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Korean Economy 1981-2006: A Growth Theory Perspective

Jeong Yeon Lee

This paper develops a standard neoclassical growth framework to examine the recent history of economic growth in Korea. In our framework, TFP change is a key to understanding a country's economic growth, and is assumed to reflect technological progress exogenously given to the country in the form of improving OECD best practices as well as the country's changing capacity to absorb the prevailing best practice. First, we find evidence that Korea's extraordinary economic growth during the 1980s and early 1990s was achieved mainly through massive mobilizations of fixed capital investment. Our analytical framework clearly indicates that this type of economic growth is not sustainable due to diminishing marginal returns to capital. Nevertheless, Korea's economic growth has never wound down except for a brief depression in 1998 in the middle of the economic crisis, mainly thanks to the country's TFP that appears to have begun to grow strongly from 1992. This robust TFP growth considerably above the OECD average is expected to have enabled the Korean economy to defy the gravity of diminishing marginal returns and sustain its growth by creating ample additional room for capital accumulation. From 2003, economic growth in Korea visibly slowed down, and we find that noticeably stagnant TFP growth was largely behind this persistent slowdown. In the government's efforts at fostering future economic growth, therefore, the fiscal measures targeted solely at the demand side would have only limited effects unless they are accompanied by other measures that would truly enhance the country's level of TFP.

Keywords: Korea, Economic Growth, Total Factor Productivity, Malmquist index

1. INTRODUCTION

Even before shock waves of the global financial crisis following the collapse of Lehman Brothers struck Korea, the country had suffered a persistently weak economy for a number of years. The public frustration with sluggish economic growth throughout the previous administration subsequently cost the then incumbent party the presidential election that took place in December 2007. The weak capital investment was often blamed as a major culprit for this economic slowdown. In fact, non-residential fixed capital formation grew only an average of 2.8 percent annually during 2003-2006, compared to its growth over the two previous decades at an annual average of more than 10 percent.[1]

Various factors have been presented as possible reasons for this remarkable slowdown in fixed capital investment. One of the most frequently cited in the press was the anti-business posture of the previous administration. It was alleged that the introduction of a series of government regulations detrimental to business during the previous administration undermined "the will to do business" and discouraged new corporate investment. Another popular line of argument laid the blame instead on the business community by lamenting loss

[1] In calculating the average for the period 1981-2002, we did not include the sharp contraction of non-residential fixed capital formation in 1998 during in the height of the economic crisis.

of strong entrepreneurial spirit that appears to have never been in short supply in corporate chieftains in the 1960s and 1970s, such as late founders of Samsung and Hyundai who were arguably never afraid of taking risks and pushed ahead with large capital investments against the odds. Whatever incarnations they are of in, most of the arguments on the table are based on the assumption of “under-investment.”

Whether the level of fixed capital investment during the previous administration was really lower than optimal or not is an empirical question, but it is difficult to expect that under-investment continued for five years just because of demand-side weakness due to factors such as politics and corporate culture. In fact, a standard neoclassical framework identifies total factor productivity (TFP) as a key determinant of a country’s pace of fixed capital investment. TFP growth is expected to expand out the country’s long-run level of capital stock and also accelerate the rate at which a given level of capital stock may grow in the economy. Our estimates of TFP growth for Korea using the Malmquist index provide evidence that the country’s TFP growth became visibly stagnant during 2003-2006. This torpidity in TFP growth is expected to have induced a slowdown in the country’s fixed capital investment during those years. The problem was after all a low growth rate of overall productivity.

This paper is organized as follows. In Section 2, we develop a standard growth model to examine the Korean economy. Section 3 outlines the Malmquist index and its decomposition. This is followed by a discussion of data and estimation results in Section 4. Concluding remarks are made in the last section

2. GROWTH MODEL

We structure our analysis within a standard neoclassical framework with a constant, exogenous saving rate that traces back to Solow (1956) and Swan (1956).[2] The aggregate production function is assumed to be described by the Cobb-Douglas function,

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

where Y is aggregate output, K is aggregate capital, and L is total employment. $A > 0$ is the level of TFP and α is a constant with $0 < \alpha < 1$.

For simplicity, we suppose that the economy is closed and there are no government expenditures on goods and services. Hence, aggregate output is either consumed or invested in this economy. Investment is used to create new units of capital which depreciates at the constant rate $\delta > 0$. In addition, we assume a constant fraction of aggregate output is saved at the rate of s ($0 \leq s \leq 1$). Given that the amount saved equals the amount invested in a closed economy, the investment rate is also s in this economy. We also assume total employment grows at a constant, exogenous rate of $n \geq 0$.

