;\ g_L = \Delta InL\ ;\ g_E = \Delta InE\ ;\ g_M = \Delta InM\ ; g_S = \Delta InS$$

Therefore,

$s_K g_K$ denoting the contribution of capital input to the growth of the economy, $s_L g_L$ denoting the contribution of labor input to the economic growth , $s_E g_E$ for the contribution of energy input, $s_M g_M$ denoting the contribution of material input, and $s_S g_S$ denoting the contribution of services input, respectively.

4.2. Data structure & presentation

4.2.1. Data structure

Gross Output

The Bank of Korea's National Accounts reports annual sequence of nominal gross outputs at basic prices, both nominal and real value-added at basic prices, nominal compensation of employees, and operating surplus at current prices of 78 industries with 34 manufacturing industries. Since some industries in this 78-industry classification do not match with our 72-industry classification, the Bank of Korea's internal data that includes both nominal and real gross output series for more detailed industries is used. We have reclassified these 72 industries into 5 different sectors; agriculture (1-3), mining (4-8), manufacturing (9-39), utilities (40-43) and services (44-72).

Capital Input

The accomplishment of late industrialization by recently industrializing economies couldn't have been possible on condition that both the rapid accumulation of capital and its changing distribution among sectors were not recognized in their development process. However, it is difficult to identify these factors empirically because the time series data of capital stocks in emerging economies by both types of assets and by industries are not readily available. The lack of investment data for a suitably long period of time to apply the continuous inventory estimation method was the main cause of the problem. However, the National Statistical Office of the Republic of Korea has conducted nation-wide national wealth survey four times since 1968. Korea is one of a few countries which have conducted economy-wide national wealth surveys at a regular interval. Since the first National Wealth Survey (NWS) was conducted in 1968, the subsequent surveys were made in every ten years in 1977, 1987, and 1997, respectively. The estimation of national wealth by types of assets and by industries was made by Pyo (2003) by modified perpetual inventory method and polynomial benchmark year estimation method using four benchmark-year estimates. As for the data used in estimating capital, we used capital stock (2000 prices) measured in Korean Won (KRW) and its share, which is the share of capital.

Labor Input

To measure labor input for KLEMS model, we made use of the quantity data of labor such as hours worked (total working hours) and also the share of labor. These are the only information collected from the database for this study. The remaining information are based on assumptions. Take for example, the issue of gender, age and education. Following the suggestion by the EU KLEMS Manual and Jorgenson, Gollop and Fraumeni (1987), we have used two types of gender (male and female), three types of age (below 29, 30-49, and 50 or above), and three types of education (middle school or below, high school, college or above) and, therefore, there are total 18 categories of labor.

Intermediate Input

National Accounts also report annual series of intermediate inputs which are decomposed into energy, materials, and services inputs. Identified are some commodities as energy inputs, and primary commodities while some manufacturing commodities as material inputs, and remaining service inputs (44-72) as service inputs.

4.2.2. Data presentation

The data below, from Korea Productivity Center (KPC) contains results based on calculating Korea's total factor productivity growth between 1970 – 2012. This was obtained using Korea KLEMS Growth and Productivity database with all its 72 industries taken into account.

Tables 1-6 show data of output and inputs (KLEMS) at both aggregate and sector levels for 1970-2012 (2000 prices, KRW million &millions of total working hours) based on equation 1.

Table 1: Data of output and inputs (KLEMS) at aggregate level for 1970-2012 at (2000 prices, KRW millions & millions of total working hours).

AGG	Y_AGG	K_AGG	L_AGG	E_AGG	M_AGG	S_AGG
1970	111,613,235	54,304,255	24,451	5,030,043	25,264,038	14,905,798
1971	122,146,376	67,565,939	25,309	5,731,476	28,136,154	16,723,119
1972	129,188,992	78,877,860	26,078	6,227,058	30,463,068	17,737,271
1973	148,271,786	89,948,948	27,050	7,521,271	36,859,924	20,644,163
1974	160,272,036	85,477,550	28,627	8,148,912	41,144,312	22,082,617
1975	173,349,319	90,486,293	32,276	9,221,468	45,319,134	24,529,105
1976	195,108,652	107,646,028	34,366	10,632,732	53,631,651	27,133,336
1977	214,593,245	126,612,620	35,648	12,046,699	59,448,674	29,610,629
1978	241,241,374	144,514,735	37,371	14,101,807	70,436,089	33,575,560
1979	259,397,182	155,830,204	38,056	15,345,255	76,450,772	36,228,999
1980	257,669,509	153,413,969	36,982	15,934,736	76,061,444	36,187,073

1981	273,898,027	169,533,138	36,408	16,945,836	81,283,828	37,946,948
1982	294,172,016	196,265,101	37,827	17,977,559	87,601,018	40,970,978
1983	331,654,071	231,076,185	37,806	20,663,726	101,213,865	46,705,283
1984	363,817,918	273,104,763	37,647	22,855,675	113,431,064	51,429,250
1985	389,721,415	311,727,599	38,464	24,685,040	121,519,523	55,288,194
1986	440,335,739	362,988,386	39,697	25,655,154	144,931,761	61,986,409
1987	502,008,860	417,818,018	42,385	28,075,655	172,818,408	71,194,650
1988	560,579,307	467,884,688	43,340	30,521,066	196,147,652	80,368,591
1989	598,282,099	526,538,590	44,397	33,606,800	208,560,277	86,761,742
1990	659,042,573	579,444,295	45,227	35,646,116	222,857,461	107,840,304
1991	722,012,835	644,201,560	45,396	40,499,740	244,056,791	119,202,324
1992	764,461,970	724,355,961	47,196	44,912,488	256,995,435	126,775,952
1993	813,223,010	840,033,639	48,609	45,984,425	276,025,497	135,903,901
1994	884,421,847	957,078,591	49,787	48,462,464	303,475,362	149,068,148
1995	969,102,005	1,072,797,614	51,162	65,667,973	319,698,548	167,366,565
1996	1,042,319,043	1,213,420,213	50,854	72,910,761	341,636,774	184,815,202
1997	1,100,406,287	1,327,190,242	51,303	83,109,744	355,898,299	197,168,621
1998	1,024,179,273	1,402,401,944	48,439	79,742,326	324,250,413	182,532,609
1999	1,149,848,591	1,488,841,092	50,338	86,671,416	383,137,460	204,420,726
2000	1,269,951,936	1,592,500,727	51,636	92,163,226	435,904,466	227,830,207
2001	1,319,231,895	1,691,199,664	52,111	93,624,527	450,731,917	240,450,977
2002	1,429,588,818	1,798,354,061	53,200	97,285,625	496,825,517	265,041,574
2003	1,490,601,833	1,908,951,739	53,124	97,721,643	530,037,630	274,850,468
2004	1,582,885,521	2,019,748,909	55,886	102,681,690	573,736,341	288,732,557
2005	1,686,180,549	2,130,671,608	54,220	111,661,287	623,161,721	307,425,789
2006	1,778,083,693	2,245,215,101	54,656	116,392,617	661,271,156	324,930,106
2007	1,934,688,162	2,365,077,517	53,455	125,353,446	743,908,022	362,774,265
2008	1,995,253,605	2,475,272,194	53,220	131,180,111	763,630,156	375,783,770
2009	2,001,017,885	2,575,379,893	54,688	127,870,307	758,569,446	383,103,954
2010	2,262,071,866	2,688,677,585	54,941	144,712,098	898,817,859	424,459,025
2011	2,396,217,079	2,796,061,113	54,464	152,073,288	972,217,026	445,177,072
2012	2,444,964,159	2,894,149,158	53,560	156,647,915	988,640,016	454,639,067

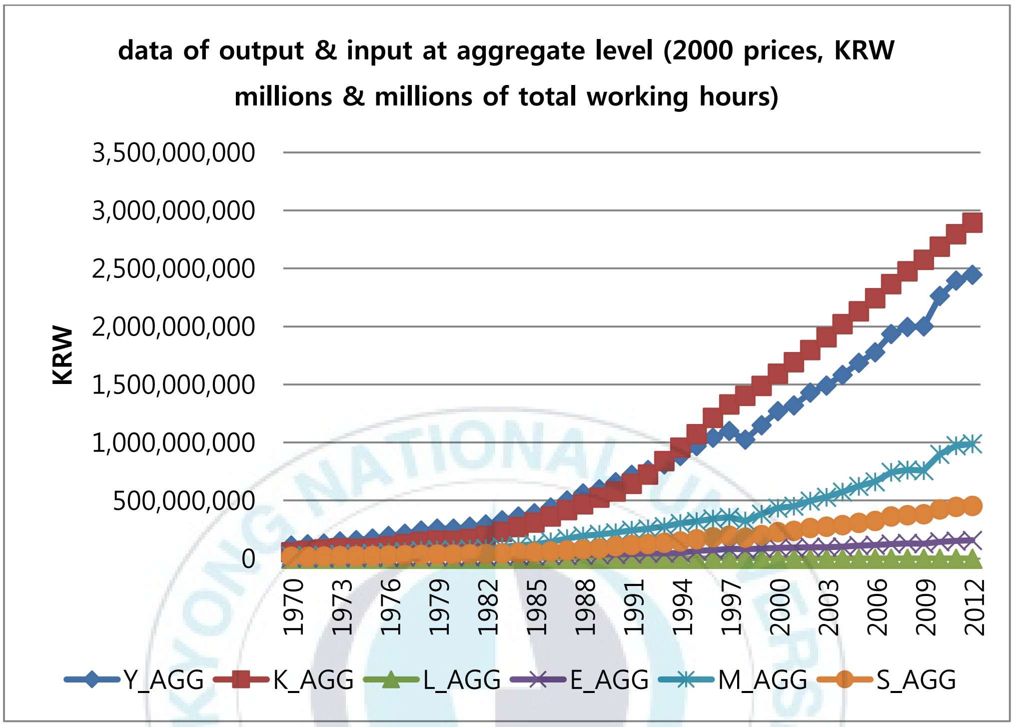
Source: www.kpc.or.kr

From table 1 above, capital stock witnessed an increase far more than gross output from the years 1993 to 2012 unlike in the preceding years that is from 1970 to 1992 where gross output was greater than capital stock. On the other hand, the other factor inputs experienced a normal growth rate which was as a result of a change in time.

In the late 1990s, a financial disaster struck Asia. Many Southeast and East Asian countries found themselves in a seriously troubled state, witnessing their real GDP growth rate plunge, their stock markets collapse, and their government deficit become unsustainably high. Among the group of unfortunate countries affected by the 1997 Asian Financial Crisis was South Korea, which had been showing steady and robust growth in the years immediately earlier to the crisis.

The data of output and input (KLEMS) at aggregate level for 1970-2012 on table above is represented on the chart below.

Chart 1: Output and inputs (KLEMS) at aggregate level for 1970-2012 (2000 prices, KRW millions & millions of total working hours)



Source: by author using data in table 1

From the chart above, we can deduce that at aggregate level, between the years 1970 to 1996, all the input factors of the productive sector in the Korean economy were growing positively as input factors kept on rising. According to findings, in twenty-five years, between 1962 and 1987, Korea's GNP increased more than ten times, from $12 billion to nearly $120 billion, and the country's hard-working population of 40 million people had accomplished more in a shorter period of time than some other countries such as Brazil with its 130 million or Mexico with 75 million. This rise experienced two major setbacks with the first taking place in the late 1990s while the second occurred in the late 2000s, not leaving behind the business slowdown, increased unemployment, inflation, an unfavorable trade environment, and a deteriorating balance of payments that plagued Korea in 1974 due to its oil shocks.

Table 2: Data of output and inputs (KLEMS) of agricultural sector for 1970-2012 at (2000 prices, KRW millions & millions of total working hours).

AGR	Y_AGR	K_AGR	L_AGR	E_AGR	M_AGR	S_AGR
1970	18,345,956	4,543,793	12,058	428,384	3,325,892	841,821
1971	19,079,711	5,452,832	11,936	446,662	3,467,807	877,742
1972	19,816,387	6,329,907	12,832	472,225	3,666,275	927,976
1973	21,347,679	6,938,462	13,368	520,873	4,043,965	1,023,575
1974	22,480,012	8,005,549	13,515	543,894	4,222,695	1,068,813
1975	23,272,429	8,385,286	14,412	550,553	4,274,398	1,081,899
1976	25,200,638	8,963,434	14,894	576,311	4,474,372	1,132,516
1977	25,490,370	9,917,029	14,614	562,796	4,369,445	1,105,958
1978	23,807,894	10,971,392	14,138	599,261	4,652,553	1,177,614
1979	26,045,162	12,336,158	13,285	635,890	4,936,932	1,249,595
1980	22,558,140	12,924,218	12,656	658,665	5,113,760	1,294,353
1981	25,569,795	13,478,965	11,975	674,216	5,234,499	1,324,912
1982	26,448,096	14,065,274	11,602	665,997	5,170,684	1,308,760
1983	28,818,565	14,955,339	10,103	778,603	6,044,940	1,530,044
1984	29,045,386	16,034,621	9,157	839,452	6,517,352	1,649,617
1985	29,934,133	16,820,379	8,753	837,954	6,505,727	1,646,675
1986	31,470,827	18,155,292	8,608	762,610	6,980,458	1,771,522
1987	31,206,480	19,967,956	8,433	742,199	7,595,156	1,874,271
1988	33,060,370	26,056,390	8,220	690,487	7,768,338	1,893,088
1989	33,381,584	28,800,209	8,121	775,526	8,106,452	2,014,530
1990	32,002,883	30,161,583	7,665	976,658	7,876,720	2,124,195
1991	32,480,079	32,273,469	6,471	1,011,567	7,901,653	2,113,844
1992	35,144,590	34,587,211	6,348	1,092,857	8,335,448	2,259,433
1993	34,378,440	37,968,614	6,187	1,108,606	8,865,362	2,349,179
1994	35,021,124	41,498,894	5,961	1,150,240	9,279,850	2,447,910
1995	36,722,459	44,775,609	5,763	995,574	9,460,325	2,957,976
1996	37,851,114	48,269,216	5,583	1,024,406	9,908,730	3,072,360

1997	39,215,300	50,274,605	5,505	1,069,292	10,034,523	3,164,816
1998	37,390,944	51,566,332	5,782	1,020,269	9,965,731	3,049,566
1999	38,987,963	53,867,646	5,566	1,023,762	10,137,320	3,096,519
2000	39,177,956	56,934,022	5,447	983,766	10,118,184	3,046,188
2001	39,852,523	59,908,446	5,134	1,023,973	10,341,379	3,177,923
2002	38,805,486	62,643,366	4,938	1,020,938	10,195,718	3,166,587
2003	37,355,700	65,091,433	4,669	1,053,419	9,951,022	3,212,973
2004	39,661,344	66,898,108	4,469	1,080,304	9,976,567	3,345,932
2005	40,169,650	68,953,295	3,985	1,135,414	10,153,161	3,434,434
2006	39,843,751	71,308,917	3,984	1,188,942	10,350,144	3,519,403
2007	43,103,482	73,898,915	3,719	1,416,813	11,239,461	3,999,977
2008	44,473,004	76,444,008	3,583	1,415,912	11,095,388	3,975,766
2009	46,011,910	78,920,566	3,686	1,452,981	11,451,090	4,093,133
2010	44,066,323	81,739,543	3,455	1,363,419	10,713,781	3,838,965
2011	42,812,526	84,560,826	3,293	1,320,334	10,277,409	3,695,948
2012	43,925,295	87,312,277	3,195	1,337,051	10,987,670	3,841,829

Source: www.kpc.or.kr

From the above table, labor input starts declining from the year 1977 while its energy input also experienced a sudden shrink by half in the year 1995. Capital stock also experienced an increase in 1989 more than gross output, which was a means for the Korean government to encourage and promote the agricultural sector. The rest of the input factors undergo little or no adverse change. This must have been as a result of industrialization process at that time.

Table 3: Data of output and inputs (KLEMS) of mining sector for 1970-2012 at (2000 prices, KRW millions & millions of total working hours)

MIN	Y_MIN	K_MIN	L_MIN	E_MIN	M_MIN	S_MIN
1970	3,065,624	590,035	219	405,737	380,217	324,698
1971	3,150,427	660,416	163	415,280	389,159	332,336
1972	3,082,865	741,274	119	401,929	376,649	321,651
1973	3,565,068	810,155	100	448,758	420,531	359,127
1974	3,891,984	751,714	116	499,010	467,623	399,342
1975	4,435,934	783,160	163	575,331	539,143	460,419
1976	4,345,634	844,082	174	551,553	516,862	441,391
1977	4,831,332	921,743	265	587,575	550,617	470,218
1978	5,095,747	1,003,847	275	614,345	575,703	491,641
1979	5,019,952	1,048,360	299	621,575	582,479	497,427
1980	4,972,611	1,012,197	304	629,415	589,825	503,701
1981	5,129,670	1,125,849	300	673,703	631,327	539,143
1982	4,859,056	1,321,455	273	673,067	630,730	538,633
1983	5,089,015	1,531,417	263	707,380	662,886	566,093
1984	5,405,368	1,779,497	352	760,510	712,674	608,611
1985	5,746,736	1,976,606	357	824,156	772,318	659,546
1986	6,170,142	2,241,688	442	889,304	845,282	719,280
1987	6,192,041	2,407,135	404	882,442	871,007	738,145
1988	6,176,424	2,216,057	313	876,965	843,065	715,883
1989	5,651,596	1,759,145	195	722,657	799,892	653,002
1990	5,230,122	1,720,402	176	471,312	670,076	862,159
1991	4,908,745	1,508,740	128	394,331	637,885	783,811
1992	4,032,401	1,434,285	141	284,890	475,646	577,127
1993	3,668,268	1,457,973	121	221,304	432,057	501,042
1994	3,559,825	1,311,137	92	183,442	420,318	469,452
1995	3,308,130	1,321,361	62	271,466	186,720	517,784
1996	3,245,638	1,302,611	56	263,719	185,587	522,630
1997	3,202,928	1,194,296	62	259,218	186,316	518,728
1998	2,690,147	1,335,294	46	214,186	147,177	422,555
1999	2,843,970	1,446,192	50	225,620	155,882	452,964

2000	2,895,582	1,592,113	41	231,526	163,227	463,924
2001	3,010,924	1,721,978	46	281,384	184,154	510,320
2002	2,982,375	1,859,062	43	313,820	211,785	578,034
2003	3,101,892	1,997,649	41	341,084	231,969	633,941
2004	3,153,632	2,123,859	39	342,219	243,307	638,549
2005	3,102,338	2,212,252	39	352,048	247,851	642,090
2006	3,207,845	2,313,196	42	366,498	257,242	665,460
2007	3,214,044	2,421,329	43	267,750	182,578	463,909
2008	3,303,085	2,518,867	46	272,265	187,148	474,105
2009	3,132,322	2,595,699	53	250,666	175,737	446,879
2010	2,883,807	2,687,135	49	238,696	171,294	436,049
2011	2,751,548	2,773,769	42	223,275	160,374	405,202
2012	2,815,369	2,849,179	34	230,822	167,921	423,593

Source: www.kpc.or.kr

Looking at the above table, the mining sector began experiencing a downward trend between 1987-1988 in all its productive sectors. The fluctuating nature of this sector in all its input factors was indicative of the fact that the mining sector was becoming less productive, unlike the other sectors. This was evident with the inconsistent increase and decrease in all input factors. This was due the fact that South Korea has few significant mineral resources, and no oil or natural gas. Its available minerals are lead, zinc, and copper, which supply only a fraction of its needs.

Table 4: Data of output and inputs (KLEMS) of manufacturing sector for 1970-2012 at (2000 prices, KRW millions & millions of total working hours)

MNF	Y_MNF	K_MNF	L_MNF	E_MNF	M_MNF	S_MNF
1970	23,467,965	10,879,453	3,592	1,885,696	14,170,430	2,392,713
1971	26,948,592	14,041,337	3,774	2,224,203	16,104,615	2,709,320
1972	30,288,415	17,117,332	3,836	2,550,874	17,886,897	3,003,851
1973	38,362,373	19,443,259	4,507	3,299,427	22,280,138	3,729,787
1974	44,080,767	19,551,087	5,316	3,714,850	25,521,554	4,250,206
1975	49,115,235	21,509,776	6,556	4,284,141	28,137,111	4,682,834
1976	61,332,474	27,082,379	7,967	5,384,049	35,089,563	5,829,449
1977	69,441,479	33,380,749	8,298	6,356,968	39,289,225	6,599,152
1978	84,329,541	40,253,050	8,967	7,760,376	47,686,054	8,052,069
1979	92,356,356	45,278,805	9,323	8,491,970	52,234,686	8,797,346
1980	91,852,561	43,406,039	8,445	9,057,141	51,571,844	8,661,170
1981	100,235,501	47,751,870	8,202	9,732,300	56,132,453	9,381,748
1982	107,521,670	53,203,289	8,726	10,292,016	60,515,825	10,115,260
1983	124,541,816	60,179,123	9,520	12,071,672	69,904,015	11,796,619
1984	142,854,828	71,266,057	9,730	13,628,923	79,666,279	13,501,393
1985	153,105,271	82,959,154	9,915	14,777,716	85,454,320	14,454,494
1986	184,150,893	98,020,412	10,831	15,747,096	104,642,548	17,559,984
1987	220,489,882	121,205,228	12,750	17,459,203	126,658,004	21,322,609
1988	249,481,183	136,661,223	13,128	18,956,200	144,268,860	24,648,204
1989	261,142,693	153,836,707	13,287	20,917,398	150,778,541	25,727,501
1990	286,134,115	174,160,920	13,169	23,519,334	160,458,025	32,631,553
1991	313,549,770	190,000,918	13,139	27,033,854	175,282,383	35,404,500
1992	332,053,739	204,952,770	13,048	30,330,377	185,266,859	37,498,653
1993	350,433,045	223,243,323	12,605	30,502,622	197,409,749	39,501,888
1994	386,257,948	246,108,470	12,661	31,539,175	218,687,195	43,532,508
1995	427,939,780	263,069,788	12,776	39,946,788	232,436,170	52,277,615
1996	455,479,088	305,709,343	12,062	43,817,891	246,667,834	55,067,628
1997	481,248,998	335,524,947	11,494	51,314,916	257,125,672	57,534,076
1998	442,395,232	338,166,858	9,761	49,986,044	234,047,310	52,188,828
1999	534,810,391	349,000,005	10,540	53,960,517	288,216,963	63,345,355

2000	618,478,347	370,092,048	11,143	56,691,585	336,828,922	73,714,874
2001	630,985,500	383,692,194	10,818	55,628,656	344,972,867	75,880,714
2002	688,892,986	401,453,363	10,593	56,301,143	382,292,138	84,056,794
2003	730,045,762	421,711,053	10,503	55,698,707	409,515,439	89,414,598
2004	803,572,330	445,847,252	11,112	58,122,881	451,792,529	98,771,325
2005	879,296,760	472,790,944	10,591	63,797,052	498,418,209	108,408,148
2006	940,119,690	502,768,681	10,274	65,936,448	532,724,650	115,270,574
2007	1,049,687,061	533,351,845	9,913	69,498,912	607,639,782	132,187,372
2008	1,083,422,760	560,258,336	9,799	73,447,244	624,376,292	135,915,094
2009	1,069,731,185	583,552,851	9,977	70,479,846	614,239,187	134,170,198
2010	1,293,442,979	610,224,364	10,523	80,681,703	752,234,742	162,138,815
2011	1,411,056,335	634,731,165	10,773	85,971,698	825,476,631	176,862,779
2012	1,437,119,138	656,191,349	10,430	87,949,931	838,666,290	178,784,245

Source: www.kpc.or.kr

Table 4 focuses on the manufacturing sector, where there is little or an insignificant change in all the input factors as they all are increasing gradually due to change in time. The only anomaly is witnessed at its labor input, which starts decreasing at an increasing rate from 1989 to 2008. A downturn in the South Korean economy in 1989 was prompted by a sharp decrease in exports and foreign orders, which caused a deep concern in the manufacturing sector.

Table 5: Data of output and inputs (KLEMS) of utilities sector for 1970-2012 (2000 prices, KRW millions & millions of total working hours)

UTL	Y_UTL	K_UTL	L_UTL	E_UTL	M_UTL	S_UTL
1970	9,423,824	3,158,307	713	428,690	2,607,367	1,446,004
1971	9,412,068	4,089,049	868	453,216	2,622,653	1,457,686
1972	9,336,695	4,881,598	1,086	482,016	2,572,273	1,435,146
1973	12,052,378	5,797,409	957	626,567	3,377,586	1,883,528
1974	13,571,275	5,512,979	1,225	696,927	3,852,675	2,145,876
1975	14,602,131	5,904,035	1,434	776,556	4,146,231	2,313,244
1976	16,231,863	7,222,019	1,481	871,725	4,641,907	2,590,129
1977	20,212,688	8,625,413	1,751	1,059,092	5,629,229	3,141,329

1978	25,190,729	9,822,365	2,284	1,220,190	6,754,218	3,761,755
1979	26,532,809	10,974,822	2,401	1,352,888	7,111,106	3,970,455
1980	26,223,023	11,183,716	2,348	1,354,359	7,057,824	3,942,396
1981	25,140,841	13,206,113	2,341	1,355,926	6,743,048	3,775,590
1982	29,415,557	15,522,252	2,265	1,529,354	7,997,598	4,466,563
1983	35,823,777	18,535,205	2,228	1,742,201	9,744,939	5,424,771
1984	38,313,195	21,834,861	2,487	1,777,272	10,482,741	5,821,388
1985	40,670,544	24,686,697	2,420	1,890,327	11,265,630	6,253,285
1986	42,780,988	27,120,505	2,369	1,819,744	12,522,533	5,985,215
1987	50,084,033	30,310,583	2,464	2,246,617	15,330,190	7,264,604
1988	56,926,289	33,824,611	2,727	2,739,900	17,955,854	8,524,581
1989	66,071,047	37,190,981	3,012	3,147,170	21,230,301	10,088,159
1990	84,198,124	42,142,346	3,534	3,389,354	27,397,528	14,137,474
1991	95,611,943	50,387,421	4,045	3,764,341	30,879,237	16,412,137
1992	96,758,411	61,289,122	4,368	4,114,420	31,013,409	16,594,780
1993	107,686,404	73,293,783	4,453	4,562,610	35,032,918	18,583,528
1994	115,378,638	85,049,599	4,640	5,032,024	37,486,120	19,973,860
1995	126,398,258	89,703,801	4,853	7,884,276	40,027,257	21,677,838
1996	138,253,515	103,606,982	4,987	9,134,273	43,255,567	23,871,437
1997	144,012,186	112,354,785	4,871	10,077,097	44,689,557	24,799,626
1998	129,592,774	116,543,800	3,901	9,372,133	39,219,271	21,964,214
1999	127,618,621	123,368,403	3,770	10,693,909	38,643,489	22,114,201
2000	129,386,903	130,062,207	3,933	11,967,800	38,786,911	22,492,968
2001	137,408,898	137,023,739	3,886	12,807,560	41,182,596	23,970,731
2002	144,578,832	143,757,323	4,147	13,747,448	43,670,447	25,373,568
2003	156,358,825	150,160,759	4,353	14,378,143	47,853,225	27,597,445
2004	159,842,282	155,898,162	4,513	15,502,177	47,882,066	27,963,594
2005	162,063,890	162,501,955	4,363	17,014,706	47,339,169	27,936,386
2006	163,158,074	169,682,228	4,445	17,602,527	47,163,106	28,025,941
2007	171,558,191	177,493,605	4,303	20,217,420	49,866,182	30,021,535
2008	169,222,188	185,096,076	4,271	20,336,381	48,269,383	29,218,379
2009	170,767,450	192,429,981	4,158	19,149,112	48,979,256	29,390,648
2010	174,103,415	200,748,936	4,175	23,353,453	48,009,143	29,658,639
2011	171,444,632	209,007,852	4,001	24,634,148	46,207,794	28,969,676

2012	172,736,392	216,988,158	3,915	26,302,180	45,929,223	29,126,207

Source: www.kpc.or.kr

Under the utilities sector, we have industries like construction, electricity supply, gas and water supply which are vital to human existence. Far any meaningful development to follow, these four are prioritized. Contrarily, Power restructuring remains slow. The denationalization of Korea South East Power Company Limited – the first genco earmarked for denationalization – has been extra delayed, due to the absence of investor interest as well as low assessments. According to table 5 above, we witnessed that from 2006 to 2012, capital stock increased more than gross output while labor input experienced a slight drop as from 2005 to 2012.

Table 6: Data of output and inputs (KLEMS) of services sector for 1970-2012 (2000 prices, KRW millions & millions of total working hours).

SRV	Y_SRV	K_SRV	L_SRV	E_SRV	M_SRV	S_SRV
1970	57,309,866	35,132,667	7,870	1,881,536	4,780,132	9,900,562
1971	63,555,578	43,322,305	8,568	2,192,115	5,551,920	11,346,035
1972	66,664,630	49,807,749	8,205	2,320,014	5,960,974	12,048,647
1973	72,944,288	56,959,663	8,118	2,625,646	6,737,704	13,648,146
1974	76,247,998	51,656,221	8,454	2,694,231	7,079,765	14,218,380
1975	81,923,590	53,904,036	9,711	3,034,887	8,222,251	15,990,709
1976	87,998,043	63,534,114	9,850	3,249,094	8,908,947	17,139,851
1977	94,617,376	73,767,686	10,719	3,480,268	9,610,158	18,293,972
1978	102,817,463	82,464,081	11,706	3,907,635	10,767,561	20,092,481
1979	109,442,903	86,192,059	12,749	4,242,932	11,585,569	21,714,176
1980	112,063,174	84,887,799	13,229	4,235,156	11,728,191	21,785,453
1981	117,822,220	93,970,341	13,589	4,509,691	12,542,501	22,925,555
1982	125,927,637	112,152,831	14,861	4,817,125	13,286,181	24,541,762
1983	137,380,898	135,875,101	15,693	5,363,870	14,857,085	27,387,756
1984	148,199,141	162,189,727	15,920	5,849,518	16,052,018	29,848,241
1985	160,264,731	185,284,763	17,019	6,354,887	17,521,528	32,274,194

1986	175,762,889	217,490,489	17,446	6,436,400	19,940,940	35,950,408
1987	194,036,424	243,927,116	18,334	6,745,194	22,364,051	39,995,021
1988	214,935,041	269,126,407	18,952	7,257,514	25,311,535	44,586,835
1989	232,035,179	304,951,548	19,782	8,044,049	27,645,091	48,278,550
1990	251,477,329	331,259,044	20,683	7,289,458	26,455,112	58,084,923
1991	275,462,298	370,031,012	21,614	8,295,647	29,355,633	64,488,032
1992	296,472,829	422,092,573	23,291	9,089,944	31,904,073	69,845,959
1993	317,056,853	504,069,946	25,243	9,589,283	34,285,411	74,968,264
1994	344,204,312	583,110,491	26,434	10,557,583	37,601,879	82,644,418
1995	374,733,378	673,927,055	27,709	16,569,869	37,588,076	89,935,352
1996	407,489,688	754,532,061	28,166	18,670,472	41,619,056	102,281,147
1997	432,726,875	827,841,609	29,370	20,389,221	43,862,231	111,151,375
1998	412,110,176	894,789,660	28,948	19,149,694	40,870,924	104,907,446
1999	445,587,646	961,158,846	30,412	20,767,608	45,983,806	115,411,687
2000	480,013,148	1,033,820,337	31,071	22,288,549	50,007,222	128,112,253
2001	507,974,050	1,108,853,307	32,227	23,882,954	54,050,921	136,911,289
2002	554,329,139	1,188,640,947	33,479	25,902,276	60,455,429	151,866,591
2003	563,739,654	1,269,990,845	33,558	26,250,290	62,485,975	153,991,511
2004	576,655,933	1,348,981,528	35,752	27,634,109	63,841,872	158,013,157
2005	601,547,911	1,424,213,162	35,242	29,362,067	67,003,331	167,004,731
2006	631,754,333	1,499,142,079	35,911	31,298,202	70,776,014	177,448,728
2007	667,125,384	1,577,911,823	35,478	33,952,551	74,980,019	196,101,472
2008	694,832,568	1,650,954,907	35,521	35,708,309	79,701,945	206,200,426
2009	711,375,018	1,717,880,796	36,814	36,537,702	83,724,176	215,003,096
2010	747,575,342	1,793,277,607	36,738	39,074,827	87,688,899	228,386,557
2011	768,152,038	1,864,987,501	36,355	39,923,833	90,094,818	235,243,467
2012	788,367,965	1,930,808,195	35,986	40,827,931	92,888,912	242,463,193

Source: www.kpc.or.kr

Empirically, the service sector lags behind when compared with the manufacturing sector. Comparatively, the capital stock for the service sector is far lower to that of the manufacturing sector, same as its material input which is far less than that of the manufacturing sector.

Input Shares of Capital, Labor, Energy, Material and Services

Numerous requests in economics practice multi–sector versions of the growth model. In this paper, our shares of capital, labor, energy, material and service inputs at the sectorial level for the Korean economy were taken from the Korean productivity center website. It is difficult for us to pinpoint as to how these shares were decomposed into the income shares of land, structures, and equipment. From the data we have, we find that the capital shares differ across sectors. For example, the capital share of our manufacturing sector is more than two times that of the mining and agricultural sectors and almost twice larger than that of labor and material or service inputs combined at the aggregate level. Moreover, manufacturing sector has by far been Korea's main driving force, which mostly explains why it has the largest capital share.

Tables 7-12 show shares of inputs at both aggregate and sector levels (based on equation 4).

Table 7: Share of inputs at aggregate level (%)

AGG	sK_AGG	sL_AGG	sE_AGG	sM_AGG	sS_AGG
1970	0.2419	0.2088	0.0742	0.3416	0.1374
1971	0.2410	0.2075	0.0750	0.3428	0.1375
1972	0.2423	0.2053	0.0747	0.3430	0.1385
1973	0.2363	0.2014	0.0770	0.3486	0.1404
1974	0.2303	0.1868	0.0818	0.3615	0.1433
1975	0.2290	0.1921	0.0812	0.3578	0.1436
1976	0.2338	0.1998	0.0792	0.3319	0.1589
1977	0.2279	0.2096	0.0794	0.3181	0.1686
1978	0.2254	0.2156	0.0789	0.3092	0.1744
1979	0.2211	0.2164	0.0803	0.3049	0.1807
1980	0.2164	0.2148	0.0821	0.3051	0.1849
1981	0.2113	0.2130	0.0820	0.3126	0.1842
1982	0.2051	0.2163	0.0814	0.3179	0.1824

1983	0.2020	0.2231	0.0807	0.3203	0.1770
1984	0.2045	0.2208	0.0802	0.3246	0.1730
1985	0.2107	0.2188	0.0813	0.3280	0.1644
1986	0.2192	0.2220	0.0684	0.3279	0.1659
1987	0.2172	0.2199	0.0652	0.3322	0.1687
1988	0.2142	0.2308	0.0590	0.3277	0.1715
1989	0.2113	0.2390	0.0574	0.3252	0.1703
1990	0.2053	0.2424	0.0565	0.3135	0.1854
1991	0.2052	0.2476	0.0553	0.3094	0.1857
1992	0.2105	0.2386	0.0556	0.3087	0.1898
1993	0.2092	0.2417	0.0527	0.3085	0.1911
1994	0.2132	0.2433	0.0509	0.3044	0.1915
1995	0.2080	0.2468	0.0533	0.2856	0.2095
1996	0.1983	0.2487	0.0574	0.2905	0.2082
1997	0.2021	0.2402	0.0600	0.2934	0.2073
1998	0.2039	0.2301	0.0623	0.2992	0.2076
1999	0.2160	0.2229	0.0639	0.2976	0.2029
2000	0.2143	0.2257	0.0666	0.2950	0.2016
2001	0.2120	0.2207	0.0677	0.2942	0.2087
2002	0.2124	0.2182	0.0675	0.2929	0.2123
2003	0.2048	0.2217	0.0680	0.2932	0.2154
2004	0.2028	0.2180	0.0688	0.2939	0.2197
2005	0.1958	0.2166	0.0710	0.2955	0.2241
2006	0.1944	0.2136	0.0741	0.2962	0.2246
2007	0.1965	0.2091	0.0746	0.2975	0.2253
2008	0.1905	0.1990	0.0798	0.3026	0.2310
2009	0.1910	0.1996	0.0784	0.3020	0.2320
2010	0.1916	0.1958	0.0778	0.3031	0.2346
2011	0.1902	0.1921	0.0797	0.3042	0.2366
2012	0.1955	0.1959	0.0802	0.2997	0.2316

Source: www.kpc.or.kr

Table 8: Share of inputs in agricultural sector (%)

AGR	sK_AGR	sL_AGR	sE_AGR	sM_AGR	sS_AGR
1970	0.4677	0.2820	0.0175	0.2044	0.0284
1971	0.4882	0.2742	0.0166	0.1940	0.0270
1972	0.4843	0.2721	0.0170	0.1989	0.0276
1973	0.4715	0.2905	0.0167	0.1943	0.0270
1974	0.4665	0.2377	0.0207	0.2415	0.0335
1975	0.4698	0.2439	0.0200	0.2338	0.0325
1976	0.4591	0.2430	0.0225	0.2373	0.0380
1977	0.4957	0.2516	0.0202	0.1975	0.0350
1978	0.4652	0.2406	0.0245	0.2264	0.0433
1979	0.4600	0.2899	0.0215	0.1900	0.0385
1980	0.3873	0.3039	0.0272	0.2322	0.0493
1981	0.3863	0.2924	0.0291	0.2418	0.0503
1982	0.4238	0.2531	0.0299	0.2434	0.0498
1983	0.3958	0.2784	0.0308	0.2457	0.0494
1984	0.3914	0.2790	0.0317	0.2486	0.0493
1985	0.3993	0.2770	0.0316	0.2443	0.0478
1986	0.3945	0.2825	0.0262	0.2478	0.0491
1987	0.3929	0.2756	0.0236	0.2572	0.0507
1988	0.3782	0.2949	0.0205	0.2557	0.0508
1989	0.3566	0.3065	0.0216	0.2618	0.0536
1990	0.3422	0.3065	0.0282	0.2683	0.0548
1991	0.3704	0.2900	0.0276	0.2555	0.0565
1992	0.3857	0.2706	0.0281	0.2542	0.0614
1993	0.3411	0.3092	0.0272	0.2574	0.0651
1994	0.3696	0.2909	0.0259	0.2476	0.0659
1995	0.3870	0.2688	0.0366	0.2002	0.1074
1996	0.3646	0.2881	0.0386	0.2026	0.1061
1997	0.3587	0.2872	0.0407	0.2074	0.1061
1998	0.3399	0.2816	0.0432	0.2263	0.1090
1999	0.3858	0.2510	0.0439	0.2150	0.1042
2000	0.3773	0.2660	0.0449	0.2101	0.1017

2001	0.3631	0.2650	0.0475	0.2214	0.1029
2002	0.3517	0.2593	0.0510	0.2326	0.1054
2003	0.3306	0.2782	0.0521	0.2356	0.1036
2004	0.3439	0.2462	0.0556	0.2473	0.1069
2005	0.3112	0.2525	0.0598	0.2667	0.1099
2006	0.3122	0.2350	0.0650	0.2743	0.1135
2007	0.3190	0.2186	0.0655	0.2813	0.1156
2008	0.3192	0.2056	0.0666	0.2908	0.1177
2009	0.3394	0.2057	0.0604	0.2844	0.1102
2010	0.3389	0.2005	0.0626	0.2853	0.1127
2011	0.3397	0.2097	0.0629	0.2760	0.1116
2012	0.3028	0.2378	0.0635	0.2824	0.1134

Source: www.kpc.or.kr

Table 9: Share of inputs in mining sector (%)

MIN	sK_MIN	sL_MIN	sE_MIN	sM_MIN	sS_MIN
1970	0.3565	0.2745	0.0417	0.2226	0.1046
1971	0.3639	0.2792	0.0406	0.2144	0.1019
1972	0.3531	0.2815	0.0408	0.2229	0.1016
1973	0.3638	0.2895	0.0387	0.2119	0.0962
1974	0.3586	0.2481	0.0410	0.2544	0.0979
1975	0.3529	0.2623	0.0403	0.2482	0.0964
1976	0.3439	0.2582	0.0438	0.2490	0.1052
1977	0.3648	0.2874	0.0409	0.2061	0.1008
1978	0.3476	0.2641	0.0453	0.2331	0.1098
1979	0.3642	0.2918	0.0425	0.1959	0.1057
1980	0.3534	0.2627	0.0466	0.2238	0.1135
1981	0.3605	0.2247	0.0510	0.2410	0.1228
1982	0.3668	0.2154	0.0518	0.2431	0.1228
1983	0.3689	0.2182	0.0521	0.2374	0.1234
1984	0.3633	0.2158	0.0537	0.2410	0.1263
1985	0.2992	0.2724	0.0553	0.2431	0.1299
1986	0.3064	0.2665	0.0492	0.2434	0.1345

1987	0.3114	0.2587	0.0450	0.2491	0.1359
1988	0.3120	0.2622	0.0404	0.2490	0.1365
1989	0.3077	0.2504	0.0411	0.2571	0.1437
1990	0.2933	0.2314	0.0479	0.2559	0.1715
1991	0.3198	0.2274	0.0461	0.2425	0.1642
1992	0.3774	0.1525	0.0479	0.2470	0.1753
1993	0.3689	0.1533	0.0486	0.2490	0.1802
1994	0.3798	0.1539	0.0486	0.2427	0.1750
1995	0.4564	0.1965	0.0443	0.1502	0.1527
1996	0.4613	0.1943	0.0558	0.1467	0.1419
1997	0.4574	0.2019	0.0636	0.1446	0.1326
1998	0.4439	0.2103	0.0711	0.1463	0.1284
1999	0.4642	0.1983	0.0748	0.1421	0.1206
2000	0.4683	0.2499	0.0577	0.1278	0.0963
2001	0.4498	0.1897	0.0847	0.1469	0.1291
2002	0.4352	0.1727	0.0858	0.1623	0.1439
2003	0.4159	0.1795	0.0817	0.1680	0.1548
2004	0.4067	0.1676	0.0761	0.1815	0.1681
2005	0.4050	0.1485	0.0690	0.1970	0.1806
2006	0.4033	0.1365	0.0750	0.2053	0.1799
2007	0.4259	0.1296	0.0732	0.2016	0.1696
2008	0.4295	0.1273	0.0742	0.1967	0.1722
2009	0.4395	0.1412	0.0679	0.1871	0.1643
2010	0.4125	0.1542	0.0707	0.1923	0.1702
2011	0.4160	0.1508	0.0713	0.1923	0.1696
2012	0.4306	0.1516	0.0695	0.1900	0.1583

Source: www.kpc.or.kr

Table 10: Share of inputs in manufacturing sector (%)

MNF	sK_MNF	sL_MNF	sE_MNF	sM_MNF	sS_MNF
1970	0.1569	0.1234	0.0797	0.5680	0.0719
1971	0.1545	0.1226	0.0801	0.5707	0.0722
1972	0.1592	0.1207	0.0802	0.5680	0.0719
1973	0.1514	0.1153	0.0807	0.5792	0.0735
1974	0.1421	0.1055	0.0836	0.5932	0.0757
1975	0.1427	0.1132	0.0827	0.5868	0.0745
1976	0.1385	0.1250	0.0815	0.5464	0.1086
1977	0.1315	0.1281	0.0822	0.5277	0.1305
1978	0.1239	0.1359	0.0824	0.5129	0.1448
1979	0.1154	0.1344	0.0847	0.5079	0.1576
1980	0.1071	0.1407	0.0858	0.5019	0.1645
1981	0.1084	0.1396	0.0871	0.5131	0.1518
1982	0.1104	0.1399	0.0872	0.5238	0.1387
1983	0.1127	0.1446	0.0875	0.5309	0.1242
1984	0.1159	0.1426	0.0882	0.5425	0.1108
1985	0.1237	0.1399	0.0889	0.5513	0.0962
1986	0.1205	0.1347	0.0787	0.5671	0.0990
1987	0.1137	0.1324	0.0738	0.5779	0.1021
1988	0.1133	0.1458	0.0665	0.5716	0.1028
1989	0.1128	0.1484	0.0673	0.5673	0.1042
1990	0.1076	0.1506	0.0686	0.5591	0.1141
1991	0.1112	0.1514	0.0678	0.5536	0.1160
1992	0.1116	0.1504	0.0684	0.5512	0.1184
1993	0.1147	0.1512	0.0646	0.5498	0.1198
1994	0.1287	0.1504	0.0617	0.5400	0.1192
1995	0.1067	0.1572	0.0506	0.5394	0.1462
1996	0.1020	0.1584	0.0532	0.5421	0.1444
1997	0.1108	0.1481	0.0533	0.5443	0.1435
1998	0.1184	0.1312	0.0545	0.5521	0.1439
1999	0.1289	0.1291	0.0563	0.5463	0.1394
2000	0.1322	0.1355	0.0582	0.5376	0.1365

2001	0.1270	0.1376	0.0577	0.5363	0.1414
2002	0.1265	0.1385	0.0570	0.5327	0.1453
2003	0.1186	0.1405	0.0571	0.5339	0.1499
2004	0.1148	0.1406	0.0557	0.5341	0.1548
2005	0.1058	0.1395	0.0585	0.5357	0.1605
2006	0.1038	0.1366	0.0607	0.5362	0.1627
2007	0.1039	0.1337	0.0611	0.5383	0.1629
2008	0.1021	0.1246	0.0629	0.5456	0.1647
2009	0.1070	0.1218	0.0624	0.5441	0.1647
2010	0.1091	0.1177	0.0622	0.5457	0.1654
2011	0.1057	0.1175	0.0629	0.5479	0.1659
2012	0.1087	0.1268	0.0622	0.5391	0.1633