Eq. (1) can be rewritten in intensive form as

$$y_t = A_t k_t^{\alpha} \tag{2}$$

where $y \equiv Y/L$ and $k \equiv K/L$

[2] For a more detailed exposition of this framework, see Barro and Sala-i-Martin (2004).

The steady state value of k for the given level of TFP, A_τ, is denoted as $\bar{k}_\tau$, and satisfies the condition

$$sA_\tau \bar{k}_\tau^{\alpha} = (n+\delta) \cdot \bar{k}_\tau \tag{3}$$

If k is below $\bar{k}_\tau$, k is expected to increase over time until it reaches $\bar{k}_\tau$. The growth rate of k at t along the transition is characterized by

$$\dot{k}_t/k_t = sA_\tau k_t^{-(1-\alpha)} - (n+\delta) \tag{4}$$

It is worth to note that the growth rate of k falls as k increases and it approaches 0 as k approaches $\bar{k}_\tau$. Using Eq. (3), the growth rate of k at t along the transition can also be expressed as

$$\dot{k}_t/k_t = (n+\delta) \cdot \left[\left(\frac{k_t}{\bar{k}_\tau}\right)^{\alpha-1} - 1\right] \tag{5}$$

Subsequently, the economy's growth rate of capital per worker at t depends on the distance between the t period level of capital per worker, k_t, and its steady-state level, $\bar{k}_\tau$. From Eq. (3), $\bar{k}_\tau$ in turn depends crucially on the level of TFP, A_τ. An improvement in TFP will raise the steady-state level of capital per worker when the economy's saving rate, depreciation rate, and employment growth rate remain constant. Hence, any changes in TFP are expected to have immediate effects on the growth rate of capital per worker.

We illustrate the relationship between the economy's TFP and capital growth in Figure 1. Starting from capital per worker in period 0, k_0, with the level of TFP, A_0, the economy's growth rate of capital per worker is measured by *ac* with the steady-state level of capital per worker, $\bar{k}_0$. This positive growth in capital per worker will result in a higher level of capital per worker in a future period 1, say k_1. If the economy's TFP remains the same, then the growth rate of capital per worker in period 1 will be measured by *ab* with the steady-state level of capital per worker continuing to be $\bar{k}_0$. The new growth rate, *ab*, is lower than period 0's *ac* due to diminishing returns to capital. However, if there is an improvement in TFP from period 0 to period 1, the steady-state level of capital per worker will jump to a new level, $\bar{k}_1$, under the new level of TFP, A_1. We should note that period 1's growth rate of capital per worker, measured by (*ab* + *bd*), can be higher than period 0's growth rate, *ac*, with an improvement in TFP even when k_1 is larger than k_0.

Figure 1 illustrates how a country may resist the gravity of diminishing returns to capital and achieve an accelerating pace of economic growth. TFP growth would shift the country's steady-state position further away and may expand the distance between the current and steady-state levels of capital per worker, thereby inducing faster growth even at a higher level of capital per worker. Therefore, TFP growth has not only long-run implications for economic growth by altering the long-run or steady-state level of capital per worker, but it also has immediate effects on the current pace of economic growth.

There are a number of different ways to conceptualize technological progress in the existing literature on economic growth. In this paper, we focus on the members of the Organization for Economic Cooperation and Development (OECD), and assume that technological progress has the nature of a public good within the OECD area. Technological

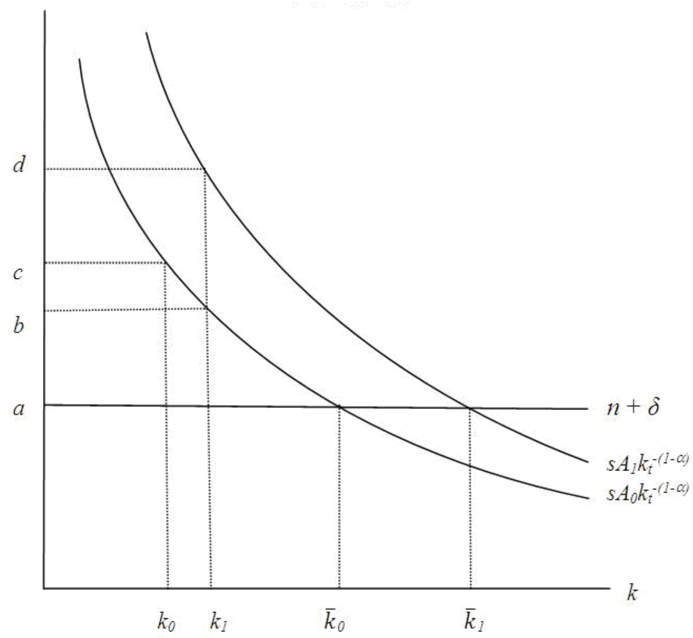

Figure 1.

progress includes not only innovations both in products and processes, but also any government policies and institutional changes that affect the position of the production function. Given that one primary role of the OECD is to promote the exchange of information among its member countries, the public good nature of technological progress within the grouping appears to be a reasonable assumption. In this regard, technological progress is assumed to be exogenously given to an individual country in the form of OECD best practices. However, each country is assumed to benefit from it in different degrees depending on its own absorptive capacity. In our analysis, therefore, TFP changes for Korea are assumed to reflect any changes in OECD best practices as well as changes in the country's capacity to absorb the existing best practices.[3]

3. THE MALMQUIST INDEX

To estimate TFP changes, economists often use the tools of growth accounting. The aim of growth accounting is to produce the TFP residual which measures the portion of economic growth that is not explained by the growth in all measurable inputs. The growth accounting approach implicitly assumes that all units of production are technically efficient. However, the notion of TFP changes in our analysis implies that a country's production may not be

[3] Since Korea joined the OECD only in 1996, we are implicitly assuming that Korea had been able to observe OECD best practices even before its accession to the organization. This is not an entirely unrealistic assumption given that Korea was invited to participate in various OECD activities from the early 1980s and send liaison officers to the organization's secretariat from 1989.

technically efficient unless the country leads OECD best practices or manages to fully adopt the prevailing best practices all the time. Subsequently, this paper uses the Malmquist index approach proposed by Caves et al. (1982) that allows for technical inefficiency in estimating TFP growth rates.

The basic idea of the Malmquist index approach is to construct the best-practice frontier using data on input-output combinations of a sample of countries, and measure the distance between any particular observation and the frontier. Following Shephard (1970) and Caves et al. (1982), the output distance function at t, D_0^t, is defined as follows:

$$D_0^t(X_t,Y_t) = \inf \ \{\theta : (X_t, Y_t/\theta) \in T^t\} \qquad (6)$$

where T^τ denotes the production technology which is defined as $T^\tau = \{(X_t, Y_t)$: X_t can produce Y_t at time $t\}$. X_t is a vector of inputs at t, (K_t, L_t), and Y_t is aggregate output at t. Note that $D_0^t \leq 1$ corresponds to $(X_t, Y_t) \in T^\tau$, and that $D_0^t = 1$ indicates that (X_t, Y_t) lies on the best-practice frontier. Caves et al. (1982) define the output-based Malmquist index between period t and period $t + 1$ as

$$M_o (X_{t+1}, Y_{t+1}, X_t, Y_t) = \qquad (7)$$

A value of M_o greater than 1 indicates positive growth of TFP from period t to period t+1, and a value less than 1 represents deterioration in TFP.

As mentioned above, the Malmquist index allows for technical inefficiency by relying on the best-practice frontier concept in contrast to the Törnqvist-index formulation of the growth accounting approach. Following Färe et al. (1994), the Malmquist index in Eq. (7) can be rewritten as

$$M_o (X_{t+1}, Y_{t+1}, X_t, Y_t) = \frac{D_0^{t+1}(X_{t+1},Y_{t+1})}{D_0^t(X_t, Y_t)} \times \left[\frac{D_0^t(X_{t+1},Y_{t+1})}{D_0^{t+1}(X_{t+1},Y_{t+1})} \frac{D_0^t(X_t, Y_t)}{D_0^{t+1}(X_t, Y_t)} \right]^{1/2} \qquad (8)$$

Eq. (8) shows the decomposition of the Malmquist index into two basic components – “technical change” and “efficiency change”. Each ratio inside the bracket on the right hand side of Eq. (8) measures a shift in the best-practice frontier estimated at the input level in each period, and the geometric mean of these two shifts represents “technical change”. In terms of our model, “technical change” signifies the change in the prevailing OECD best practice, and a value greater than 1 indicates an improvement in the OECD best practice at the input level. The first ratio on the right hand side of Eq. (8) represents “efficiency change” measuring the change in technical efficiency from period t to period $t + 1$. Subsequently, “efficiency change” determines whether production is moving closer to or away from the prevailing frontier, and captures the efficiency catch-up effect between the two periods t and $t + 1$. The value of “efficiency change” greater than 1 implies that the country has closed the gap of its production method with the prevailing OECD best practice. If a sufficient number of observations are provided in each period, these change indexes based on pairs of successive periods can then be calculated.