Source: www.kpc.or.kr

Table 11: Share of inputs in utilities sector (%)

UTL	sK_UTL	sL_UTL	sE_UTL	sM_UTL	sS_UTL
1970	0.3530	0.1586	0.1529	0.2431	0.0923
1971	0.3313	0.1499	0.1674	0.2544	0.0970
1972	0.3497	0.1703	0.1513	0.2389	0.0898
1973	0.3029	0.1407	0.1871	0.2662	0.1031
1974	0.2315	0.1067	0.2343	0.3054	0.1220
1975	0.2332	0.1096	0.2337	0.3024	0.1211
1976	0.2637	0.1155	0.2256	0.2690	0.1262
1977	0.2369	0.1426	0.2341	0.2552	0.1313
1978	0.2380	0.1791	0.2277	0.2302	0.1250
1979	0.2357	0.1831	0.2308	0.2242	0.1262
1980	0.2495	0.1392	0.2432	0.2330	0.1351
1981	0.2388	0.1396	0.2469	0.2394	0.1354
1982	0.2690	0.1279	0.2363	0.2362	0.1306
1983	0.2730	0.1419	0.2257	0.2333	0.1260
1984	0.2961	0.1512	0.2089	0.2253	0.1185
1985	0.2771	0.1499	0.2186	0.2342	0.1202
1986	0.3676	0.1606	0.1620	0.2068	0.1030

1987	0.3186	0.1441	0.1938	0.2285	0.1150
1988	0.3404	0.1499	0.1772	0.2192	0.1133
1989	0.3270	0.1743	0.1697	0.2145	0.1145
1990	0.2902	0.1779	0.1856	0.2275	0.1188
1991	0.2779	0.1998	0.1769	0.2211	0.1242
1992	0.3173	0.1658	0.1722	0.2160	0.1286
1993	0.3316	0.1663	0.1576	0.2146	0.1300
1994	0.3226	0.1613	0.1527	0.2250	0.1385
1995	0.3237	0.1628	0.2313	0.1463	0.1358
1996	0.3003	0.1737	0.2464	0.1461	0.1335
1997	0.2949	0.1669	0.2607	0.1471	0.1305
1998	0.3024	0.1551	0.2589	0.1542	0.1294
1999	0.3305	0.1462	0.2494	0.1517	0.1223
2000	0.3230	0.1293	0.2717	0.1531	0.1229
2001	0.3184	0.1417	0.2658	0.1523	0.1219
2002	0.3166	0.1471	0.2640	0.1524	0.1199
2003	0.3119	0.1508	0.2680	0.1510	0.1183
2004	0.2885	0.1527	0.2822	0.1539	0.1227
2005	0.2706	0.1508	0.2971	0.1559	0.1255
2006	0.2646	0.1485	0.3079	0.1564	0.1227
2007	0.2570	0.1480	0.3119	0.1583	0.1248
2008	0.1844	0.1395	0.3667	0.1692	0.1401
2009	0.2107	0.1465	0.3401	0.1678	0.1348
2010	0.2247	0.1415	0.3300	0.1687	0.1350
2011	0.2102	0.1387	0.3402	0.1721	0.1387
2012	0.1945	0.1346	0.3515	0.1761	0.1433

Source: www.kpc.or.kr

Table 12: Share of inputs in services sector (%)

SRV	sK_SRV	sL_SRV	sE_SRV	sM_SRV	sS_SRV
1970	0.2801	0.2977	0.0626	0.1361	0.2236
1971	0.2810	0.2982	0.0621	0.1357	0.2230
1972	0.2824	0.2904	0.0630	0.1391	0.2251
1973	0.2838	0.2891	0.0629	0.1376	0.2267
1974	0.2889	0.2757	0.0639	0.1431	0.2284
1975	0.2826	0.2764	0.0642	0.1443	0.2325
1976	0.2964	0.2828	0.0617	0.1298	0.2293
1977	0.2970	0.2914	0.0601	0.1236	0.2280
1978	0.2991	0.2954	0.0593	0.1195	0.2268
1979	0.3040	0.2973	0.0585	0.1163	0.2239
1980	0.3055	0.2891	0.0598	0.1194	0.2262
1981	0.2937	0.2919	0.0566	0.1217	0.2361
1982	0.2706	0.3055	0.0561	0.1222	0.2456
1983	0.2622	0.3117	0.0557	0.1209	0.2495
1984	0.2622	0.3060	0.0563	0.1197	0.2558
1985	0.2733	0.3029	0.0565	0.1173	0.2500
1986	0.2800	0.3117	0.0468	0.1119	0.2496
1987	0.2853	0.3150	0.0407	0.1073	0.2517
1988	0.2817	0.3223	0.0363	0.1039	0.2558
1989	0.2781	0.3363	0.0329	0.1022	0.2505
1990	0.2749	0.3423	0.0263	0.0848	0.2718
1991	0.2638	0.3521	0.0263	0.0846	0.2732
1992	0.2642	0.3515	0.0261	0.0840	0.2741
1993	0.2592	0.3524	0.0255	0.0855	0.2774
1994	0.2457	0.3591	0.0255	0.0872	0.2824
1995	0.2437	0.3593	0.0315	0.0660	0.2995
1996	0.2358	0.3554	0.0347	0.0749	0.2992
1997	0.2347	0.3455	0.0383	0.0799	0.3015
1998	0.2324	0.3401	0.0421	0.0828	0.3026
1999	0.2427	0.3327	0.0438	0.0856	0.2952
2000	0.2384	0.3282	0.0463	0.0898	0.2973

2001	0.2411	0.3211	0.0474	0.0856	0.3048
2002	0.2478	0.3136	0.0473	0.0843	0.3071
2003	0.2463	0.3155	0.0480	0.0826	0.3076
2004	0.2480	0.3106	0.0495	0.0816	0.3103
2005	0.2454	0.3097	0.0507	0.0811	0.3132
2006	0.2437	0.3082	0.0534	0.0810	0.3137
2007	0.2472	0.3036	0.0533	0.0809	0.3150
2008	0.2455	0.2907	0.0561	0.0830	0.3247
2009	0.2359	0.2944	0.0574	0.0839	0.3284
2010	0.2355	0.2892	0.0575	0.0846	0.3333
2011	0.2372	0.2798	0.0599	0.0856	0.3375
2012	0.2496	0.2737	0.0612	0.0846	0.3309

Source: www.kpc.or.kr

CHAPTER V - EMPIRICAL RESULTS

The impact or role of structural change to aggregate productivity growth depends on differences in inter-sector productivity levels (e.g., between agriculture and non-agricultural sectors or between activities in agriculture, services and manufacturing). These differentials remain high in many Emerging Markets and Developing Economies (EMDEs), and are much larger than in advanced economies, pointing to potential growth benefits from further structural transformation.

From our research findings on estimating total factor productivity of Korea, we used the Korea productivity center as our source of data which was between the years 1970 to 2012. After using the data of output and inputs at both aggregate and sector levels, we came out with the following empirical results using tables and charts which will help us discover as to what extent technical progress can contribute to the growth of the Korean economy.
Tables 13-18 show an annual change in output and inputs at aggregate level (KRW millions & millions of total working hours) are based on equation 2.

5-1. Annual change in output and inputs (based on equation 2)

Table 13: Annual change in output and inputs at aggregate level (KRW millions & millions of total working hours)

AGG	ΔY_AGG	ΔK_AGG	ΔL_AGG	ΔE_AGG	ΔM_AGG	ΔS_AGG
1970						
1971	10,533,141	13,261,684	858	701,433	2,872,116	1,817,321
1972	7,042,616	11,311,921	769	495,582	2,326,914	1,014,152
1973	19,082,794	11,071,088	972	1,294,213	6,396,856	2,906,892
1974	12,000,250	-4,471,398	1,577	627,641	4,284,388	1,438,454
1975	13,077,283	5,008,743	3,649	1,072,556	4,174,822	2,446,488
1976	21,759,333	17,159,735	2,090	1,411,264	8,312,517	2,604,231
1977	19,484,593	18,966,592	1,282	1,413,967	5,817,023	2,477,293
1978	26,648,129	17,902,115	1,723	2,055,108	10,987,415	3,964,931
1979	18,155,808	11,315,469	685	1,243,448	6,014,683	2,653,439
1980	-1,727,673	-2,416,235	-1,074	589,481	-389,328	-41,926
1981	16,228,518	16,119,169	-574	1,011,100	5,222,384	1,759,875
1982	20,273,989	26,731,963	1,419	1,031,723	6,317,190	3,024,030
1983	37,482,055	34,811,084	-21	2,686,167	13,612,847	5,734,305
1984	32,163,847	42,028,578	-159	2,191,949	12,217,199	4,723,967
1985	25,903,497	38,622,836	817	1,829,365	8,088,459	3,858,944
1986	50,614,324	51,260,787	1,233	970,114	23,412,238	6,698,215
1987	61,673,121	54,829,632	2,688	2,420,501	27,886,647	9,208,241
1988	58,570,447	50,066,670	955	2,445,411	23,329,244	9,173,941
1989	37,702,792	58,653,902	1,057	3,085,734	12,412,625	6,393,151
1990	60,760,474	52,905,705	830	2,039,316	14,297,184	21,078,562
1991	62,970,262	64,757,265	169	4,853,624	21,199,330	11,362,020
1992	42,449,135	80,154,401	1,800	4,412,748	12,938,644	7,573,628
1993	48,761,040	115,677,678	1,413	1,071,937	19,030,062	9,127,949
1994	71,198,837	117,044,952	1,178	2,478,039	27,449,865	13,164,247
1995	84,680,158	115,719,023	1,375	17,205,509	16,223,186	18,298,417
1996	73,217,038	140,622,599	-308	7,242,788	21,938,226	17,448,637
1997	58,087,244	113,770,029	449	10,198,983	14,261,525	12,353,419
1998	-76,227,014	75,211,702	-2,864	-3,367,418	-31,647,886	-14,636,012
1999	125,669,318	86,439,148	1,899	6,929,090	58,887,047	21,888,117

2000	120,103,345	103,659,635	1,298	5,491,810	52,767,006	23,409,481
2001	49,279,959	98,698,937	475	1,461,301	14,827,451	12,620,770
2002	110,356,923	107,154,397	1,089	3,661,098	46,093,600	24,590,597
2003	61,013,015	110,597,678	-76	436,018	33,212,113	9,808,894
2004	92,283,688	110,797,170	2,762	4,960,047	43,698,711	13,882,089
2005	103,295,028	110,922,699	-1,666	8,979,597	49,425,380	18,693,232
2006	91,903,144	114,543,493	436	4,731,330	38,109,435	17,504,317
2007	156,604,469	119,862,416	-1,201	8,960,829	82,636,866	37,844,159
2008	60,565,443	110,194,677	-235	5,826,665	19,722,134	13,009,505
2009	5,764,280	100,107,699	1,468	-3,309,804	-5,060,710	7,320,184
2010	261,053,981	113,297,692	253	16,841,791	140,248,413	41,355,071
2011	134,145,213	107,383,528	-477	7,361,190	73,399,167	20,718,047
2012	48,747,080	98,088,045	-904	4,574,627	16,422,990	9,461,995

Source: by author using data from KPC

From table 13, output was negatively affected in the years 1980 and 1998. This is due to its input factors of capital, labor, material and services whose inputs were negative that same year. The 1997/98 Asian financial crisis greatly affected the Korean economy as seen in the table above with all input factors affected negatively except capital input at aggregate level.

Table 14: Annual change in output and inputs of agriculture sector (KRW millions & millions of total working hours)

AGR	ΔY_AGR	ΔK_AGR	ΔL_AGR	ΔE_AGR	ΔM_AGR	ΔS_AGR
1970						
1971	733,755	909,039	-122	18,278	141,915	35,921
1972	736,676	877,075	896	25,563	198,468	50,234
1973	1,531,292	608,555	536	48,648	377,690	95,599
1974	1,132,333	1,067,087	147	23,021	178,730	45,238
1975	792,417	379,737	897	6,659	51,703	13,086
1976	1,928,209	578,148	482	25,758	199,974	50,617
1977	289,732	953,595	-280	-13,515	-104,927	-26,558
1978	-1,682,476	1,054,363	-476	36,465	283,108	71,656

1979	2,237,268	1,364,766	-853	36,629	284,379	71,981
1980	-3,487,022	588,060	-629	22,775	176,828	44,758
1981	3,011,655	554,747	-681	15,551	120,739	30,559
1982	878,301	586,309	-373	-8,219	-63,815	-16,152
1983	2,370,469	890,065	-1,499	112,606	874,256	221,284
1984	226,821	1,079,282	-946	60,849	472,412	119,573
1985	888,747	785,758	-404	-1,498	-11,625	-2,942
1986	1,536,694	1,334,913	-145	-75,344	474,731	124,847
1987	-264,347	1,812,664	-175	-20,411	614,698	102,749
1988	1,853,890	6,088,434	-213	-51,712	173,182	18,817
1989	321,214	2,743,819	-99	85,039	338,114	121,442
1990	-1,378,701	1,361,374	-456	201,132	-229,732	109,665
1991	477,196	2,111,886	-1,194	34,909	24,933	-10,351
1992	2,664,511	2,313,742	-123	81,290	433,795	145,589
1993	-766,150	3,381,403	-161	15,749	529,914	89,746
1994	642,684	3,530,280	-226	41,634	414,488	98,731
1995	1,701,335	3,276,715	-198	-154,666	180,475	510,066
1996	1,128,655	3,493,607	-180	28,832	448,405	114,384
1997	1,364,186	2,005,389	-78	44,886	125,793	92,456
1998	-1,824,356	1,291,727	277	-49,023	-68,792	-115,250
1999	1,597,019	2,301,314	-216	3,493	171,589	46,953
2000	189,993	3,066,376	-119	-39,996	-19,136	-50,331
2001	674,567	2,974,424	-313	40,207	223,195	131,735
2002	-1,047,037	2,734,920	-196	-3,035	-145,661	-11,336
2003	-1,449,786	2,448,067	-269	32,481	-244,696	46,386
2004	2,305,644	1,806,675	-200	26,885	25,545	132,959
2005	508,306	2,055,187	-484	55,110	176,594	88,502
2006	-325,899	2,355,622	-1	53,528	196,983	84,969
2007	3,259,731	2,589,998	-265	227,871	889,317	480,574
2008	1,369,522	2,545,093	-136	-901	-144,073	-24,211
2009	1,538,906	2,476,558	103	37,069	355,702	117,367
2010	-1,945,587	2,818,977	-231	-89,562	-737,309	-254,168
2011	-1,253,797	2,821,283	-162	-43,085	-436,372	-143,017
2012	1,112,769	2,751,451	-98	16,717	710,261	145,881

Source: by author using data from KPC

The agricultural sector, as portrayed in table 8 is in a declining state despite government efforts to revamp it as seen in the amount of capital stock put into the sector yearly, its output is far less than expected. This is also true when we look at its labor input; we discover that it is also at a declining state, and thus making the role of technology practically insignificant.

Table 15: Annual change in output and inputs in mining sector (KRW millions & millions of total working hours)

MIN	ΔY_MIN	ΔK_MIN	ΔL_MIN	ΔE_MIN	ΔM_MIN	ΔS_MIN
1970						
1971	84,803	70,381	-56	9,543	8,942	7,638
1972	-67,562	80,858	-44	-13,351	-12,510	-10,685
1973	482,203	68,881	-19	46,829	43,882	37,476
1974	326,916	-58,441	16	50,252	47,092	40,215
1975	543,950	31,446	47	76,321	71,520	61,077
1976	-90,300	60,922	11	-23,778	-22,281	-19,028
1977	485,698	77,661	91	36,022	33,755	28,827
1978	264,415	82,104	10	26,770	25,086	21,423
1979	-75,795	44,513	24	7,230	6,776	5,786
1980	-47,341	-36,163	5	7,840	7,346	6,274
1981	157,059	113,652	-4	44,288	41,502	35,442
1982	-270,614	195,606	-27	-636	-597	-510
1983	229,959	209,962	-10	34,313	32,156	27,460
1984	316,353	248,080	89	53,130	49,788	42,518
1985	341,368	197,109	5	63,646	59,644	50,935
1986	423,406	265,082	85	65,148	72,964	59,734
1987	21,899	165,447	-38	-6,862	25,725	18,865
1988	-15,617	-191,078	-91	-5,477	-27,942	-22,262
1989	-524,828	-456,912	-118	-154,308	-43,173	-62,881
1990	-421,474	-38,743	-19	-251,345	-129,816	209,157
1991	-321,377	-211,662	-48	-76,981	-32,191	-78,348

1992	-876,344	-74,455	13	-109,441	-162,239	-206,684
1993	-364,133	23,688	-20	-63,586	-43,589	-76,085
1994	-108,443	-146,836	-29	-37,862	-11,739	-31,590
1995	-251,695	10,224	-30	88,024	-233,598	48,332
1996	-62,492	-18,750	-6	-7,747	-1,133	4,846
1997	-42,710	-108,315	6	-4,501	729	-3,902
1998	-512,781	140,998	-16	-45,032	-39,139	-96,173
1999	153,823	110,898	4	11,434	8,705	30,409
2000	51,612	145,921	-9	5,906	7,345	10,960
2001	115,342	129,865	5	49,858	20,927	46,396
2002	-28,549	137,084	-3	32,436	27,631	67,714
2003	119,517	138,587	-2	27,264	20,184	55,907
2004	51,740	126,210	-2	1,135	11,338	4,608
2005	-51,294	88,393	0	9,829	4,544	3,541
2006	105,507	100,944	3	14,450	9,391	23,370
2007	6,199	108,133	1	-98,748	-74,664	-201,551
2008	89,041	97,538	3	4,515	4,570	10,196
2009	-170,763	76,832	7	-21,599	-11,411	-27,226
2010	-248,515	91,436	-4	-11,970	-4,443	-10,830
2011	-132,259	86,634	-7	-15,421	-10,920	-30,847
2012	63,821	75,410	-8	7,547	7,547	18,391

Source: by author using data from KPC

The mining sector stands out as the worst sector as regards to the level of labor input. It stands out as the least among the five different sectors in terms of total inputs under study. This sector in Korea could be boosted by events in Japan while in the short term. South Korean companies such as Korea zinc are likely to benefit from greater demand for lead, as consumers resort to battery power for energy supplies. More so, reconstruction efforts in Japan are likely to increase demand for South Korean steel and copper.

Table 16: Annual change in output and inputs in manufacturing sector (KRW millions & millions of total working hours)

MNF	ΔY_MNF	ΔK_MNF	ΔL_MNF	ΔE_MNF	ΔM_MNF	ΔS_MNF
1970						
1971	3,480,627	3,161,884	182	338,507	1,934,185	316,607
1972	3,339,823	3,075,995	62	326,671	1,782,282	294,531
1973	8,073,958	2,325,927	671	748,553	4,393,241	725,936
1974	5,718,394	107,828	809	415,423	3,241,416	520,419
1975	5,034,468	1,958,689	1,240	569,291	2,615,557	432,628
1976	12,217,239	5,572,603	1,411	1,099,908	6,952,452	1,146,615
1977	8,109,005	6,298,370	331	972,919	4,199,662	769,703
1978	14,888,062	6,872,301	669	1,403,408	8,396,829	1,452,917
1979	8,026,815	5,025,755	356	731,594	4,548,632	745,277
1980	-503,795	-1,872,766	-878	565,171	-662,842	-136,176
1981	8,382,940	4,345,831	-243	675,159	4,560,609	720,578
1982	7,286,169	5,451,419	524	559,716	4,383,372	733,512
1983	17,020,146	6,975,834	794	1,779,656	9,388,190	1,681,359
1984	18,313,012	11,086,934	210	1,557,251	9,762,264	1,704,774
1985	10,250,443	11,693,097	185	1,148,793	5,788,041	953,101
1986	31,045,622	15,061,258	916	969,380	19,188,228	3,105,490
1987	36,338,989	23,184,816	1,919	1,712,107	22,015,456	3,762,625
1988	28,991,301	15,455,995	378	1,496,997	17,610,856	3,325,595
1989	11,661,510	17,175,484	159	1,961,198	6,509,681	1,079,297
1990	24,991,422	20,324,213	-118	2,601,936	9,679,484	6,904,052
1991	27,415,655	15,839,998	-30	3,514,520	14,824,358	2,772,947
1992	18,503,969	14,951,852	-91	3,296,523	9,984,476	2,094,153
1993	18,379,306	18,290,553	-443	172,245	12,142,890	2,003,235
1994	35,824,903	22,865,147	56	1,036,553	21,277,446	4,030,620
1995	41,681,832	16,961,318	115	8,407,613	13,748,975	8,745,107
1996	27,539,308	42,639,555	-714	3,871,103	14,231,664	2,790,013
1997	25,769,910	29,815,604	-568	7,497,025	10,457,838	2,466,448
1998	-38,853,766	2,641,911	-1,733	-1,328,872	-23,078,362	-5,345,248
1999	92,415,159	10,833,147	779	3,974,473	54,169,653	11,156,527

2000	83,667,956	21,092,043	603	2,731,068	48,611,959	10,369,519
2001	12,507,153	13,600,146	-325	-1,062,929	8,143,945	2,165,840
2002	57,907,486	17,761,169	-225	672,487	37,319,271	8,176,080
2003	41,152,776	20,257,690	-90	-602,436	27,223,301	5,357,804
2004	73,526,568	24,136,199	609	2,424,174	42,277,090	9,356,727
2005	75,724,430	26,943,692	-521	5,674,171	46,625,680	9,636,823
2006	60,822,930	29,977,737	-317	2,139,396	34,306,441	6,862,426
2007	109,567,371	30,583,164	-361	3,562,464	74,915,132	16,916,798
2008	33,735,699	26,906,491	-114	3,948,332	16,736,510	3,727,722
2009	-13,691,575	23,294,515	178	-2,967,398	-10,137,105	-1,744,896
2010	223,711,794	26,671,513	546	10,201,857	137,995,555	27,968,617
2011	117,613,356	24,506,801	250	5,289,995	73,241,889	14,723,964
2012	26,062,803	21,460,184	-343	1,978,233	13,189,659	1,921,466

Source: by author using data from KPC

Table 16 presents us with the changes in factor inputs due to change in time in the manufacturing sector. From this table, we realize the level of government investment in this sector as it is incomparably greater than the other industrial sectors. This sector is considered as the growth engine of the Korean economy.

Table17: Annual change in output and inputs in utilities sector (KRW millions & millions of total working hours)

UTL	ΔY_UTL	ΔK_UTL	ΔL_UTL	ΔE_UTL	ΔM_UTL	ΔS_UTL
1970						
1971	-11,756	930,742	155	24,526	15,286	11,682
1972	-75,373	792,549	218	28,800	-50,380	-22,540
1973	2,715,683	915,811	-129	144,551	805,313	448,382
1974	1,518,897	-284,430	268	70,360	475,089	262,348
1975	1,030,856	391,056	209	79,629	293,556	167,368
1976	1,629,732	1,317,984	47	95,169	495,676	276,885
1977	3,980,825	1,403,394	270	187,367	987,322	551,200
1978	4,978,041	1,196,952	533	161,098	1,124,989	620,426
1979	1,342,080	1,152,457	117	132,698	356,888	208,700

1980	-309,786	208,894	-53	1,471	-53,282	-28,059
1981	-1,082,182	2,022,397	-7	1,567	-314,776	-166,806
1982	4,274,716	2,316,139	-76	173,428	1,254,550	690,973
1983	6,408,220	3,012,953	-37	212,847	1,747,341	958,208
1984	2,489,418	3,299,656	259	35,071	737,802	396,617
1985	2,357,349	2,851,836	-67	113,055	782,889	431,897
1986	2,110,444	2,433,808	-51	-70,583	1,256,903	-268,070
1987	7,303,045	3,190,078	95	426,873	2,807,657	1,279,389
1988	6,842,256	3,514,028	263	493,283	2,625,664	1,259,977
1989	9,144,758	3,366,370	285	407,270	3,274,447	1,563,578
1990	18,127,077	4,951,365	522	242,184	6,167,227	4,049,315
1991	11,413,819	8,245,075	511	374,987	3,481,709	2,274,663
1992	1,146,468	10,901,701	323	350,079	134,172	182,643
1993	10,927,993	12,004,661	85	448,190	4,019,509	1,988,748
1994	7,692,234	11,755,816	187	469,414	2,453,202	1,390,332
1995	11,019,620	4,654,202	213	2,852,252	2,541,137	1,703,978
1996	11,855,257	13,903,181	134	1,249,997	3,228,310	2,193,599
1997	5,758,671	8,747,803	-116	942,824	1,433,990	928,189
1998	-14,419,412	4,189,015	-970	-704,964	-5,470,286	-2,835,412
1999	-1,974,153	6,824,603	-131	1,321,776	-575,782	149,987
2000	1,768,282	6,693,804	163	1,273,891	143,422	378,767
2001	8,021,995	6,961,532	-47	839,760	2,395,685	1,477,763
2002	7,169,934	6,733,584	261	939,888	2,487,851	1,402,837
2003	11,779,993	6,403,436	206	630,695	4,182,778	2,223,877
2004	3,483,457	5,737,403	160	1,124,034	28,841	366,149
2005	2,221,608	6,603,793	-150	1,512,529	-542,897	-27,208
2006	1,094,184	7,180,273	82	587,821	-176,063	89,555
2007	8,400,117	7,811,377	-142	2,614,893	2,703,076	1,995,594
2008	-2,336,003	7,602,471	-32	118,961	-1,596,799	-803,156
2009	1,545,262	7,333,905	-113	-1,187,269	709,873	172,269
2010	3,335,965	8,318,955	17	4,204,341	-970,113	267,991
2011	-2,658,783	8,258,916	-174	1,280,695	-1,801,349	-688,963
2012	1,291,760	7,980,306	-86	1,668,032	-278,571	156,531

Source: by author using data from KPC

This sector comprises of the electricity supply, water supply, gas supply and construction industries. This sector is highly prioritized due to its necessity in all walks of our daily lives. Its labor input is also lagging behind as in the agricultural and mining sectors.

Table 18: Annual change in output and inputs services sector (KRW millions & millions of total working hours)

SRV	ΔY_SRV	ΔK_SRV	ΔL_SRV	ΔE_SRV	ΔM_SRV	ΔS_SRV
1970						
1971	6,245,712	8,189,638	698	310,579	771,788	1,445,473
1972	3,109,052	6,485,444	-363	127,899	409,054	702,612
1973	6,279,658	7,151,914	-87	305,632	776,730	1,599,499
1974	3,303,710	-5,303,442	336	68,585	342,061	570,234
1975	5,675,592	2,247,815	1,257	340,656	1,142,486	1,772,329
1976	6,074,453	9,630,078	139	214,207	686,696	1,149,142
1977	6,619,333	10,233,572	869	231,174	701,211	1,154,121
1978	8,200,087	8,696,395	987	427,367	1,157,403	1,798,509
1979	6,625,440	3,727,978	1,043	335,297	818,008	1,621,695
1980	2,620,271	-1,304,260	480	-7,776	142,622	71,277
1981	5,759,046	9,082,542	360	274,535	814,310	1,140,102
1982	8,105,417	18,182,490	1,272	307,434	743,680	1,616,207
1983	11,453,261	23,722,270	832	546,745	1,570,904	2,845,994
1984	10,818,243	26,314,626	227	485,648	1,194,933	2,460,485
1985	12,065,590	23,095,036	1,099	505,369	1,469,510	2,425,953
1986	15,498,158	32,205,726	427	81,513	2,419,412	3,676,214
1987	18,273,535	26,436,627	888	308,794	2,423,111	4,044,613
1988	20,898,617	25,199,291	618	512,320	2,947,484	4,591,814
1989	17,100,138	35,825,141	830	786,535	2,333,556	3,691,715
1990	19,442,150	26,307,496	901	-754,591	-1,189,979	9,806,373
1991	23,984,969	38,771,968	931	1,006,189	2,900,521	6,403,109
1992	21,010,531	52,061,561	1,677	794,297	2,548,440	5,357,927
1993	20,584,024	81,977,373	1,952	499,339	2,381,338	5,122,305
1994	27,147,459	79,040,545	1,191	968,300	3,316,468	7,676,154

1995	30,529,066	90,816,564	1,275	6,012,286	-13,803	7,290,934
1996	32,756,310	80,605,006	457	2,100,603	4,030,980	12,345,795
1997	25,237,187	73,309,548	1,204	1,718,749	2,243,175	8,870,228
1998	-20,616,699	66,948,051	-422	-1,239,527	-2,991,307	-6,243,929
1999	33,477,470	66,369,186	1,464	1,617,914	5,112,882	10,504,241
2000	34,425,502	72,661,491	659	1,520,941	4,023,416	12,700,566
2001	27,960,902	75,032,970	1,156	1,594,405	4,043,699	8,799,036
2002	46,355,089	79,787,640	1,252	2,019,322	6,404,508	14,955,302
2003	9,410,515	81,349,898	79	348,014	2,030,546	2,124,920
2004	12,916,279	78,990,683	2,194	1,383,819	1,355,897	4,021,646
2005	24,891,978	75,231,634	-510	1,727,958	3,161,459	8,991,574
2006	30,206,422	74,928,917	669	1,936,135	3,772,683	10,443,997
2007	35,371,051	78,769,744	-433	2,654,349	4,204,005	18,652,744
2008	27,707,184	73,043,084	43	1,755,758	4,721,926	10,098,954
2009	16,542,450	66,925,889	1,293	829,393	4,022,231	8,802,670
2010	36,200,324	75,396,811	-76	2,537,125	3,964,723	13,383,461
2011	20,576,696	71,709,894	-383	849,006	2,405,919	6,856,910
2012	20,215,927	65,820,694	-369	904,098	2,794,094	7,219,726

Source: by author using data from KPC

The changes in the service sector which are as a result of changes in time are almost similar to that of the manufacturing sector with technical progress growing negatively insignificant, contrarily to the manufacturing sector.

5.2. Growth rate of output and inputs (based on equation 3)

Table 19: Growth rate of output and inputs at aggregate level (%)

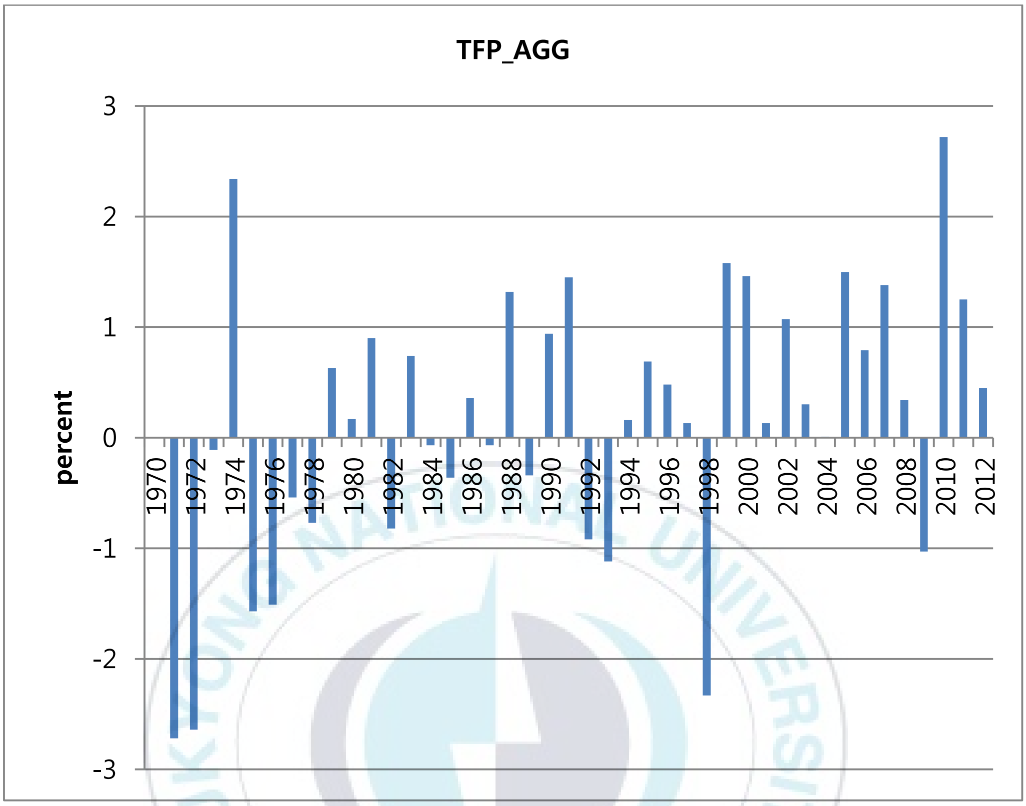
AGG	gY_AGG	gK_AGG	gL_AGG	gE_AGG	gM_AGG	gS_AGG	gA_AGG
1970							
1971	8.62	19.63	3.39	12.24	10.21	10.87	-2.72
1972	5.45	14.34	2.95	7.96	7.64	5.72	-2.64
1973	12.87	12.31	3.59	17.21	17.35	14.08	-0.11
1974	7.49	-5.23	5.51	7.70	10.41	6.51	2.34
1975	7.54	5.54	11.31	11.63	9.21	9.97	-1.57
1976	11.15	15.94	6.08	13.27	15.50	9.60	-1.51
1977	9.08	14.98	3.60	11.74	9.78	8.37	-0.54
1978	11.05	12.39	4.61	14.57	15.60	11.81	-0.77
1979	7.00	7.26	1.80	8.10	7.87	7.32	0.63
1980	-0.67	-1.57	-2.90	3.70	-0.51	-0.12	0.17
1981	5.93	9.51	-1.58	5.97	6.42	4.64	0.90
1982	6.89	13.62	3.75	5.74	7.21	7.38	-0.82
1983	11.30	15.06	-0.06	13.00	13.45	12.28	0.74
1984	8.84	15.39	-0.42	9.59	10.77	9.19	-0.07
1985	6.65	12.39	2.12	7.41	6.66	6.98	-0.36
1986	11.49	14.12	3.11	3.78	16.15	10.81	0.36
1987	12.29	13.12	6.34	8.62	16.14	12.93	-0.07
1988	10.45	10.70	2.20	8.01	11.89	11.41	1.32
1989	6.30	11.14	2.38	9.18	5.95	7.37	-0.34
1990	9.22	9.13	1.84	5.72	6.42	19.55	0.94
1991	8.72	10.05	0.37	11.98	8.69	9.53	1.45
1992	5.55	11.07	3.81	9.83	5.03	5.97	-0.92
1993	6.00	13.77	2.91	2.33	6.89	6.72	-1.12
1994	8.05	12.23	2.37	5.11	9.05	8.83	0.16
1995	8.74	10.79	2.69	26.20	5.07	10.93	0.69
1996	7.02	11.59	-0.61	9.93	6.42	9.44	0.48
1997	5.28	8.57	0.88	12.27	4.01	6.27	0.13
1998	-7.44	5.36	-5.91	-4.22	-9.76	-8.02	-2.33
1999	10.93	5.81	3.77	7.99	15.37	10.71	1.58
2000	9.46	6.51	2.51	5.96	12.11	10.27	1.46

2001	3.74	5.84	0.91	1.56	3.29	5.25	0.13
2002	7.72	5.96	2.05	3.76	9.28	9.28	1.07
2003	4.09	5.79	-0.14	0.45	6.27	3.57	0.30
2004	5.83	5.49	4.94	4.83	7.62	4.81	0.01
2005	6.13	5.21	-3.07	8.04	7.93	6.08	1.50
2006	5.17	5.10	0.80	4.06	5.76	5.39	0.79
2007	8.09	5.07	-2.25	7.15	11.11	10.43	1.38
2008	3.04	4.45	-0.44	4.44	2.58	3.46	0.34
2009	0.29	3.89	2.68	-2.59	-0.67	1.91	-1.03
2010	11.54	4.21	0.46	11.64	15.60	9.74	2.72
2011	5.60	3.84	-0.88	4.84	7.55	4.65	1.25
2012	1.99	3.39	-1.69	2.92	1.66	2.08	0.45

Source: by author using data from KPC

From table 19, we see the inter-relation existing among the different factor inputs. This is in regard to Nadiri and Rosen’s assertion that the behavior of interrelated factor demands the change in one factor price will result in utilization change of another factor, for example changes in the price of energy input will obviously change labor and capital utilization. From the table above, while input factors of capital, energy, material and services have been contributing positively as evident in their respective growth rates, labor input hasn’t been that impressive. This is as a result of its declining nature which is caused by various factors.

Chart 2: TFP at aggregate level (%)



Source: by author using data from column 8 table 19

The chart above presents total factor productivity growth of Korea at aggregate level. The final result obtained is that of constant fluctuations in the growth rate of total factor productivity. Visibly, early in the 1970s, Korea experienced shocks in oil that greatly affected its economy while in the 1980s, there was the debt shock. In 1997-98, the economy was badly burned during the Asian financial crisis. It should also be made known that between 1975 and 1985, there was severe inflation in Korea, though the relative price level did not change much between these years, as Korean Won was devalued repeatedly after 1979. The price level of agriculture moved up more than double that of the U.S. while the manufacturing price level remained close to that of the U.S.

Table 20: Growth rate of output and inputs of agricultural sector (%)

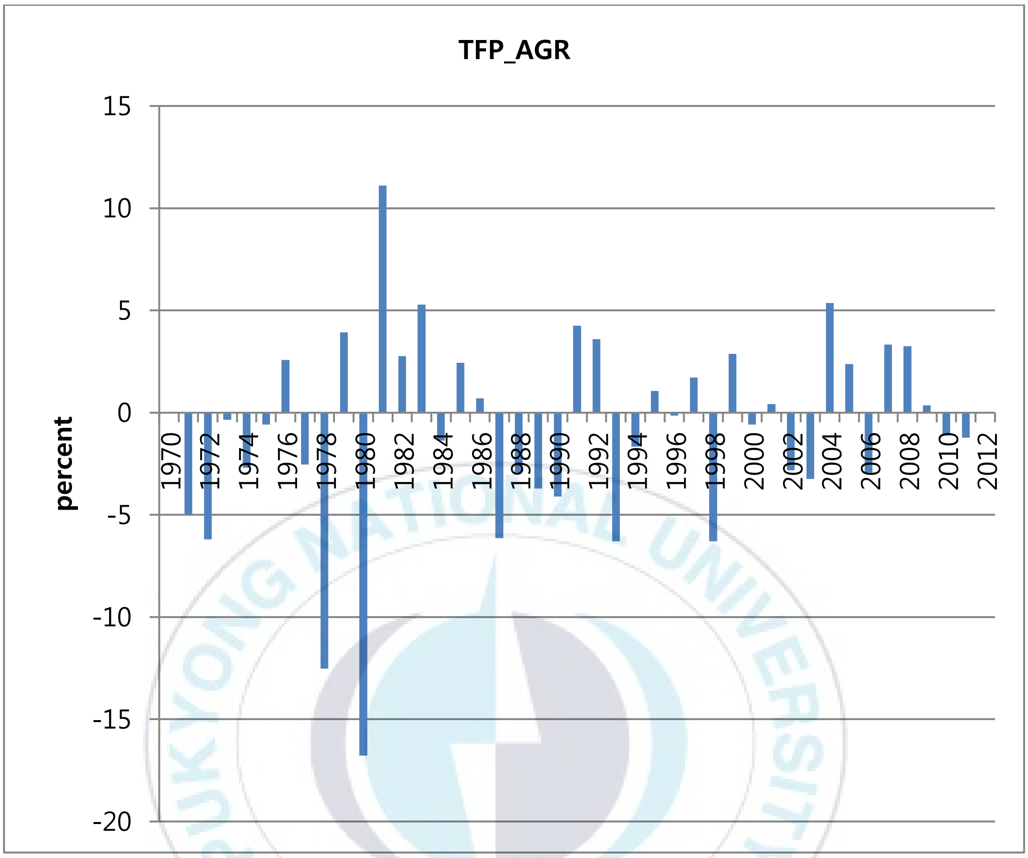
AGR	gY_AGR	gK_AGR	gL_AGR	gE_AGR	gM_AGR	gS_AGR	gA_AGR
1970							
1971	3.85	16.67	-1.02	4.09	4.09	4.09	-4.98
1972	3.72	13.86	6.98	5.41	5.41	5.41	-6.21
1973	7.17	8.77	4.01	9.34	9.34	9.34	-0.35
1974	5.04	13.33	1.09	4.23	4.23	4.23	-2.69
1975	3.40	4.53	6.22	1.21	1.21	1.21	-0.59
1976	7.65	6.45	3.24	4.47	4.47	4.47	2.57
1977	1.14	9.62	-1.92	-2.40	-2.40	-2.40	-2.54
1978	-7.07	9.61	-3.37	6.08	6.09	6.08	-12.52
1979	8.59	11.06	-6.42	5.76	5.76	5.76	3.92
1980	-15.46	4.55	-4.97	3.46	3.46	3.46	-16.78
1981	11.78	4.12	-5.69	2.31	2.31	2.31	11.11
1982	3.32	4.17	-3.21	-1.23	-1.23	-1.23	2.77
1983	8.23	5.95	-14.84	14.46	14.46	14.46	5.29
1984	0.78	6.73	-10.33	7.25	7.25	7.25	-1.36
1985	2.97	4.67	-4.62	-0.18	-0.18	-0.18	2.44
1986	4.88	7.35	-1.68	-9.88	6.80	7.05	0.69
1987	-0.85	9.08	-2.08	-2.75	8.09	5.48	-6.14
1988	5.61	23.37	-2.59	-7.49	2.23	0.99	-2.93
1989	0.96	9.53	-1.22	10.97	4.17	6.03	-3.71
1990	-4.31	4.51	-5.95	20.59	-2.92	5.16	-4.11
1991	1.47	6.54	-18.45	3.45	0.32	-0.49	4.25
1992	7.58	6.69	-1.94	7.44	5.20	6.44	3.60
1993	-2.23	8.91	-2.60	1.42	5.98	3.82	-6.29
1994	1.84	8.51	-3.79	3.62	4.47	4.03	-1.67
1995	4.63	7.32	-3.44	-15.54	1.91	17.24	1.06
1996	2.98	7.24	-3.22	2.81	4.53	3.72	-0.15
1997	3.48	3.99	-1.42	4.20	1.25	2.92	1.71
1998	-4.88	2.50	4.79	-4.80	-0.69	-3.78	-6.30
1999	4.10	4.27	-3.88	0.34	1.69	1.52	2.88
2000	0.48	5.39	-2.18	-4.07	-0.19	-1.65	-0.58

2001	1.69	4.96	-6.10	3.93	2.16	4.15	0.41
2002	-2.70	4.37	-3.97	-0.30	-1.43	-0.36	-2.82
2003	-3.88	3.76	-5.76	3.08	-2.46	1.44	-3.25
2004	5.81	2.70	-4.48	2.49	0.26	3.97	5.36
2005	1.27	2.98	-12.15	4.85	1.74	2.58	2.37
2006	-0.82	3.30	-0.03	4.50	1.90	2.41	-2.93
2007	7.56	3.50	-7.13	16.08	7.91	12.01	3.33
2008	3.08	3.33	-3.80	-0.06	-1.30	-0.61	3.25
2009	3.34	3.14	2.79	2.55	3.11	2.87	0.35
2010	-4.42	3.45	-6.69	-6.57	-6.88	-6.62	-1.12
2011	-2.93	3.34	-4.92	-3.26	-4.25	-3.87	-1.22
2012	2.53	3.15	-3.07	1.25	6.46	3.80	-0.03

Source: by author using data from KPC

From table 20, the agricultural sector's total factor productivity growth has dropped significantly as the nation moves towards the urbanization and industrialization of the economy. Back in 1987, according to experts, the agricultural sector alone made up a considerable percent of the nation's total GDP. Noticeably is the insignificant and adverse performance in the growth rate of its labor input between 1978 – 2012 indicative of a decline of the labor input in the agricultural sector.

Chart 3: TFP growth rate of agricultural sector (%)



Source: by author using data from column 8 table 20

Associated with the industrial and service sectors, agriculture remained the most sluggish sector of the Korean economy. In 1982, its TFP growth was only 2.77 percent, down from approximately 11.11 percent the previous year. Economists are of the opinion that the country's rural areas had gained more than they had contributed in the course of industrialization. Still, the growth of agricultural output, which averaged -0.81 percent per year between 1970 and 2012 was enough reason for concern.

A drop in its TFP growth in the late 1980s was as a result of the agricultural crisis in which its labor costs rose as young people left rural areas for urban jobs and farm work was mainly done by women and old men. The government in response initiated various programs to improve rural conditions with the most extensive of these being the New Community Movement (Saemaul undong) known as the Saemaul Movement whose goal was to mobilize villagers in their own service. Initially, the movement was quite successful but later on deteriorated in the early 1980s.