4. DATA AND ESTIMATION RESULTS

4.1. Total Economy

The final sample for construction of the best-practice frontier consists of 22 OECD countries for which data on GDP, non-residential fixed capital formation, and total employment are available over the period of 1980-2006 from the OECD.Stat. They include: Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Turkey, the United Kingdom, and the United States. Among the current OECD member countries, 8 countries are not included in our study due to data unavailability; they include Belgium, Czech Republic, Hungary, Mexico, New Zealand, Poland, Slovak Republic, and Switzerland.

Our measure of aggregate output is constant price GDP adjusted in 2000 prices. Total employment and the fixed capital stock are the two aggregate input proxies. Total employment is defined as the number of workers, and the fixed capital stock is the cumulated and depreciated sum of past investment. The fixed capital stock does not include residential construction, and is calculated from gross fixed capital formation – adjusted in 2000 prices as well – using the perpetual inventory method with the depreciation rate of 10 percent.[4] The fixed capital stock as well as GDP figures of individual countries are all converted to U.S. dollars using the purchasing power parity (PPP) exchange rate from the OECD.Stat.

For estimation of the best-practice frontiers, several methods have been developed since Farrell (1957). This paper uses the data envelopment analysis (DEA) approach to estimate the frontiers and calculate Malmquist indexes. In the DEA approach, the best-practice frontiers are estimated by non-parametric linear programming methods. We assume constant returns to scale (CRS) as underlying technology and calculate TFP growth employing the DEA approach. Variable returns to scale (VRS) may be an alternative specification of technology, but the Malmquist index is equivalent to the traditional notion of TFP under a CRS benchmark (Färe et al., 1997; and Ray and Desli, 1997). For calculation of indexes, we use DEAP version 2.1 (Coelli, 1996).

Table 1 summarizes Korea’s Malmquist indexes and their decomposed indexes, technical changes and efficiency changes, over the period 1981-2006. According to calculations of the Malmquist index, the country’s TFP is estimated to grow an average of 0.6 percent per year over the period, slightly behind OECD average of 0.9 percent during the same period. However, annual growth rates of TFP tend to vary considerably from year to year as shown in Figure 2. For example, TFP growth was very slow during 1981-1991. TFP in fact fell, instead of growing, in Korea for most of the period, trailing far behind the OECD average. During the same period, however, the country’s real GDP grew strongly at more than 8 percent per year as shown in Figure 3. This suggests that economic growth in Korea during the 1980s and early 1990s was mainly driven by input accumulation and supported little by TFP growth. Subsequently, the capital stock in Korea appears to have rapidly approached to its steady-state levels during the period.

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[4] Alternative measures of the fixed capital stock were also calculated assuming different rates of depreciation, but provided a similar pattern. Malmquist indexes and their components assuming the depreciation rate of 15 percent are reported in Appendix.

Table 1. TFP Growth, Technical Change, and Efficiency Change in Korea

	Malmquist Index	Technical Change	Efficiency Change
1981	0.949	0.959	0.990
1982	0.979	0.950	1.030
1983	1.013	0.958	1.057
1984	0.980	1.006	0.974
1985	0.960	0.979	0.980
1986	1.003	0.977	1.026
1987	1.007	1.024	0.984
1988	0.987	1.005	0.982
1989	0.955	1.019	0.937
1990	0.973	0.996	0.977
1991	0.962	1.055	0.912
1992	1.007	1.048	0.961
1993	1.028	1.032	0.996
1994	1.038	1.031	1.007
1995	1.047	1.010	1.036
1996	1.033	1.012	1.020
1997	1.015	1.023	0.992
1998	0.967	1.007	0.960
1999	1.073	1.020	1.052
2000	1.041	1.019	1.021
2001	1.011	0.989	1.022
2002	1.038	1.005	1.032
2003	1.025	1.003	1.022
2004	1.024	1.026	0.999
2005	1.025	1.017	1.008
2006	1.033	1.004	1.029
Mean	1.006	1.006	1.000

If the Korean economy had continued to grow without meaningful increases in TFP during the 1990s as well, this input-driven growth would have further narrowed the gap between the country's current and steady-state levels of the capital stock substantially, and its economic growth would have inevitably faced a sharp slowdown under the gravity of diminishing marginal returns. According to our TFP measures, however, Korea's TFP began to exhibit robust growth from 1992, considerably outperforming the OECD average. This strong TFP growth is expected to have shifted Korea's production function considerably, and accordingly the distance between the country's current and steady-state levels of capital stock is expected to have departed the hitherto declining path and begun to widen. This suggests growing room for sustained expansion of the economy's capital stock. In fact, during 1993-1996, non-residential fixed capital investment as measured by a share of GDP grew consistently in Korea as shown in Figure 4, and the country's real GDP also grew robustly at an annual average rate of almost 8 percent.