Table 21: Growth rate of output and inputs of mining sector (%)

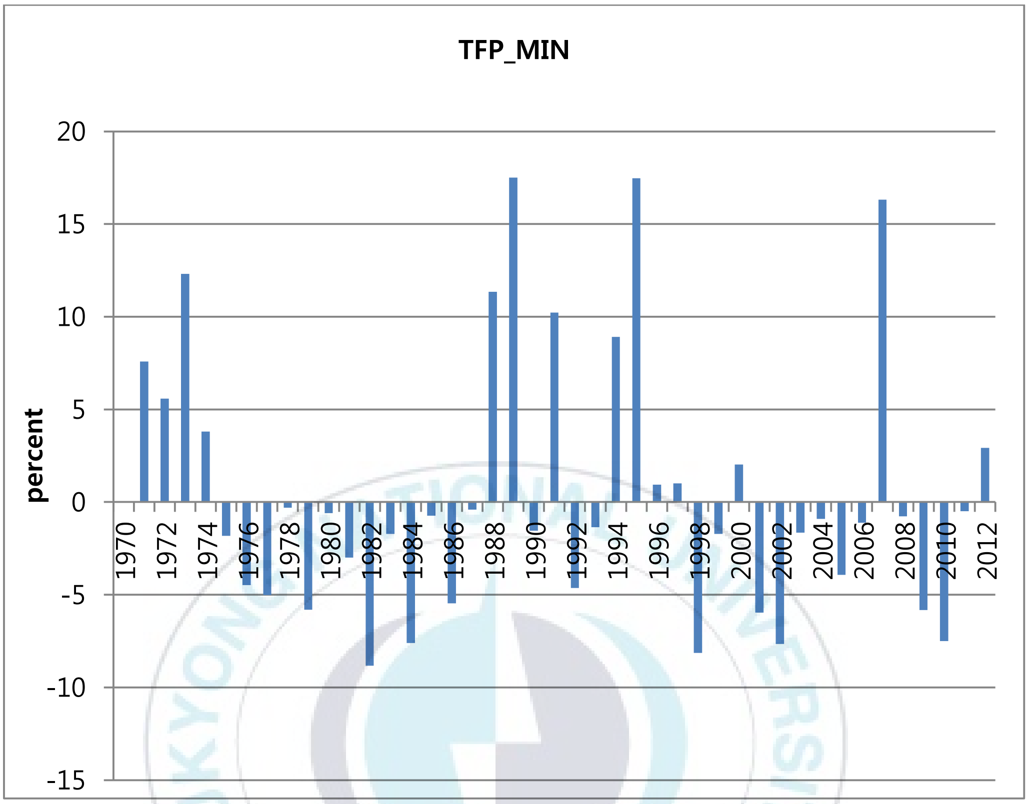
MIN	gY_MIN	gK_MIN	gL_MIN	gE_MIN	gM_MIN	gS_MIN	gA_MIN
1970							
1971	2.69	10.66	-34.36	2.30	2.30	2.30	7.59
1972	-2.19	10.91	-36.97	-3.32	-3.32	-3.32	5.58
1973	13.53	8.50	-19.00	10.44	10.43	10.44	12.31
1974	8.40	-7.77	13.79	10.07	10.07	10.07	3.80
1975	12.26	4.02	28.83	13.27	13.27	13.27	-1.82
1976	-2.08	7.22	6.32	-4.31	-4.31	-4.31	-4.48
1977	10.05	8.43	34.34	6.13	6.13	6.13	-5.02
1978	5.19	8.18	3.64	4.36	4.36	4.36	-0.31
1979	-1.51	4.25	8.03	1.16	1.16	1.16	-5.80
1980	-0.95	-3.57	1.64	1.25	1.25	1.25	-0.60
1981	3.06	10.09	-1.33	6.57	6.57	6.57	-3.00
1982	-5.57	14.80	-9.89	-0.09	-0.09	-0.09	-8.83
1983	4.52	13.71	-3.80	4.85	4.85	4.85	-1.71
1984	5.85	13.94	25.28	6.99	6.99	6.99	-7.61
1985	5.94	9.97	1.40	7.72	7.72	7.72	-0.73
1986	6.86	11.83	19.23	7.33	8.63	8.30	-5.46
1987	0.35	6.87	-9.41	-0.78	2.95	2.56	-0.40
1988	-0.25	-8.62	-29.07	-0.62	-3.31	-3.11	11.34
1989	-9.29	-25.97	-60.51	-21.35	-5.40	-9.63	17.51
1990	-8.06	-2.25	-10.80	-53.33	-19.37	24.26	-1.55
1991	-6.55	-14.03	-37.50	-19.52	-5.05	-10.00	10.23
1992	-21.73	-5.19	9.22	-38.42	-34.11	-35.81	-4.64
1993	-9.93	1.62	-16.53	-28.73	-10.09	-15.19	-1.35
1994	-3.05	-11.20	-31.52	-20.64	-2.79	-6.73	8.92

1995	-7.61	0.77	-48.39	32.43	-125.11	9.33	17.48
1996	-1.93	-1.44	-10.71	-2.94	-0.61	0.93	0.94
1997	-1.33	-9.07	9.68	-1.74	0.39	-0.75	1.01
1998	-19.06	10.56	-34.78	-21.02	-26.59	-22.76	-8.13
1999	5.41	7.67	8.00	5.07	5.58	6.71	-1.72
2000	1.78	9.17	-21.95	2.55	4.50	2.36	2.03
2001	3.83	7.54	10.87	17.72	11.36	9.09	-5.96
2002	-0.96	7.37	-6.98	10.34	13.05	11.71	-7.65
2003	3.85	6.94	-4.88	7.99	8.70	8.82	-1.64
2004	1.64	5.94	-5.13	0.33	4.66	0.72	-0.91
2005	-1.65	4.00	0.00	2.79	1.83	0.55	-3.92
2006	3.29	4.36	7.14	3.94	3.65	3.51	-1.12
2007	0.19	4.47	2.33	-36.88	-40.89	-43.45	16.31
2008	2.70	3.87	6.52	1.66	2.44	2.15	-0.77
2009	-5.45	2.96	13.21	-8.62	-6.49	-6.09	-5.82
2010	-8.62	3.40	-8.16	-5.01	-2.59	-2.48	-7.49
2011	-4.81	3.12	-16.67	-6.91	-6.81	-7.61	-0.50
2012	2.27	2.65	-23.53	3.27	4.49	4.34	2.93

Source: by author using data from KPC

In table 21, the mining sector is not doing too well as both the government is reluctant to invest fully in a sector that can offer little towards economic growth. Despite government's effort to invest huge capital, for example between 1981 to 1986, its TFP was still negative. This may be as a result of the poor quality mining resources the economy has, which explains the reason why most of the country's used natural resources are mostly imported with huge government spending on the imported natural resources.

Chart 4: TFP of mining sector (%)



Source: by author using data from column 8 table 21

The mining sector is an insignificant sector in the Korean economy with mining and quarrying as insignificant economic activities, accounting for about 17.51 percent in 1989, the highest so far between 1970 and 2012. This is due the fact that South Korea has few significant mineral resources, and no oil or natural gas. Its available minerals are lead, zinc, and copper, which supply only a fraction of its needs. That notwithstanding, we realized that in the mid-1970s to late 1980s, the sector has been performing very poorly, with the hardest hit befalling the sector in the year 1998 where it recorded a negative growth rate of -8.13 percent in its TFP during the Asian financial crisis, closely followed in the 2002 with a -7.65 percent and in 2010 recording a negative growth rate of -7.49 percent

Table 22: Growth rate of output and inputs of manufacturing sector (%)

MNF	gY_MNF	gK_MNF	gL_MNF	gE_MNF	gM_MNF	gS_MNF	gA_MNF
1970							
1971	12.92	22.52	4.82	15.22	12.01	11.69	-0.07
1972	11.03	17.97	1.62	12.81	9.96	9.81	0.58
1973	21.05	11.96	14.89	22.69	19.72	19.46	2.84
1974	12.97	0.55	15.22	11.18	12.70	12.24	1.89
1975	10.25	9.11	18.91	13.29	9.30	9.24	-0.43
1976	19.92	20.58	17.71	20.43	19.81	19.67	0.23
1977	11.68	18.87	3.99	15.30	10.69	11.66	0.26
1978	17.65	17.07	7.46	18.08	17.61	18.04	1.39
1979	8.69	11.10	3.82	8.62	8.71	8.47	0.41
1980	-0.55	-4.31	-10.40	6.24	-1.29	-1.57	1.74
1981	8.36	9.10	-2.96	6.94	8.12	7.68	1.85
1982	6.78	10.25	6.01	5.44	7.24	7.25	-0.47
1983	13.67	11.59	8.34	14.74	13.43	14.25	0.96
1984	12.82	15.56	2.16	11.43	12.25	12.63	1.65
1985	6.70	14.10	1.87	7.77	6.77	6.59	-0.37
1986	16.86	15.37	8.46	6.16	18.34	17.69	1.23
1987	16.48	19.13	15.05	9.81	17.38	17.65	-0.26
1988	11.62	11.31	2.88	7.90	12.21	13.49	1.03
1989	4.47	11.16	1.20	9.38	4.32	4.20	-0.49
1990	8.73	11.67	-0.90	11.06	6.03	21.16	1.07
1991	8.74	8.34	-0.23	13.00	8.46	7.83	1.38
1992	5.57	7.30	-0.70	10.87	5.39	5.58	0.49
1993	5.24	8.19	-3.51	0.56	6.15	5.07	0.81
1994	9.27	9.29	0.44	3.29	9.73	9.26	1.45
1995	9.74	6.45	0.90	21.05	5.92	16.73	2.21
1996	6.05	13.95	-5.92	8.83	5.77	5.07	1.23
1997	5.35	8.89	-4.94	14.61	4.07	4.29	1.49
1998	-8.78	0.78	-17.75	-2.66	-9.86	-10.24	0.52
1999	17.28	3.10	7.39	7.37	18.79	17.61	2.79
2000	13.53	5.70	5.41	4.82	14.43	14.07	2.08

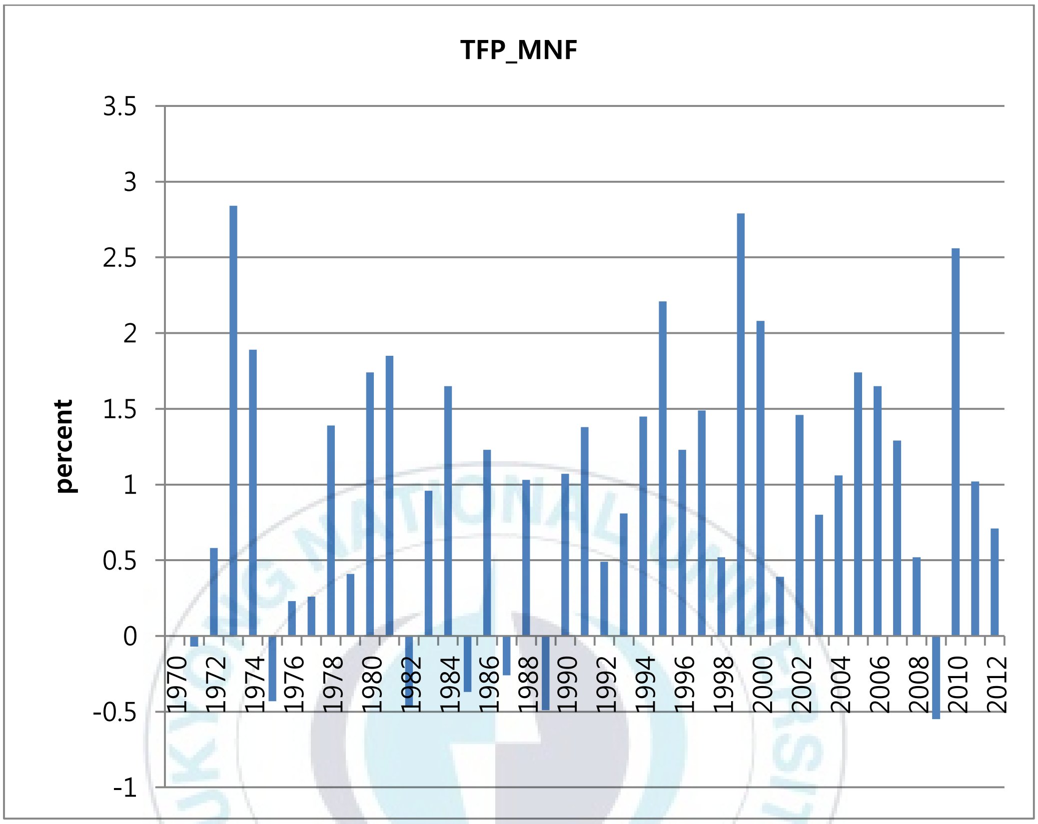
2001	1.98	3.54	-3.00	-1.91	2.36	2.85	0.39
2002	8.41	4.42	-2.12	1.19	9.76	9.73	1.46
2003	5.64	4.80	-0.86	-1.08	6.65	5.99	0.80
2004	9.15	5.41	5.48	4.17	9.36	9.47	1.06
2005	8.61	5.70	-4.92	8.89	9.35	8.89	1.74
2006	6.47	5.96	-3.09	3.24	6.44	5.95	1.65
2007	10.44	5.73	-3.64	5.13	12.33	12.80	1.29
2008	3.11	4.80	-1.16	5.38	2.68	2.74	0.52
2009	-1.28	3.99	1.78	-4.21	-1.65	-1.30	-0.55
2010	17.30	4.37	5.19	12.64	18.34	17.25	2.56
2011	8.34	3.86	2.32	6.15	8.87	8.33	1.02
2012	1.81	3.27	-3.29	2.25	1.57	1.07	0.71

Source: by author using data from KPC

The manufacturing sector is considered as a major growth engine for South Korea during its economic progress in the 1980s with some of its largest industries like electronics, automobiles, telecommunication and shipbuilding. This sector is the most interesting sector in terms of Korea's productive performance. This is the sector on which most of the economy's success has been built and where Korean firms have been very successful.

The data on total factor productivity of manufacturing sector on the above table in column 8 is a representation of the chart below.

Chart 5: TFP of manufacturing sector (%)



Source: by author using data from column 8 table 22

This sector is termed the engine of growth and development for South Korea. The contribution of growth in capital input is the largest which stood at an average of about 9.11 percent of the output growth between 1970 and 2012 in the total manufacturing sector. Labor man-hours contributed about 2.24 percent growth while the growth in TFP was 1.00 percent averagely. This sector made some substantial progress in terms of relative productivity, thanks to its TFP or growth rate in technical progress as illustrated on the chart above. From the chart above, we can say that the manufacturing sector is the most productive sector so far as the Korean economy is concerned. This is due to its TFP growth performance between 1970 and 2012 despite the fact that it also witnessed some setbacks or declines in its output. This is evident in the years

1971, 1975, 1982, 1985, 1987, 1989, and 2009 with a TFP growth record of -0.07 percent, -0.43 percent, -0.47 percent, -0.37 percent, -0.26 percent, -0.49 percent, and -0.55 percent, respectively. A downturn in the South Korean economy in 1989 was caused by a sharp decrease in exports and foreign orders.

Table 23: Growth rate of output and inputs of utilities sector (%)

UTL	gY_UTL	gK_UTL	gL_UTL	gE_UTL	gM_UTL	gS_UTL	gA_UTL
1970							
1971	-0.12	22.76	17.86	5.41	0.58	0.80	-11.47
1972	-0.81	16.24	20.07	5.97	-1.96	-1.57	-10.20
1973	22.53	15.80	-13.48	23.07	23.84	23.81	6.53
1974	11.19	-5.16	21.88	10.10	12.33	12.23	2.43
1975	7.06	6.62	14.57	10.25	7.08	7.24	-1.50
1976	10.04	18.25	3.17	10.92	10.68	10.69	-1.82
1977	19.69	16.27	15.42	17.69	17.54	17.55	2.72
1978	19.76	12.19	23.34	13.20	16.66	16.49	3.78
1979	5.06	10.50	4.87	9.81	5.02	5.26	-2.36
1980	-1.18	1.87	-2.26	0.11	-0.75	-0.71	-1.09
1981	-4.30	15.31	-0.30	0.12	-4.67	-4.42	-6.23
1982	14.53	14.92	-3.36	11.34	15.69	15.47	2.54
1983	17.89	16.26	-1.66	12.22	17.93	17.66	4.52
1984	6.50	15.11	10.41	1.97	7.04	6.81	-2.36
1985	5.80	11.55	-2.77	5.98	6.95	6.91	-0.76
1986	4.93	8.97	-2.15	-3.88	10.04	-4.48	0.99
1987	14.58	10.52	3.86	19.00	18.31	17.61	0.78
1988	12.02	10.39	9.64	18.00	14.62	14.78	-1.03
1989	13.84	9.05	9.46	12.94	15.42	15.50	1.95
1990	21.53	11.75	14.77	7.15	22.51	28.64	5.64
1991	11.94	16.36	12.63	9.96	11.28	13.86	-1.11
1992	1.18	17.79	7.39	8.51	0.43	1.10	-7.39
1993	10.15	16.38	1.91	9.82	11.47	10.70	-1.00
1994	6.67	13.82	4.03	9.33	6.54	6.96	-2.30

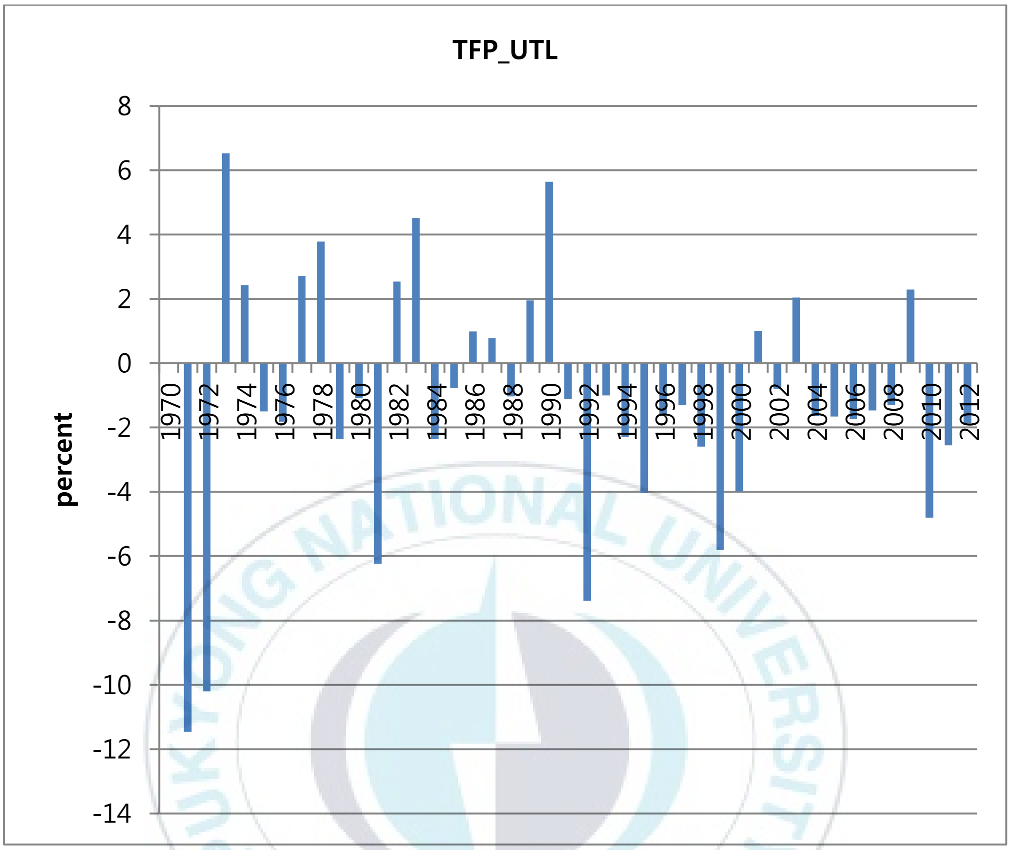
1995	8.72	5.19	4.39	36.18	6.35	7.86	-4.04
1996	8.58	13.42	2.69	13.68	7.46	9.19	-1.61
1997	4.00	7.79	-2.38	9.36	3.21	3.74	-1.30
1998	-11.13	3.59	-24.87	-7.52	-13.95	-12.91	-2.59
1999	-1.55	5.53	-3.47	12.36	-1.49	0.68	-5.81
2000	1.37	5.15	4.14	10.64	0.37	1.68	-3.99
2001	5.84	5.08	-1.21	6.56	5.82	6.16	1.01
2002	4.96	4.68	6.29	6.84	5.70	5.53	-0.79
2003	7.53	4.26	4.73	4.39	8.74	8.06	2.04
2004	2.18	3.68	3.55	7.25	0.06	1.31	-1.64
2005	1.37	4.06	-3.44	8.89	-1.15	-0.10	-1.66
2006	0.67	4.23	1.84	3.34	-0.37	0.32	-1.73
2007	4.90	4.40	-3.30	12.93	5.42	6.65	-1.47
2008	-1.38	4.11	-0.75	0.58	-3.31	-2.75	-1.30
2009	0.90	3.81	-2.72	-6.20	1.45	0.59	2.29
2010	1.92	4.14	0.41	18.00	-2.02	0.90	-4.80
2011	-1.55	3.95	-4.35	5.20	-3.90	-2.38	-2.55
2012	0.75	3.68	-2.20	6.34	-0.61	0.54	-1.87

Source: by author using data from KPC

The lone successful industry in this sector is construction. This is evident with Korean firms being heavily involved in construction not only in the Middle East, but worldwide as construction is one of the fast growing activities in the Korean economy. Contrary to the construction industry, the water, electricity and gas supply industries are lagging behind as their supply is not commensurate to their demands.

The data on total factor productivity growth rate of utilities sector is a representation of the chart below.

Chart 6: TFP growth rate of utilities sector (%)



Source: by author using data from column 8 table 23

The TFP growth rate of this sector is almost practically negative most especially between 1991 and 2012. Despite the positive contribution of the other factor inputs, the role of technical progress is negative, unlike in the other sectors. This may be as a result of lack of innovative machinery and strategies put in place to boost this sector. The best TFP growth rate was recorded in 1973 with a growth rate of 6.53 percent while the worst was in 1971 which stood at a negative growth rate of -11.47 percent.

Table 24: Growth rate of output and inputs of services sector (%)

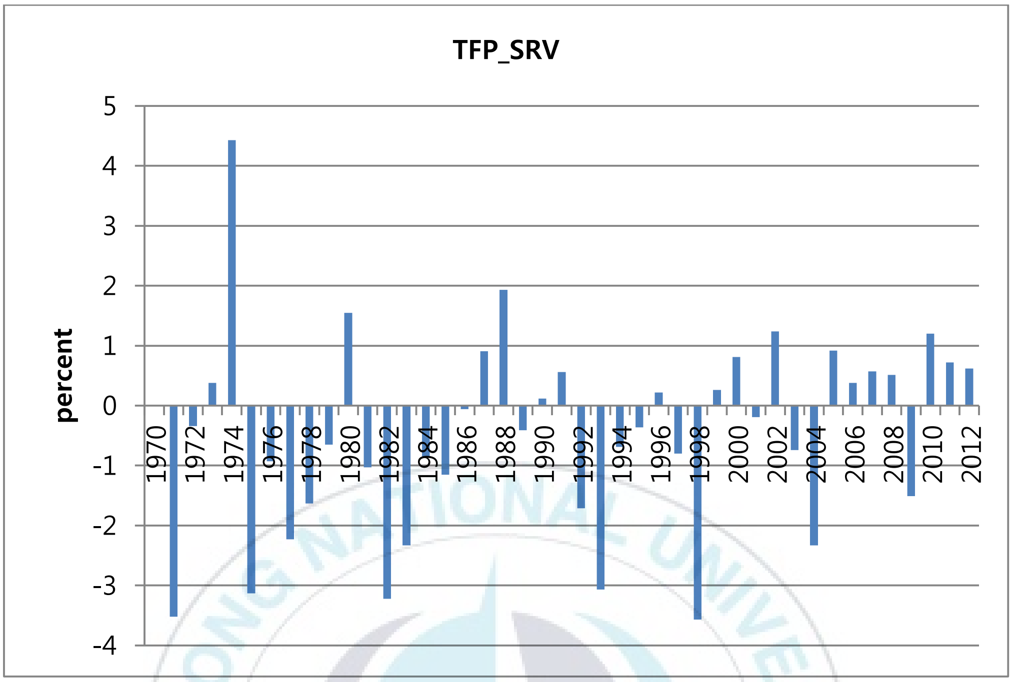
SRV	gY_SRV	gK_SRV	gL_SRV	gE_SRV	gM_SRV	gS_SRV	gA_SRV
1970							
1971	9.83	18.90	8.15	14.17	13.90	12.74	-3.52
1972	4.66	13.02	-4.42	5.51	6.86	5.83	-0.34
1973	8.61	12.56	-1.07	11.64	11.53	11.72	0.38
1974	4.33	-10.27	3.97	2.55	4.83	4.01	4.43
1975	6.93	4.17	12.94	11.22	13.90	11.08	-3.13
1976	6.90	15.16	1.41	6.59	7.71	6.70	-0.93
1977	7.00	13.87	8.11	6.64	7.30	6.31	-2.23
1978	7.98	10.55	8.43	10.94	10.75	8.95	-1.63
1979	6.05	4.33	8.18	7.90	7.06	7.47	-0.65
1980	2.34	-1.54	3.63	-0.18	1.22	0.33	1.55
1981	4.89	9.67	2.65	6.09	6.49	4.97	-1.03
1982	6.44	16.21	8.56	6.38	5.60	6.59	-3.22
1983	8.34	17.46	5.30	10.19	10.57	10.39	-2.33
1984	7.30	16.22	1.43	8.30	7.44	8.24	-0.86
1985	7.53	12.46	6.46	7.95	8.39	7.52	-1.15
1986	8.82	14.81	2.45	1.27	12.13	10.23	-0.06
1987	9.42	10.84	4.84	4.58	10.83	10.11	0.91
1988	9.72	9.36	3.26	7.06	11.64	10.30	1.93
1989	7.37	11.75	4.20	9.78	8.44	7.65	-0.41
1990	7.73	7.94	4.36	-10.35	-4.50	16.88	0.12
1991	8.71	10.48	4.31	12.13	9.88	9.93	0.56
1992	7.09	12.33	7.20	8.74	7.99	7.67	-1.71
1993	6.49	16.26	7.73	5.21	6.95	6.83	-3.07
1994	7.89	13.55	4.51	9.17	8.82	9.29	-0.69
1995	8.15	13.48	4.60	36.28	-0.04	8.11	-0.36
1996	8.04	10.68	1.62	11.25	9.69	12.07	0.22
1997	5.83	8.86	4.10	8.43	5.11	7.98	-0.80
1998	-5.00	7.48	-1.46	-6.47	-7.32	-5.95	-3.57
1999	7.51	6.91	4.81	7.79	11.12	9.10	0.26
2000	7.17	7.03	2.12	6.82	8.05	9.91	0.81

2001	5.50	6.77	3.59	6.68	7.48	6.43	-0.19
2002	8.36	6.71	3.74	7.80	10.59	9.85	1.24
2003	1.67	6.41	0.24	1.33	3.25	1.38	-0.74
2004	2.24	5.86	6.14	5.01	2.12	2.55	-2.33
2005	4.14	5.28	-1.45	5.89	4.72	5.38	0.92
2006	4.78	5.00	1.86	6.19	5.33	5.89	0.38
2007	5.30	4.99	-1.22	7.82	5.61	9.51	0.57
2008	3.99	4.42	0.12	4.92	5.92	4.90	0.51
2009	2.33	3.90	3.51	2.27	4.80	4.09	-1.51
2010	4.84	4.20	-0.21	6.49	4.52	5.86	1.20
2011	2.68	3.85	-1.05	2.13	2.67	2.91	0.72
2012	2.56	3.41	-1.03	2.21	3.01	2.98	0.62

Source: by author using data from KPC

When put side by side with the manufacturing sector, the service sector is lagging behind. This is due to industrialization whereby priorities are put on the manufacturing sector at the expense of services by experimenting the changes in productivity of the service subsectors between 1970-2012, we discover that liberalization may have positively contributed to the productivity of the liberalized service subsectors such as ‘transport and communications’ which was partially liberalized in the 1990s, showed a gain in the early 2000s, from -1.71 percent in 1992 to 1.24 percent in 2002.

Chart 7: TFP growth rate of services sector (%)



Source: by author using data from column 8 table 24

Looking at chart 7 above, we realize that the services sector, judging from the look of things in terms of the disparity between the manufacturing and service sectors, it is perfect to consider that the hypothesis that liberalization in services may increase the productivity of the manufacturing subsectors which use liberalized services as inputs as can also be tested by comparing the growth rates of productivity by manufacturing subsectors and the input coefficients of services to those manufacturing subsectors.

Tables 25-30 show the contributions of all factor inputs to the growth rate of output at both aggregate and sector levels based on equation 5.

Table 25: Contributions of all factor inputs to the growth rate of output at aggregate level (%)

AGG	sK.gK_AGG	sL.gL_AGG	sE.gE_AGG	sM.gM_AGG	sS.gS_AGG	gA_AGG
1970						
1971	4.73	0.70	0.92	3.50	1.49	-2.72
1972	3.47	0.61	0.59	2.62	0.79	-2.64
1973	2.91	0.72	1.32	6.05	1.98	-0.11
1974	-1.20	1.03	0.63	3.76	0.93	2.34
1975	1.27	2.17	0.94	3.30	1.43	-1.57
1976	3.73	1.21	1.05	5.14	1.53	-1.51
1977	3.41	0.75	0.93	3.11	1.41	-0.54
1978	2.79	0.99	1.15	4.82	2.06	-0.77
1979	1.61	0.39	0.65	2.40	1.32	0.63
1980	-0.34	-0.62	0.30	-0.16	-0.02	0.17
1981	2.01	-0.34	0.49	2.01	0.85	0.90
1982	2.79	0.81	0.47	2.29	1.35	-0.82
1983	3.04	-0.01	1.05	4.31	2.17	0.74
1984	3.15	-0.09	0.77	3.50	1.59	-0.07
1985	2.61	0.46	0.60	2.18	1.15	-0.36
1986	3.09	0.69	0.26	5.30	1.79	0.36
1987	2.85	1.39	0.56	5.36	2.18	-0.07
1988	2.29	0.51	0.47	3.90	1.96	1.32
1989	2.35	0.57	0.53	1.94	1.25	-0.34
1990	1.87	0.44	0.32	2.01	3.62	0.94
1991	2.06	0.09	0.66	2.69	1.77	1.45
1992	2.33	0.91	0.55	1.55	1.13	-0.92
1993	2.88	0.70	0.12	2.13	1.28	-1.12
1994	2.61	0.58	0.26	2.75	1.69	0.16
1995	2.24	0.66	1.40	1.45	2.29	0.69
1996	2.30	-0.15	0.57	1.87	1.97	0.48
1997	1.73	0.21	0.74	1.18	1.30	0.13
1998	1.09	-1.36	-0.26	-2.92	-1.66	-2.33
1999	1.25	0.84	0.51	4.57	2.17	1.58

2000	1.40	0.57	0.40	3.57	2.07	1.46
2001	1.24	0.20	0.11	0.97	1.10	0.13
2002	1.27	0.45	0.25	2.72	1.97	1.07
2003	1.19	-0.03	0.03	1.84	0.77	0.30
2004	1.11	1.08	0.33	2.24	1.06	0.01
2005	1.02	-0.67	0.57	2.34	1.36	1.50
2006	0.99	0.17	0.30	1.71	1.21	0.79
2007	1.00	-0.47	0.53	3.30	2.35	1.38
2008	0.85	-0.09	0.35	0.78	0.80	0.34
2009	0.74	0.54	-0.20	-0.20	0.44	-1.03
2010	0.81	0.09	0.91	4.73	2.29	2.72
2011	0.73	-0.17	0.39	2.30	1.10	1.25
2012	0.66	-0.33	0.23	0.50	0.48	0.45

Source: by author using data from KPC

Capital input seems to play a major role from the table above on the contributions of technical progress to the growth rate of output and inputs at aggregate level. Though not in its entirety, as the other input factors aren't dormant.

Table 26: Contributions of technical progress to the growth rate of output and inputs of agricultural sector (%)

AGR	sK.gK_AGR	sL.gL_AGR	sE.gE_AGR	sM.gM_AGR	sS.gS_AGR	gA_AGR
1970						
1971	8.14	-0.28	0.07	0.79	0.11	-4.98
1972	6.71	1.90	0.09	1.08	0.15	-6.21
1973	4.14	1.16	0.16	1.82	0.25	-0.35
1974	6.22	0.26	0.09	1.02	0.14	-2.69
1975	2.13	1.52	0.02	0.28	0.04	-0.59
1976	2.96	0.79	0.10	1.06	0.17	2.57
1977	4.77	-0.48	-0.05	-0.47	-0.08	-2.54
1978	4.47	-0.81	0.15	1.38	0.26	-12.52
1979	5.09	-1.86	0.12	1.09	0.22	3.92

1980	1.76	-1.51	0.09	0.80	0.17	-16.78
1981	1.59	-1.66	0.07	0.56	0.12	11.11
1982	1.77	-0.81	-0.04	-0.30	-0.06	2.77
1983	2.36	-4.13	0.45	3.55	0.71	5.29
1984	2.63	-2.88	0.23	1.80	0.36	-1.36
1985	1.87	-1.28	-0.01	-0.04	-0.01	2.44
1986	2.90	-0.48	-0.26	1.68	0.35	0.69
1987	3.57	-0.57	-0.06	2.08	0.28	-6.14
1988	8.84	-0.76	-0.15	0.57	0.05	-2.93
1989	3.40	-0.37	0.24	1.09	0.32	-3.71
1990	1.54	-1.82	0.58	-0.78	0.28	-4.11
1991	2.42	-5.35	0.10	0.08	-0.03	4.25
1992	2.58	-0.52	0.21	1.32	0.40	3.60
1993	3.04	-0.80	0.04	1.54	0.25	-6.29
1994	3.14	-1.10	0.09	1.11	0.27	-1.67
1995	2.83	-0.92	-0.57	0.38	1.85	1.06
1996	2.64	-0.93	0.11	0.92	0.40	-0.15
1997	1.43	-0.41	0.17	0.26	0.31	1.71
1998	0.85	1.35	-0.21	-0.16	-0.41	-6.30
1999	1.65	-0.97	0.01	0.36	0.16	2.88
2000	2.03	-0.58	-0.18	-0.04	-0.17	-0.58
2001	1.80	-1.62	0.19	0.48	0.43	0.41
2002	1.54	-1.03	-0.02	-0.33	-0.04	-2.82
2003	1.24	-1.60	0.16	-0.58	0.15	-3.25
2004	0.93	-1.10	0.14	0.06	0.42	5.36
2005	0.93	-3.07	0.29	0.46	0.28	2.37
2006	1.03	-0.01	0.29	0.52	0.27	-2.93
2007	1.12	-1.56	1.05	2.23	1.39	3.33
2008	1.06	-0.78	0.00	-0.38	-0.07	3.25
2009	1.07	0.57	0.15	0.88	0.32	0.35
2010	1.17	-1.34	-0.41	-1.96	-0.75	-1.12
2011	1.13	-1.03	-0.21	-1.17	-0.43	-1.22
2012	0.95	-0.73	0.08	1.83	0.43	-0.03

Source: by author using data from KPC

The share and growth rate of technical progress for agricultural sector towards economic growth is meager despite government policies geared towards encouraging agriculture in the economy. The contributions of capital and material inputs have been partially significant despite its general low output experienced within this sector. This is indicative of the role played by labor input in the sector which cannot be underestimated.

Table 27: Contributions of technical progress to the growth rate of output and inputs of mining sector (%)

MIN	sK.gK_MIN	sL.gL_MIN	sE.gE_MIN	sM.gM_MIN	sS.gS_MIN	gA_MIN
1970						
1971	3.88	-9.59	0.09	0.49	0.23	7.59
1972	3.85	-10.41	-0.14	-0.74	-0.34	5.58
1973	3.09	-5.50	0.40	2.21	1.00	12.31
1974	-2.79	3.42	0.41	2.56	0.99	3.80
1975	1.42	7.56	0.53	3.29	1.28	-1.82
1976	2.48	1.63	-0.19	-1.07	-0.45	-4.48
1977	3.07	9.87	0.25	1.26	0.62	-5.02
1978	2.84	0.96	0.20	1.02	0.48	-0.31
1979	1.55	2.34	0.05	0.23	0.12	-5.80
1980	-1.26	0.43	0.06	0.28	0.14	-0.60
1981	3.64	-0.30	0.34	1.58	0.81	-3.00
1982	5.43	-2.13	0.00	-0.02	-0.01	-8.83
1983	5.06	-0.83	0.25	1.15	0.60	-1.71
1984	5.06	5.46	0.38	1.68	0.88	-7.61
1985	2.98	0.38	0.43	1.88	1.00	-0.73
1986	3.62	5.13	0.36	2.10	1.12	-5.46
1987	2.14	-2.43	-0.03	0.74	0.35	-0.40
1988	-2.69	-7.62	-0.03	-0.83	-0.42	11.34
1989	-7.99	-15.15	-0.88	-1.39	-1.38	17.51
1990	-0.66	-2.50	-2.55	-4.96	4.16	-1.55
1991	-4.49	-8.53	-0.90	-1.22	-1.64	10.23

1992	-1.96	1.41	-1.84	-8.42	-6.28	-4.64
1993	0.60	-2.53	-1.40	-2.51	-2.74	-1.35
1994	-4.25	-4.85	-1.00	-0.68	-1.18	8.92
1995	0.35	-9.51	1.44	-18.79	1.43	17.48
1996	-0.66	-2.08	-0.16	-0.09	0.13	0.94
1997	-4.15	1.95	-0.11	0.06	-0.10	1.01
1998	4.69	-7.31	-1.49	-3.89	-2.92	-8.13
1999	3.56	1.59	0.38	0.79	0.81	-1.72
2000	4.29	-5.49	0.15	0.57	0.23	2.03
2001	3.39	2.06	1.50	1.67	1.17	-5.96
2002	3.21	-1.21	0.89	2.12	1.69	-7.65
2003	2.89	-0.88	0.65	1.46	1.37	-1.64
2004	2.42	-0.86	0.03	0.85	0.12	-0.91
2005	1.62	0.00	0.19	0.36	0.10	-3.92
2006	1.76	0.98	0.30	0.75	0.63	-1.12
2007	1.90	0.30	-2.70	-8.25	-7.37	16.31
2008	1.66	0.83	0.12	0.48	0.37	-0.77
2009	1.30	1.87	-0.58	-1.22	-1.00	-5.82
2010	1.40	-1.26	-0.35	-0.50	-0.42	-7.49
2011	1.30	-2.51	-0.49	-1.31	-1.29	-0.50
2012	1.14	-3.57	0.23	0.85	0.69	2.93

Source: by author using data from KPC

The contribution of capital in the mining sector is more glaring than the others, proving that the sector is mostly capital-oriented.

Table 28: Contributions of all factor inputs to the growth rate of output and inputs of manufacturing sector (%)

MNF	sK.gK_MNF	sL.gL_MNF	sE.gE_MNF	sM.gM_MNF	sS.gS_MNF	gA_MNF
1970						
1971	3.48	0.59	1.22	6.85	0.84	-0.07
1972	2.86	0.20	1.03	5.66	0.70	0.58
1973	1.81	1.72	1.83	11.42	1.43	2.84
1974	0.08	1.60	0.94	7.53	0.93	1.89
1975	1.30	2.14	1.10	5.45	0.69	-0.43
1976	2.85	2.21	1.66	10.83	2.14	0.23
1977	2.48	0.51	1.26	5.64	1.52	0.26
1978	2.12	1.01	1.49	9.03	2.61	1.39
1979	1.28	0.51	0.73	4.42	1.34	0.41
1980	-0.46	-1.46	0.54	-0.65	-0.26	1.74
1981	0.99	-0.41	0.60	4.17	1.17	1.85
1982	1.13	0.84	0.47	3.79	1.01	-0.47
1983	1.31	1.21	1.29	7.13	1.77	0.96
1984	1.80	0.31	1.01	6.65	1.40	1.65
1985	1.74	0.26	0.69	3.73	0.63	-0.37
1986	1.85	1.14	0.48	10.40	1.75	1.23
1987	2.18	1.99	0.72	10.04	1.80	-0.26
1988	1.28	0.42	0.52	6.98	1.39	1.03
1989	1.26	0.18	0.63	2.45	0.44	-0.49
1990	1.26	-0.13	0.76	3.37	2.41	1.07
1991	0.93	-0.03	0.88	4.68	0.91	1.38
1992	0.81	-0.10	0.74	2.97	0.66	0.49
1993	0.94	-0.53	0.04	3.38	0.61	0.81
1994	1.20	0.07	0.20	5.25	1.10	1.45
1995	0.69	0.14	1.06	3.19	2.45	2.21
1996	1.42	-0.94	0.47	3.13	0.73	1.23
1997	0.98	-0.73	0.78	2.21	0.62	1.49
1998	0.09	-2.33	-0.14	-5.44	-1.47	0.52
1999	0.40	0.95	0.41	10.27	2.46	2.79

2000	0.75	0.73	0.28	7.76	1.92	2.08
2001	0.45	-0.41	-0.11	1.27	0.40	0.39
2002	0.56	-0.29	0.07	5.20	1.41	1.46
2003	0.57	-0.12	-0.06	3.55	0.90	0.80
2004	0.62	0.77	0.23	5.00	1.47	1.06
2005	0.60	-0.69	0.52	5.01	1.43	1.74
2006	0.62	-0.42	0.20	3.45	0.97	1.65
2007	0.60	-0.49	0.31	6.64	2.09	1.29
2008	0.49	-0.14	0.34	1.46	0.45	0.52
2009	0.43	0.22	-0.26	-0.90	-0.21	-0.55
2010	0.48	0.61	0.79	10.01	2.85	2.56
2011	0.41	0.27	0.39	4.86	1.38	1.02
2012	0.36	-0.42	0.14	0.85	0.18	0.71

Source: by author using data from KPC

The success of the manufacturing sector is thanks to the joined efforts and contributions of all factor inputs with little or no exceptions to any of them.

Table 29: Contributions of technical progress to the growth rate of output and inputs of utilities sector (%)

UTL	sK.gK_UTL	sL.gL_UTL	sE.gE_UTL	sM.gM_UTL	sS.gS_UTL	gA_UTL
1970						
1971	7.54	2.68	0.91	0.15	0.08	-11.47
1972	5.68	3.42	0.90	-0.47	-0.14	-10.20
1973	4.78	-1.90	4.32	6.35	2.45	6.53
1974	-1.19	2.34	2.37	3.77	1.49	2.43
1975	1.54	1.60	2.40	2.14	0.88	-1.50
1976	4.81	0.37	2.46	2.87	1.35	-1.82
1977	3.85	2.20	4.14	4.48	2.30	2.72
1978	2.90	4.18	3.01	3.83	2.06	3.78
1979	2.48	0.89	2.26	1.13	0.66	-2.36
1980	0.47	-0.31	0.03	-0.18	-0.10	-1.09
1981	3.66	-0.04	0.03	-1.12	-0.60	-6.23

1982	4.01	-0.43	2.68	3.70	2.02	2.54
1983	4.44	-0.24	2.76	4.18	2.23	4.52
1984	4.47	1.57	0.41	1.59	0.81	-2.36
1985	3.20	-0.41	1.31	1.63	0.83	-0.76
1986	3.30	-0.35	-0.63	2.08	-0.46	0.99
1987	3.35	0.56	3.68	4.18	2.03	0.78
1988	3.54	1.45	3.19	3.21	1.68	-1.03
1989	2.96	1.65	2.20	3.31	1.77	1.95
1990	3.41	2.63	1.33	5.12	3.40	5.64
1991	4.55	2.52	1.76	2.49	1.72	-1.11
1992	5.64	1.23	1.47	0.09	0.14	-7.39
1993	5.43	0.32	1.55	2.46	1.39	-1.00
1994	4.46	0.65	1.42	1.47	0.96	-2.30
1995	1.68	0.71	8.37	0.93	1.07	-4.04
1996	4.03	0.47	3.37	1.09	1.23	-1.61
1997	2.30	-0.40	2.44	0.47	0.49	-1.30
1998	1.09	-3.86	-1.95	-2.15	-1.67	-2.59
1999	1.83	-0.51	3.08	-0.23	0.08	-5.81
2000	1.66	0.54	2.89	0.06	0.21	-3.99
2001	1.62	-0.17	1.74	0.89	0.75	1.01
2002	1.48	0.93	1.80	0.87	0.66	-0.79
2003	1.33	0.71	1.18	1.32	0.95	2.04
2004	1.06	0.54	2.05	0.01	0.16	-1.64
2005	1.10	-0.52	2.64	-0.18	-0.01	-1.66
2006	1.12	0.27	1.03	-0.06	0.04	-1.73
2007	1.13	-0.49	4.03	0.86	0.83	-1.47
2008	0.76	-0.10	0.21	-0.56	-0.39	-1.30
2009	0.80	-0.40	-2.11	0.24	0.08	2.29
2010	0.93	0.06	5.94	-0.34	0.12	-4.80
2011	0.83	-0.60	1.77	-0.67	-0.33	-2.55
2012	0.72	-0.30	2.23	-0.11	0.08	-1.87

Source: by author using data from KPC

Despite the dominant role played by all factor inputs as seen in the table above, but for its TFP growth contribution, the utilities sector's output (supply) cannot meet up with its existing demands for industrial purposes.

Table 30: Contributions of technical progress to the growth rate of output and inputs of services sector (%)

SRV	sK.gK_SRV	sL.gL_SRV	sE.gE_SRV	sM.gM_SRV	sS.gS_SRV	gA_SRV
1970						
1971	5.31	2.43	0.88	1.89	2.84	-3.52
1972	3.68	-1.28	0.35	0.95	1.31	-0.34
1973	3.56	-0.31	0.73	1.59	2.66	0.38
1974	-2.97	1.10	0.16	0.69	0.92	4.43
1975	1.18	3.58	0.72	2.00	2.58	-3.13
1976	4.49	0.40	0.41	1.00	1.54	-0.93
1977	4.12	2.36	0.40	0.90	1.44	-2.23
1978	3.15	2.49	0.65	1.28	2.03	-1.63
1979	1.31	2.43	0.46	0.82	1.67	-0.65
1980	-0.47	1.05	-0.01	0.15	0.07	1.55
1981	2.84	0.77	0.34	0.79	1.17	-1.03
1982	4.39	2.62	0.36	0.68	1.62	-3.22
1983	4.58	1.65	0.57	1.28	2.59	-2.33
1984	4.25	0.44	0.47	0.89	2.11	-0.86
1985	3.41	1.96	0.45	0.98	1.88	-1.15
1986	4.15	0.76	0.06	1.36	2.55	-0.06
1987	3.09	1.53	0.19	1.16	2.55	0.91
1988	2.64	1.05	0.26	1.21	2.63	1.93
1989	3.27	1.41	0.32	0.86	1.92	-0.41
1990	2.18	1.49	-0.27	-0.38	4.59	0.12
1991	2.76	1.52	0.32	0.84	2.71	0.56
1992	3.26	2.53	0.23	0.67	2.10	-1.71
1993	4.22	2.72	0.13	0.59	1.90	-3.07
1994	3.33	1.62	0.23	0.77	2.62	-0.69
1995	3.28	1.65	1.14	0.00	2.43	-0.36

1996	2.52	0.58	0.39	0.73	3.61	0.22
1997	2.08	1.42	0.32	0.41	2.41	-0.80
1998	1.74	-0.50	-0.27	-0.61	-1.80	-3.57
1999	1.68	1.60	0.34	0.95	2.69	0.26
2000	1.68	0.70	0.32	0.72	2.95	0.81
2001	1.63	1.15	0.32	0.64	1.96	-0.19
2002	1.66	1.17	0.37	0.89	3.02	1.24
2003	1.58	0.07	0.06	0.27	0.42	-0.74
2004	1.45	1.91	0.25	0.17	0.79	-2.33
2005	1.30	-0.45	0.30	0.38	1.69	0.92
2006	1.22	0.57	0.33	0.43	1.85	0.38
2007	1.23	-0.37	0.42	0.45	3.00	0.57
2008	1.09	0.04	0.28	0.49	1.59	0.51
2009	0.92	1.03	0.13	0.40	1.34	-1.51
2010	0.99	-0.06	0.37	0.38	1.95	1.20
2011	0.91	-0.29	0.13	0.23	0.98	0.72
2012	0.85	-0.28	0.14	0.25	0.99	0.62

Source: by author using data from KPC

The role of energy input has not been more encouraging when compared with those of the other inputs though all impressive. When compared with those of the manufacturing sector, we realize that the manufacturing sector is being prioritized at the expense of its services counterpart.

Table 31: TFP Growth rates at both aggregate and sector levels (%)

YEAR	gA_AGG	gA_AGR	gA_MIN	gA_MNF	gA_UTL	gA_SRV
1971	-2.72	-4.98	7.59	-0.07	-11.47	-3.52
1972	-2.64	-6.21	5.58	0.58	-10.2	-0.34
1973	-0.11	-0.35	12.31	2.84	6.53	0.38
1974	2.34	-2.69	3.8	1.89	2.43	4.43
1975	-1.57	-0.59	-1.82	-0.43	-1.50	-3.13
1976	-1.51	2.57	-4.48	0.23	-1.82	-0.93
1977	-0.54	-2.54	-5.02	0.26	2.72	-2.23
1978	-0.77	-12.52	-0.31	1.39	3.78	-1.63
1979	0.63	3.92	-5.8	0.41	-2.36	-0.65
1980	0.17	-16.78	-0.6	1.74	-1.09	1.55
1981	0.90	11.11	-3.00	1.85	-6.23	-1.03
1982	-0.82	2.77	-8.83	-0.47	2.54	-3.22
1983	0.74	5.29	-1.71	0.96	4.52	-2.33
1984	-0.07	-1.36	-7.61	1.65	-2.36	-0.86
1985	-0.36	2.44	-0.73	-0.37	-0.76	-1.15
1986	0.36	0.69	-5.46	1.23	0.99	-0.06
1987	-0.07	-6.14	-0.40	-0.26	0.78	0.91
1988	1.32	-2.93	11.34	1.03	-1.03	1.93
1989	-0.34	-3.71	17.51	-0.49	1.95	-0.41
1990	0.94	-4.11	-1.55	1.07	5.64	0.12
1991	1.45	4.25	10.23	1.38	-1.11	0.56
1992	-0.92	3.60	-4.64	0.49	-7.39	-1.71
1993	-1.12	-6.29	-1.35	0.81	-1.00	-3.07
1994	0.16	-1.67	8.92	1.45	-2.30	-0.69
1995	0.69	1.06	17.48	2.21	-4.04	-0.36
1996	0.48	-0.15	0.94	1.23	-1.61	0.22
1997	0.13	1.71	1.01	1.49	-1.30	-0.80
1998	-2.33	-6.3	-8.13	0.52	-2.59	-3.57
1999	1.58	2.88	-1.72	2.79	-5.81	0.26
2000	1.46	-0.58	2.03	2.08	-3.99	0.81
2001	0.13	0.41	-5.96	0.39	1.01	-0.19

2002	1.07	-2.82	-7.65	1.46	-0.79	1.24
2003	0.30	-3.25	-1.64	0.80	2.04	-0.74
2004	0.01	5.36	-0.91	1.06	-1.64	-2.33
2005	1.50	2.37	-3.92	1.74	-1.66	0.92
2006	0.79	-2.93	-1.12	1.65	-1.73	0.38
2007	1.38	3.33	16.31	1.29	-1.47	0.57
2008	0.34	3.25	-0.77	0.52	-1.3	0.51
2009	-1.03	0.35	-5.82	-0.55	2.29	-1.51
2010	2.72	-1.12	-7.49	2.56	-4.8	1.20
2011	1.25	-1.22	-0.5	1.02	-2.55	0.72
2012	0.45	-0.03	2.93	0.71	-1.87	0.62

Source: by author

Using TFP at aggregate level as annual standard growth rate of the Korean economy, a comparative analysis on TFP growth rates for each of the 5 sectors under study is assessed. Between 1971- 1973, all sectors experienced an insignificant growth rate which is as a result of the oil crisis witnessed within the economy. The only sector exempted from this negative effect was the mining sector in the year 1971, while for 1972, the mining and manufacturing sectors registered a positive TFP growth rate. Contrarily, in 1973 and 1974, the agriculture sector was the lone sector that witnessed a back-drop of -0.35 percent and -2.69 percent TFP growth respectively, while the rest recorded an improvement. From 1975-1978, the Korean economy's TFP growth experienced a decline with all 5 sectors being involved in 1975, agriculture and manufacturing sectors being exempted in 1976 (they recorded a positive growth rate each) while in 1977, the manufacturing and utilities sectors were the only 2 with significant results while in the year 1980, the manufacturing and services sectors had considerable TFP growth performances.

In 1981, the agriculture sector recorded its highest TFP growth rate of 11.11 percent, which greatly contributed to the Korean economy's growth rate in that year. The mining sector registered among its highest, a TFP growth rate of

17.51 percent in 1989, 17.48 percent in 1995 and 16.31 percent in 2007. This is to prove the wide gap that exists between the sector and the other sectors, despite the fact that the sector suffers neglect and abandonment due to its poor quality mines. If only some attention be given to this sector like in other sectors, it is likely to trigger the economy’s growth a little further, all things being equal vis-à-vis the other sectors. It would be wise to know that while the utilities sector recorded its highest TFP growth rates in the years 1973 and 1990 with growth rates of 6.53 percent and 5.64 percent respectively, the services sector registered its highest in 1974 with a growth rate of 4.43 percent. The manufacturing sector has maintained a constant TFP growth rate throughout our time range (between 1970-2012) of between -0.55 percent in adverse situations to 2.84 percent in favorable situations.

5.3. DISCUSSION OF EMPIRICAL RESULTS

5.3.1 Aggregate level

The results obtained this far from the calculations have a number of implications. First and foremost, based on the data structure generated from the Korea productivity Centre (KPC), TFP was estimated. A gross output growth accounting was also conducted. Throughout the entire period between 1970-2012, the economy-wide labor productivity growth rate stands at an average rate of 1.80 percent while that of capital stands at a growth rate of 8.90 percent. And as for the intermediate input factors, the average growth rate of energy was 7.71 percent, material input was 8.21 percent while it was 7.71 percent for service input, same as in energy.

From the calculations, we discovered that at aggregate level, TFP growth rate in the early 1970s was negative due to the oil shocks experienced within the economy at the time but in the year 1974, TFP registered a growth rate of 2.34 percent. In the year 2010, it also recorded a growth rate of 2.74 percent, higher than that recorded in the year 1974. This happened to be the highest TFP growth rate registered between the years 1970 and 2012. Contrarily, it recorded its worst TFP growth rate at the aggregate level in 1971 and 1972, with a negative growth rate of -2.72 percent and -2.64 percent respectively due to the oil crisis at the time. In 1998, it also witnessed a drop in its growth rate of from 0.13 percent in 1997 to -2.33 percent in 1998, all because of the Asian financial crisis at the time. This decline was also witnessed during the world's economic recession in 2009 by recording a negative growth rate of -1.03 percent.

Throughout the entire period 1970-2012, the Korean economy experienced about three break-points: mid-1970s in which it witnessed the first oil shock; later in 1997 which was as a result of the Asian financial crisis and finally in 2008 which was adversely impacted by high commodity prices, especially oil, and by financial and real shocks started by the collapse of housing prices in the U.S. and subsequent economic and financial distress that rapidly spread throughout much of the world.. The difference between these three break points can be summarized as follows. During the second half of 1970's, the growth rate of gross output was not low, but the growth rates of inputs such as capital, labor, energy, material and services especially were relatively higher. Therefore, the growth rates of TFP have been estimated to be negative at the economy-wide (aggregate) level. In case of late 1990's, the negative growth of TFP has been as a result of the drop of gross output rooted from economic crisis.

The results gotten this far from the calculations have a number of implications. Firstly, in estimate, Korea's growth slow-down (deceleration) in the 2000s can be expounded by slower growth in capital as well as by labor inputs. This tendency of rising consumption and leisure could be a natural outcome for an economy that is experiencing a sustained increase in income, held bound by constant growth in productivity, over time. Secondly, the effects of economic crises in the past two decades are issues of concern. The 1997 crisis was accompanied by a large negative productivity shock: The level of productivity reached its pre-crisis peak of 1993 only in 1998. The fact that the 1998 economic contraction was large does not necessarily imply a commensurate negative productivity shock as actually seen in that year because a sharp contraction in output was accompanied by substantial contraction in the input factors of capital and employment. Thus, the observed negative productivity shock could be understood as being caused by the destruction of intangible human capital, as there was an enormous and disorderly closing of businesses and banks in the wake of the crisis. In specific, evidence suggests that the assumed tendency of constant healthy growth in TFP might be difficult to sustain.

5.3.2 Agriculture sector

In agricultural sector, the TFP growth rate was mostly negative in the 1970s with exceptions in the years 1976 and 1979 when it registered 2.57 percent and 3.92 percent respectively. In 1981, TFP growth rate stood at 11.11 percent, the highest so far between 1970 and 2012 whereas its worst was in 1980 at 16.78 percent. It should be noted that in the early 1970s, early 1980s, the late 1990s were turbulent years in the Korean history. Despite government policies whose purpose is at boosting the agricultural sector, its TFP growth output was not satisfactorily the best. This was due to industrialization at the time as agriculture was gradually being abandoned as an activity for aged people and women while youths left the villages for the cities in search for better jobs.

From 1970-2012, the average growth rate of capital input was 6.70 percent, while that of labor input recorded an insignificant growth rate of -3.33 percent. For the intermediate factor inputs, energy’s average growth rate was 2.46

percent, material input had an average growth rate of 2.72 percent and for service input, it was 3.44 percent. Its average TFP growth rate registered was -0.81 percent. Insignificant it was when compared to that registered at aggregate level. The principal cause of this backdrop in TFP growth rate at the agricultural level is the declining nature of its labor input which is due to urbanization. Agricultural labor costs thereby increased as young people left rural areas for urban jobs, and farm work mainly was done by women and old men. Farmers' relative earnings improved during the 1970s, but fell in the 1980s. The gap between incomes of urbanites and people in rural areas widened considerably in the late 1980s. According by statistics, South Korea's agriculture added only 3 percent of the nation's total GDP in 2010, and employed 7.3 percent of the country's workforce. Back in 1987, agriculture made up about 12.3 percent of the nation's total GDP, and employed 21 percent of the workforce.

5.3.3 Mining sector

The industrial production index of the domestic mining industry has been dropping rapidly since the 1990s, and this contraction of business activities, as can be observed from the high mine abandonment rate (70% metal and 60% non-metal), leads to a contraction of mining activities, which only aggravates the circumstances of the domestic mining industry. This is evident in its TFP average growth rate of 0.45 percent between 1970- 2012, indicative of an upward trend contrarily to its corresponding average growth in input factors of labor which recorded an insignificant -6.49 percent, energy registered -2.47 percent average growth rate, material input having -3.56 percent and service input also registered -0.02 percent. It should be noted here that only capital input recorded a positive average growth rate of 3.35 percent.

In the 1970s, it is estimated that this sector recorded a positive growth rate, in the 1980s, its growth rate was estimated to be negative. Same like in the

1980s, the 1990s estimates were approximated to be negative and this applies to the 2000s.

It should also be made known that while domestic mineral resources maintain an annual mineral production of 2 trillion won, the share of the domestic mining industry with respect to GDP is only 0.23%. However, the economic influence of domestic non-metallic resources, such as limestone and kaolin, on 124 relevant industries was found to be 646 trillion won. Furthermore, an investigation by the Bank of Korea proved a relatively high current effect when grouped with industries having direct relation to non-metallic minerals, and compared to other groups among 78 industrial categories.

While Korea's natural resources are relatively poor compared to those of resource-rich countries, with its resource types limited primarily to non-metallic rock such as limestone, many preventive elements such as the small scale of mine development, high labor costs, operation difficulties, and environmental regulations are hindering the growth of the domestic mining industry. In the meantime, 97% of domestic energy is dependent on foreign resources, and while foreign resource development policies are being promoted due to the uncertainty of mineral cost and increase in resource demand, diverse mining industry policies and self-preservation efforts are underway for the active development and utilization of domestic mineral resources. By placing the concept of sustainable development at the center to harmonize resource development with the environment and become an advanced resource-managing country, the domestic mining industry is changing. This is in accordance with its 2007 "Framework Plan for the Growth of the Domestic Mining Industry (2007-2016)" to suggest various political tasks for the stability of mineral resources and the prevention of mine damage, through an analysis of the changes in the domestic and foreign mining industrial environment and the current problems of the domestic mining industry.

Despite this insignificant performance registered in the sector, coupled with the fact that the Korean economy lacks quality mining due to its underdeveloped sectors, there is hope as South Korea's mining and refining sectors could be boosted by its government's policy. Domestic Mining Industry (2007-2016)" to propose different political tasks for the steadiness of mineral resources and the stoppage of mine damage, through a scrutiny of the changes in the domestic and foreign mining industrial environment and the current problems of the domestic mining industry. Through its foreign proposal, the Korean government is using what I term "a give and take approach" in which it uses what it can offer best like say its technological expertise in ICT and agriculture to get what it wants. This was applied in some East Asian and Sub-Sahara African countries where other world giants like European, American and some Asian countries are already dominating investment wise.

5.3.4 Manufacturing sector

Manufacturing sector plays a very important role in Korea's economy. The manufacturing sector is considered as the 'engine' of Korea's economy. The average TFP growth rate is 1.00 percent, the highest among the five different sectors under study. Its average growth rate of capital input was 9.11 percent, labor input was 2.24 percent. Looking at the intermediate input factors, energy recorded an average growth rate of 8.53 percent; material inputs registered 9.05 percent, while service inputs had 9.53 percent.

It was observed that the estimated TFP growth rates in Manufacturing are in general greater than in Services. It may be due to the fact that an innovation process such as product innovation or process innovation is more sensitive and stronger in manufacturing than in services. Also the R&D investment for innovation was in general more intensive in manufacturing than in services. So the growth rates of TFP in Manufacturing seemed to be greater than in Services.

The growth in Korea's manufacturing sector exhibits an input-driven pattern, partly achieved through the quantitative growth of factors of production. That is, growth in the manufacturing sector has been achieved partly through the increase in the quantity of production factors and partly by improvements of production efficiency (technical progress). We find that it is partially quantitative growth of inputs and partially by factor productivity that is responsible for the growth of the Korean manufacturing sector. From the TFP estimates made by Lee and Song[8], over the period of 1970-2012, the productivity growth in manufacturing remained high over the period from 1970 to 2012, while the growth of TFP in services was very slow or even negative. Lee and Song estimated that in finance, insurance, real estate and business services, which are a major supplier of services for intermediate input, both per capita labor productivity and TFP recorded negative growth over the 1970-2012 periods. Even in the light of Oulton's prediction, Lee and Song's findings suggest that the productivity of the Korean economy was most likely to have been slowing down with the services sectors over the period of 1970-2012.

5.3.5 Utilities sector

A closer look at the utilities sector's TFP growth rate performance, we realize that its average TFP growth rate between 1970 – 2012 stood at -1.20 percent. This is indicative that the growth in the demand for energy in the economy continues to outpace the growth in supply as the supply ratio continues to fall. Its shortage and blackout worries becomes regular news events as the debate

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[8] Lee and Song (2005)

on the future direction of energy policy takes on an increased level of immediate attention. The national assembly in 2000 passed a legislative reform directing a supply-side restructuring process to kick start the following year. These reforms were designed to encourage private investment in order to meet-up with the sizable increases in the demand that were being forecast, also to encourage competition on order to increase the efficiency of energy sector operations, unlike the old "natural monopoly" infrastructure sectors of their economies. Despite its top rank in the world in terms of energy consumption, but lacking natural resources, a confounding 96 percent of the country's energy consumption relies on imports to approximately US$184.8 billion in 2012.

At its input level, the average growth rate of capital was 9.39 percent, labor recorded 3.54 percent, energy also stood at an average growth rate of 9.00 percent, and material input registered 6.25 percent while its services input scored an average growth rate of 6.52 percent. The cause of this poor and low growth rate may be as a result of the fact that South Korea has suffered from sporadic shortages in energy due to the increasing strain the network has been under with the country's continuing economic growth. A faster than-expected rise in energy demand has not been corresponding by a connected investment in power plants. Despite increasing demands, supply has been limited. Construction of new power plants has been delayed due to environmental concerns and civil complaints.

To successfully cope with these problems and discourse the imbalances they create, in February 2013, the South Korean government proclaimed the "6th Basic Plan for Long-Term Electricity Supply and Demand." First, the plan aims to control electricity consumption by 15 percent and thereby cut 12 percent of the overall target demand by 2027 through positive electric power demand supervision. This will diminish the need to construct new power generation facilities. Another part of the plan is to bring the price of electricity and fuel into line with the level of prime cost and to introduce a seasonal, hourly rate system, in which electricity rates will differ according to the supply situation. On the supply side, the government plans to bring reserves from standby facilities up to the level of the OECD countries, which will provide South Korea's population with energy security against power outages. More to that, the government has established a power supply mix plan that takes into consideration each power supply's characteristics and limits.

Until the early 2000s, increase in natural gas demand stemmed from the introduction and expanded distribution of City Gas across the country. Even after that period, demand for natural gas continued to be high, but this time, due to increased electricity consumption. South Korea's natural gas demand was about 38 million tons in 2012, making it the world's second-largest LNG (Liquefied Natural Gas) -importing nation after Japan.

Within this year, the South Korean government will integrate all of its energy policies introduced above and establish its second "Energy Master Plan" that will include its mid- to long term vision for a new energy mix. This plan will allow the country to ensure energy security and efficiency, and, at the same time, help the country outline a smart strategy to address environmental and safety concerns. Moreover, the government will continue to foster the energy industry so that it can play a central role in promoting a "creative economy." Last but not least, the government will strive to effectively communicate with the South Korean people in the making of these policies to win their support and trust.

Korean construction companies arrived foreign markets in the 1970s and have lately become more violent in arriving foreign markets due to the slowdown in the home construction sector. This industry's growth is expected to increase from a compound annual growth rate (CAGR) of -0.61% during the review period (2010-2014) to 2.50% over the forecast period (2015-2019). As a consequence, for the first time in Korean history, the yearly total value of construction orders received from abroad was reported to have exceeded $70 billion in 2010. Though the expansion of construction companies was concentrated in the Middle East in the past, companies are now trying to follow diversification by entering into the Southeast Asia, Central Asia, Africa, and Central and South American markets. Since the global credit crisis, and the decline in the domestic housing market and large-scale civil projects, which are supported by project financing (i.e., public-private partnership projects), the home construction sector is presently rather stagnant.

5.3.6 Services sector

Korea’s industrialization and deindustrialization experience is in line with the earlier experiences of the advanced economies. The share of manufacturing and services in output and employment considerably increased at the expense of agriculture during the industrialization process. As industry matures and deindustrialization sets in, the share of services rises at the expense of manufacturing while agriculture continues to fall. In the case of Korea, the core problem is that although the share of services in output and employment has risen, its productivity growth has drifted. Our analysis resoundingly confirms the popular belief that Korea’s services sector still lags the manufacturing sector even though deindustrialization already began in the early 1990s. Therefore, the center of gravity of the Korean economy is shifting from a dynamic world-class manufacturing sector to a stagnant third-class services sector, dragging down productivity growth for the economy as a whole.

The central challenge for Korea in the post-industrial phase is thus to renovate and upgrade its services sector so that a productive, high value-added, modern services sector can become an engine of growth. From the 2009 Asian Development Bank statistics, the worldwide financial crisis has increased the urgency of the rebalancing effort Services sector growth is thus the supply side of the rebalancing equation. From a worldwide perspective, advanced economies have a comparative advantage in modern services such as business services. Liberalizing imports of such services in Korea can thus contribute not only to the competitiveness of Asian economies but also to global rebalancing.

A self-motivated services sector can also contribute to Korea's quest for inclusive growth which includes broader swathes of the population in the growth process and spreads the fruits of growth more widely. Education and employment are especially important in reducing inequality[9]. While demographic transition toward older populations is already under way, for the most part Korea is still a relatively young country. Hundreds of millions of young job-seeking Koreans are joining the workforce every year. Furthermore, as noted, the manufacturing sector is maturing in many parts of Asia so its capacity to create jobs will become more limited. Relative to manufacturing, services tend to be labor intensive. Therefore, services sector growth can make a big contribution to employment and therefore growth inclusive. This also ties in line with the Siemens chairman- Joe Kaeser's speech delivered in October 2014 when he said ", South Korea is the strongest country in education," adding, "In terms that education is the basis for knowledge, and knowledge is root of innovation, South Korea has a good foundation for sustainable growth." This is in essence indicative of the fact that there are a number of reasons why developing the services sector matters for Korea. For one, the fact that Korea's manufacturing industries are globally competitive suggests that they have reached high productivity levels and the scope for further productivity improvements is limited. In outstanding contrast, the services sector's productivity remains low. Moreover, Korea's rapid demographic transition, along with growing levels of income inequality and

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9 Asian Development Bank (2012)

relative poverty, provide further impetus for a more robust services sector, as cited in Jones and Noland (2012). Korea's exceptionally fast population aging is driven by the collapse of fertility to one of the lowest in the world at around 1.2 children. The country currently has the fourth youngest population in the OECD area but will have the second oldest by 2050. A large and growing elderly population will increase the demand for certain types of services.

Taking a look at its average TFP growth rate between 1970- 2012 is enough reason for the government and its policy makers to redress the issue. While its average TFP growth rate stood at -0.46 percent, its capital growth rate was at an average of 8.94 percent. That for labor was 3.49, energy was at 6.82 percent, material input's growth average was 6.72 percent and that for the services input was 7.25 percent. Comparatively, the capital stock for the service sector is far lower to that of the manufacturing sector, same as its material input which is far less than that of the manufacturing sector.

The services sector is a key provider of jobs in the Asian region. Majority of the employed are now in services in several economies, including Kazakhstan, Malaysia, Maldives, Philippines, and the NIEs. Not only is the services sector now a large part of the economy, but has also been a huge contributor to overall growth. In the past ten years, the services sector accounted for more than one-half of GDP growth in most economies in the region. While the services sector has been fast rising across economies in the Asian region, the sector continues to be subjugated by traditional activities comprising wholesale and retail trade, hotels and restaurants, real estate, transport, personal services, and public administration, continue to prevail. On the other end are modern services which include information and communication, finance, and professional business services; these involve only about 8 to 12 percent of the economy in Asian countries but in advanced Organization for Economic Cooperation and Development (OECD) economies such as France, Japan, and the United States, they account for about 17 to 25 percent. In other to find new strategies to keep the economy of South Korea on an active development trajectory. We argued that increasing labor productivity in the service industry is imperative for South Korea to ensure sustainable economic development.

The unpleasant performance of Korea's services sector up to now gives rise to serious doubts about its future contribution to aggregate growth. Furthermore, we saw that the sector faces a discouraging range of weaknesses it must overcome if it is to fulfill its potential. For example, while deregulation can release competition and thus encourage Korea's service firms to raise their game, their fundamental motivation of Small and Medium-size Enterprises (SMEs) and Small and Medium-size Enterprise (SME) jobs—makes it politically difficult to follow. Nevertheless, upon closer inspection, there are some grounds for optimism about the Korean services sector's prospects.

From the results obtained, it is evident that the Korean government is investing more in the manufacturing sector than in the other sectors. Development strategies have been centered on achieving sustained productivity growth by steadily increasing the value-added of output. To achieve this, a highly educated labor force was necessary. In the 1960s, South Korea embarked on the promotion of both export and import-substitution industries, starting with subsistence agriculture (rice) and labor-intensive, light manufacturing sectors (textiles and bicycles). Substantial capital accumulation and investment in primary education during this period allowed a gradual shift up the value-added chain toward more sophisticated commodities. The key to this shift was also the use of technologies obtained through foreign licensing and modified for domestic production. In the mid-1970s, the government's use of a well-targeted industrial policy resulted in a major shift to the development of heavy industries (e.g., Chemicals and shipbuilding). Along with industrial targeting;

policies were passed to further improve technological capabilities, together with improving access to and quality of technical and vocational training.

From our calculations, the results gathered among the five sectors; agriculture, mining, manufacturing, utilities and services that have contributed to the growth of economy-wide TFP positively by decomposing relative contribution of each sector to TFP growth side by side those whose contribution to economy-wide TFP growth is negative are evident in the table below.

Table 32: Annual average TFP growth by sector of Korea (1970-2012)

SECTOR	GROWTH RATE (%)
1) Aggregate	0.15
2) Agriculture	-0.81
3) Mining	0.45
4) Manufacturing	1.00
5) Utilities & Construction	-1.20
6) Service	-0.46

Source: by author

Decomposing the growth rate of factor inputs at the aggregate and sector levels, the table below shows what was obtained.

Table 33: Annual growth rates by factor inputs (%) from 1970-2012

Factor input	*Aggregate level*	*Agricultural sector*	*Mining sector*	*Manufacturing sector*	*Utilities sector*	*Service sector*
Output	7.01	1.94	-0.45	9.14	6.39	6.01
Capital	8.90	6.70	3.35	9.11	9.39	8.94
Labor	1.80	-3.33	-6.49	2.24	3.54	3.49
Energy	7.71	2.46	-2.47	8.53	9.00	6.82
Material	8.21	2.72	-3.56	9.05	6.25	6.72
Service	7.71	3.44	-0.02	9.53	6.52	7.25
TFP	0.15	-0.81	0.45	1.00	-1.20	-0.46

Source: by author

From table 33, the different factor inputs' contribution to the economic growth of Korea are displayed. At aggregate level, all factor inputs have positively contributed to the country's growth with the least contribution got from labor input with an annual growth rate of 1.80 percent, while its TFP was 0.15 percent. At agriculture sector, all other factors have positively contributed to the growth of the economy but for labor input which recorded an annual growth rate of -3.33 percent, and so giving a TFP growth rate of -0.81 percent. Consequently, the role of labor in the agriculture sector is imperative, if not it will down-play on the economic growth of the Korean economy as seen in column 3 table 33 above. Closer look at the mining sector, we realize that its main driving force is its capital stock placed at its disposal. Despite the negative contributions of the rest of the factor inputs such as labor, energy, material and services, its TFP growth rate is significantly impressive, due to the amount of capital stock made available. The manufacturing sector, otherwise known as the 'engine' of the Korean economy. The contributions of the different input factors are impressive with the highest contributions from capital stock, material and service inputs recording annual averages of 9.11 percent, 9.05 percent and 9.53 percent respectively. This shows these are the principal driving forces of this sector, not underestimating the energy input's annual contribution of 8.53 percent. The least contribution in this sector comes from the labor input with a contribution of 2.24 percent. The utilities sector's performance is partially impressive with the significant contribution of all factor inputs despite its poor TFP growth rate of -1.20 percent. This shows that much is still to be done in order to improve the sector technically. This proves the fact that its supply side is lagging behind its corresponding demand side. And this can only be equated through the supply-side re-structural process and innovation. The services sector, though impressive with the contributions of the input factors, its TFP contribution is far less than expected. The reason behind this could be demographical and lack of professional skills as the youthful population is not professionally oriented and trained to meet up with modern standards.

Being classified as the world's 12th largest economy with a GDP (Purchasing Power Parity) of US$1.459 trillion in 2010, South Korea experienced huge economic growths from early 1960s to 1990s. Expansion in the industrial and manufacturing industries attributed to the growth of South Korea's economy and was the major growth engine for its export-orientated economy. Over the years of economic progress, South Korea was able to transform its economy from one which is labor intensive to one which is more capital and technology-orientated. Today, South Korea boasts as one of the top players in the electronics, automobile, telecommunication and shipbuilding industries. The contribution of technology thus ranges from about 10 per cent to about 56 per cent. Thus technology is one of the important factors in explaining the spectacular growth performance of the Korean economy. The other factors of growth are investments in large-scale facilities and development of infrastructure. In the case of technology, at least during the initial phase, much of it was imported from abroad. Critics often refer to the country resorting to an aggressive procurement of the most advanced technology available in the global marketplace. In the course, the Koreans have developed a range of stylish procedures for transferring technology, some of which may provide insights into practices for other developing countries. In fact, Korea has displayed its ability to be a successful follower of foreign technology and has more recently shown its emerging improvement capabilities. This technological capability was achieved by massive domestic R&D investment and by creating a supply of well-trained Science & Technology personnel. What distinguishes the Korean experience is that it has been achieved by the efforts of both the government and the private sector working side by side. It is against this background that we analyze the organization of industrial R&D in Korea.

According to Kim (1997), the Korean government has acted as a facilitator in technology learning as he asserts that 'Over the years, the Korean government has adopted an array of policy instruments designed to facilitate technological learning in industry and in turn strengthen the international competitiveness of the economy'.
From Sunil Mani's (2001) observation in "Government, Innovation and Technology Policy: An International Comparative Analysis", there are at least four ways in which the government of Korea has performed this so-called role of facilitator in technology learning, though they are not necessarily mutually exclusive. They are: (i) enactment of major laws for promoting science and technology; (ii) provision of various kinds of fiscal incentives for stimulating R&D especially by the private sector; (iii) establishment of government-supported research institutes (GRIs) and national R&D projects especially in high-tech areas; and (iv) supply of skilled manpower to engage in R&D by strengthening the domestic education sector and by reversing the brain drain through programmes such as the brain pool programme.

Using Jorgensen's and Hulten's models which allows to give a closer look at the actual sources of technology, the contribution of neutral technology in Australia, Japan and the U.S. is extremely small using Jorgenson (from 2% to 6%) and even negative using Hulten (from -6% to -15%). Only in south Korea TFP plays an important role whichever is the model used to account for it, with an annual contribution to output growth that goes from about 5% with Solow to approximately 3% with Jorgenson and Hulten. This finding can be interpreted as the empirical counterpart of the theories on TFP as an indicator of institutional factors, e.g. laws and tribunals, institutions, patent protection, infrastructures.

Assumptions have it that Korea's catch-up process with industrial nations in its late industrialization has been principally input-led and manufacturing based. We have also found that TFP growth has been positively affected by the growth of labor productivity and output growth. However, since its financial crisis in December 1997, the sources of growth seem to have switched to TFP-growth based and IT-intensive Service based. But lower productivity in service industries due to regulations and lack of competition seems to work against finding renewed sustainable growth path"[10]. According to Hamani's (1998) findings, from the early 1960s, South Korea has transformed itself from a low-income agrarian economy into a middle-income industrialized "miracle" and the agricultural sector in South Korea has not been excluded to the tremendous structural change. Agriculture, utilities and services sectors have been declining in importance relative to the manufacturing and mining sectors.

The Korean economy suffered on many levels as a result of the crisis, with several indicators of economic health displaying signs of the declining conditions. First, expectations for the equity markets dropped considerably. Stock markets on balance, serve as a barometer of opinion on the health of an economy. Because the level of any stock market is ultimately contingent upon the prospects for continued profits of the companies listed on the market, in periods when economic problems are taking place, or even anticipated, stock markets tend to fall to reflect the lower expected earnings. In the case of Korea, as in other East and Southeast Asian countries, the stock market fell drastically during 1997. Second, a decrease in the money supply—which was due to capital flight overseas—resulted in an increase in interest rates in financial markets. In addition to this market response, Korean government monetary authorities raised interest rates in an effort to prevent further, continuous depreciation of their currencies. Korea was among countries with the highest interest rates over a three-month period in 1997, excluding the

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[10] Source (OECD I Library): Productivity Measurement and Analysis, p528

Philippines. Third, the first two factors combined with subsequent currency devaluations "initiated a severe contraction in real economic activity in Korea," marked by such phenomena has increased corporate bankruptcies and rising levels of unemployment.

In 2008, Korea's economy was adversely impacted by high commodity prices, especially oil, and by financial and real shocks started by the collapse of housing prices in the U.S. and subsequent economic and financial distress that rapidly spread throughout much of the world. Commodity prices have declined, but the continuing economic and financial distress in the U.S. will continue to impact Korea. Korea's exports have declined significantly in the last few months, the economy slowed and in 2008:4 gross domestic products witnessed a decline, and government policymakers had to face a number of macroeconomic and financial stability issues in the next few years.

However, Korea's economy has absorbed the shocks to date without the degree of pain displayed in the late 1997 and 1998. Korea's main emphasis is concentrated on stimulating the nation's growth engines and upgrading its industrial structure. To do so, Korea aims to further develop its component sector and knowledge-based service sector. Although Korea continues to face major long-run challenges, as outlined by most recent OECD economic survey of Korea, Korea's flexibility in dealing with the current distress illustrates how much progress has been achieved since 1997-98. Not only has the Korean economy absorbed the current shocks without intense distress, but the commitment toward continued reform exhibited by Korean authorities provides a foundation for dealing with longer- run challenges. This cautiously optimistic view needs to be conditioned, however, by the fact that the Korean economy is declining much faster than anticipated, and how Korea adapts to the economic and financial distress is dependent on factors outside of its control because of Korea's heavy reliance on exports.

CHAPTER VI - CONCLUSION

This paper measured Total Factor Productivity of Korea using Korea KLEMS beginning at the aggregate level with all 72 industries involved. It later on classified these industries under five sectors; agriculture, mining, manufacturing, utilities and service sectors with the objective of knowing the contribution of TFP by sector and its effects towards the economic growth of Korea. The fast growth of the Korean economy explained above has been supported by political and macroeconomic stability, as well as abundant labor and capital inputs. Growth accounting studies divide the factors explaining economic growth into the input of the productivity factors of labor and capital, and then other factors, with the latter described as total factor productivity (TFP). Various TFP estimates have been carried out, producing different evaluations as to the grade of TFP contribution to the economic growth of Korea but while some attribute its growth to capital accumulation and the high rate of human labor, our paper is to present and to explain as to what extent has TFP contributed to the growth of the Korean economy by trying to estimate the TFP of Korea using Korea KLEMS database. For this objective, we used KPC as our source of data. We also divided the 72 industries into 5 subgroups.

Established on the data from KPC, we estimated 72-industries at aggregate level and at subgroup levels. During the course of the entire period between 1970- 2012, the economy-wide TFP increased at an average rate of 0.15 percent. This over-all TFP growth rate cannot necessarily be attributed to the positive contribution of all the sectors. This can be expanded further as seen in the contributions made by each sector's TFP growth. While sectors such as agriculture, utilities and services contribution to the economic growth of Korea is insignificant or negative, that for manufacturing and mining sectors is obvious. This is prove that these two sectors have greatly influenced the economic growth of the Korean economy, with a greater proportion of it coming from the manufacturing sector. The practical difference among these sectors in both levels and growth rates can signal the difference in the degree of international competitiveness, the proportion of tradable and non-tradable and the degree of domestic competition due to historically different regulatory environments. It would be hard to believe that the sector differences between the manufacturing (1.00%), the services (-0.46%) is quite enormous with more credits to the manufacturing and not the services sector. According to the investment statistics of between 2001 and 2008, the manufacturing industries (e.g. electric-electronics) attracted the most FDIs while the services industries (e.g. finance-insurance) received the most FDIs.

Moreover, we realized that the estimated TFP growth rates of manufacturing and mining sectors are greater than those in agriculture, utilities and services sectors. This might be as a result of an innovation process such as product innovation or process innovation which is more sensitive in manufacturing than in services. Therefore the growth rates of TFP in manufacturing seem to be greater than in services. In addition, the R&D investment for innovation is in general more intensive in manufacturing than in services. We can find sectors that have contributed to the growth of aggregate TFP positively by decomposing relative contribution of each sector to total TFP growth with each sector's relative weight of output. From our calculations, it is clear that TFP growth is positively correlated with all the factor inputs. Productions in an economy are not identical across industries, and productivity differences are also observed when compared with the same industry in other economies.

As a measure to curb the movement of people from rural to urban areas as a result of rapid industrialization in urban areas, the government of Korea is interested in developing rural areas as a way to tackle rural area problems like the lack of good quality education and medical services. This will help in restoring the agriculture sector in a way.

On achieving high performance in mining, many miners are implementing more sophisticated operating models to maximize the effectiveness of their global operations. This process is forcing management teams to confront tough choices about how to balance the needs of the individual mines with the broader corporate goal of boosting enterprise value. Moreover, Australia is a country with which Korea foresees a strong and sustained partnership. This is driven to some extent by Korea's need to secure a stable supply of energy and resources. Abundant mineral and energy resources, stable political situation, sound infrastructure and the know-how in developing resources make Australia an attractive investment destinations for Korea. Korean investments in Australia are expected to increase in future years fuelled by strong demands for natural resources.

There is some evidence that the services sector is drawing more attention and importance in government policies as the economy is transformed towards knowledge based economy. A clear shift happened, with government increasing its spending on the sector more than ever before. This policy change is caused by two factors. Firstly, the government recognizes the quality of human resources as the key factor in further economic growth; it regards the higher education sector as the key player in achieving that growth. Secondly, the performance of the current services sector in South Korea is perceived to be lower than expected in terms of the efficiency of service spending. Improving the services industry could help the Korean government lower the country's dependence on exports and lift growth potential to her target of 4 percent in the next three years. Park is trying to lessen the supremacy of conglomerates such as Samsung Group to permit smaller companies to succeed. According to Park, the government is determined to increase financial support for research and development in the service sector to levels in manufacturing. According to finance ministry, R&D spending in services is about one tenth the amount of manufacturers. From the perspective of its policy makers, “If the three-year economic innovation plan is implemented successfully, young people will find more job opportunities in their preferred service sectors including education, medical, finance, tourism and content-building areas”, said Park.

It is harder to generate further hurdles in income from big increases in hours and skills as Korea already stands top of the league tables. Truly, the abrupt problem is merely to maintain its excellence. Agreeing to Yeong Kwan Song’s opinion of the Korean Development Institute (KDI), companies are starting to worry that graduates are emerging from universities with the wrong skills. On some estimates, half of the recent graduates are failing to find full-time jobs and are going into further study or part-time employment. So while general education remains good, some industrial skills may be declining. Also, one of the ways to boost the skilled labor force might be to have rather more people working rather fewer hours. The extra people would be women, often highly educated ones. Quite a lot of Korean women stay at home—the participation rate for women aged 25-54 is only 62%, the fourth-lowest in the OECD—even though they are usually better educated than men. In almost all rich countries, the best-educated women are more likely to work than their less-educated sisters, which is not the case in South Korea. Shorter hours might encourage some of these skilled women into the workforce. So might a change in attitudes to schooling. The job of supervising a child's education falls to women, which is one of the reasons why relatively few women have jobs.

6.1. Policy Recommendations

To start with, agriculture is the main driver of the rural economy and for some significant change to occur in this sector, some rural policies need to be revised. First and foremost, policy makers must acknowledge the interdependence between agriculture and rural polices. Part of the solution to increasing the income of agricultural households would be to improve the opportunities to supplement farm income with off-farm work. This requires the development of a robust rural economy. Some of the basic vital elements to promote development are investment in education, transport, heath, and housing infrastructure would boost or increase the desirability of rural areas. In some cases, freeing up agricultural land for new uses will also help drive the rural economy, for example by developing the industrial complex or by making rural areas important recreational destinations through the development of sports resorts or other tourist attractions. Decisions of this nature should reflect the needs and the context in the rural areas themselves and be made locally.

Where the use of chemicals like fertilizers is causing environmental harm, effective measures must be put in place to reduce both their use and their impact. For example, promoting or requiring the use of buffer strips between agricultural fields and waterways to absorb excess nutrients and collect pesticide runoff, requiring fertilizer application to better match the nutrient requirements of crops, the use of soil testing for fertilizer and economic thresholds for the use of pesticides, and the creation of watershed-based nutrient-management plans. Care must be taken to ensure that commodity policies do not conflict with environmental goals.

Also, although the manufacturing sector has played a leading role in overall economic growth and productivity improvement, the problem is the sector’s growth has been in decline since the 1980s. Particularly, although the sector’s

total factor productivity increase rate has continuously remained at high levels, investment and job creation has fallen short of meeting expectations. To expand manufacturing investment it is necessary to facilitate the entry of new companies and support new business ventures by encouraging entrepreneurship at existing firms. To do so, technological novelty and the commercialization of revolutionized technology need to be encouraged.
Korea’s speedy economic growth has been fortified by the development of a broad-based export-oriented manufacturing sector from a relatively low base. The share of manufacturing in the economy has increased over the decades. In order to maintain its economic growth at its best, it would be wise that liberalization in services be implemented so that it may increase the productivity of the manufacturing subsectors which use liberalized services as inputs as can also be tested by comparing the growth rates of productivity by manufacturing subsectors and the input coefficients of services to those manufacturing subsectors.

Meanwhile, it is also necessary to make policies to strengthen the connection among domestic businesses within manufacturing sector, for which the government is required to push for the development of new growth engines and, at the same time, for the development of related industries, such as parts and material sectors. As for services industries, although their total factor productivity increased somewhat in the 2000s, it still remains at an insufficient level and the government needs to make greater efforts to improve productivity through proper policies. According to statistics, in 2009, people over 65 were outnumbered ten to one by the working-age population. Around 2050, there will be seven over-65s for every ten working-age adults. Unequal old-age poverty would have a huge effect on the social backing for policies intended to foster growth. Besides, when fertility rates fall, societies typically enjoy a temporary “demographic dividend,” a length of time when the relative number of children declines much faster than the number of elders rises.

The government's 2007 framework plan for the growth of the domestic mining industry (2007-2016) that suggests various political tasks for the stability of mineral resources and the prevention of mine damage, through an analysis of the changes in the domestic and foreign mining industrial environment and the current problems of the domestic mining industry should be promoted to the fullest. Also, Korea's bilateral cooperation with other mining countries should be re-enforced. Renewal of the local mining industries, the gathering of skills required for overseas resources development, and the utilization of local natural resources can be expected through the review and renovation of local mines that were in a state of neglect, which has been made possible by the modernization of renovation technology and advancements in reclamation technology. To make this materialize, private participation is encouraged in typically competitive metal mines under government observation for inspection and renovation projects.

A closer assessment of the utilities sector will prove the fact that South Korea has suffered from sporadic shortages in energy due to the increasing strain the network has been under with the country's continuing economic growth. A faster than-expected rise in energy demand has not been corresponding by a connected investment in power plants. To ensure an equitable distribution and availability of power, policy makers need to double up their investment strategies in order to meet up with its existing demand. This in a way will mean an additional investment in its power plants.

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Appendix

72-industry classification

Industry
Agriculture
Forestry
Fishing
Mining of coal and lignite; extraction of peat
Extraction of crude petroleum and natural gas and services
Mining of uranium and thorium ores
Mining of metal ores
Other mining and quarrying
Food products and beverages
Tobacco products
Textiles
Wearing Apparel, Dressing And Dying Of Fur
Leather, leather products and footwear
Wood and products of wood and cork
Pulp, paper and paper products
Publishing
Printing and reproduction
Coke, refined petroleum products and nuclear fuel
Pharmaceuticals
Chemicals excluding pharmaceuticals
Rubber and plastics products
Other non-metallic mineral products
Basic metals

Fabricated metal products
Machinery, nec
Office, accounting and computing machinery
Insulated wire
Other electrical machinery and apparatus nec
Electronic valves and tubes
Telecommunication equipment
Radio and television receivers
Scientific instruments
Other instruments
Motor vehicles, trailers and semi-trailers
Building and repairing of ships and boats
Aircraft and spacecraft
Railroad equipment and transport equipment nec
Manufacturing nec
Recycling
Electricity supply
Gas supply
Water supply
Construction
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel
Wholesale trade and commission trade, except of motor vehicles and motorcycles
Retail trade, except of motor vehicles and motorcycles; repair of household goods
Hotels and restaurants
Inland transport
Water transport

Air transport
Supporting and auxiliary transport activities; activities of travel agencies
Post and telecommunications
Financial intermediation, except insurance and pension funding
Insurance and pension funding, except compulsory social security
Activities related to financial intermediation
Imputation of owner occupied rents
Other real estate activities
Renting of machinery and equipment
Computer and related activities
Research and development
Legal, technical and advertising
Other business activities, nec
Public admin and defense; compulsory social security
Education
Health and social work
Sewage and refuse disposal, sanitation and similar activities
Activities of membership organizations nec
Media activities
Other recreational activities
Other service activities
Private households with employed persons
Extra-territorial organizations and bodies