Following the onset of the financial crisis in the fourth quarter of 1997, Korea's real GDP contracted substantially in 1998, lowering the country's TFP growth along with it. However, Korea's TFP growth sharply shot up to an annual rate of 7.3 percent in the following year.

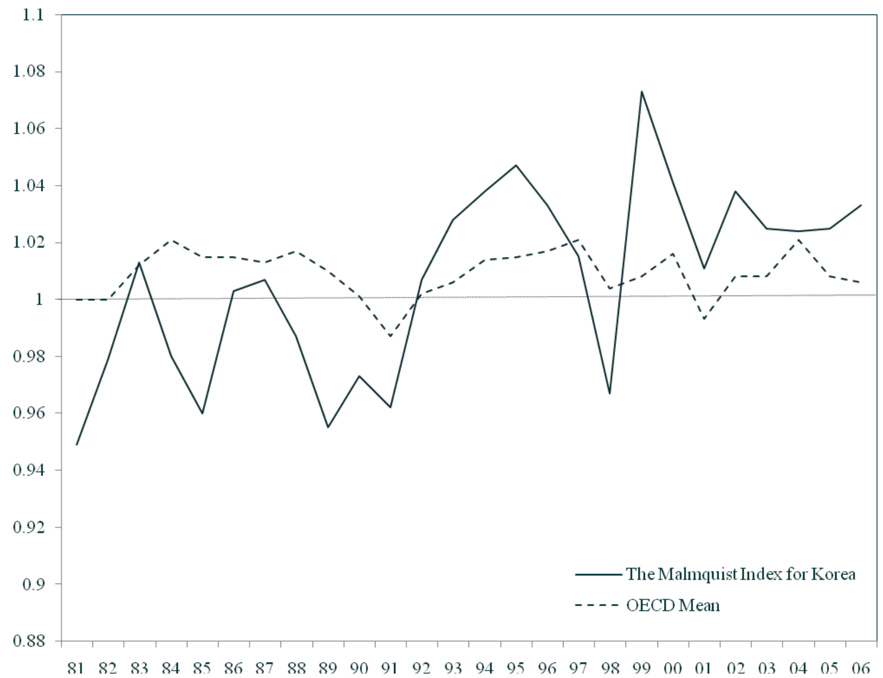
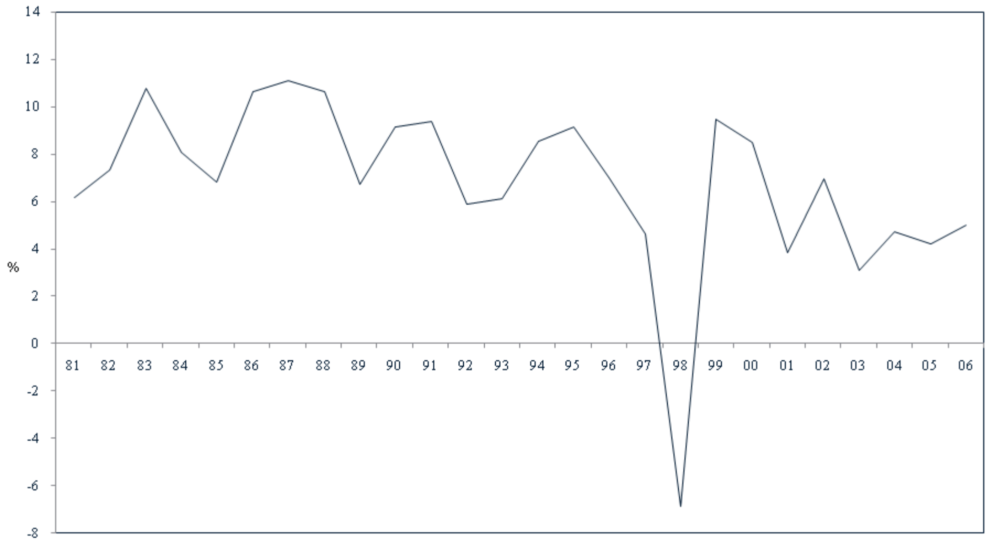
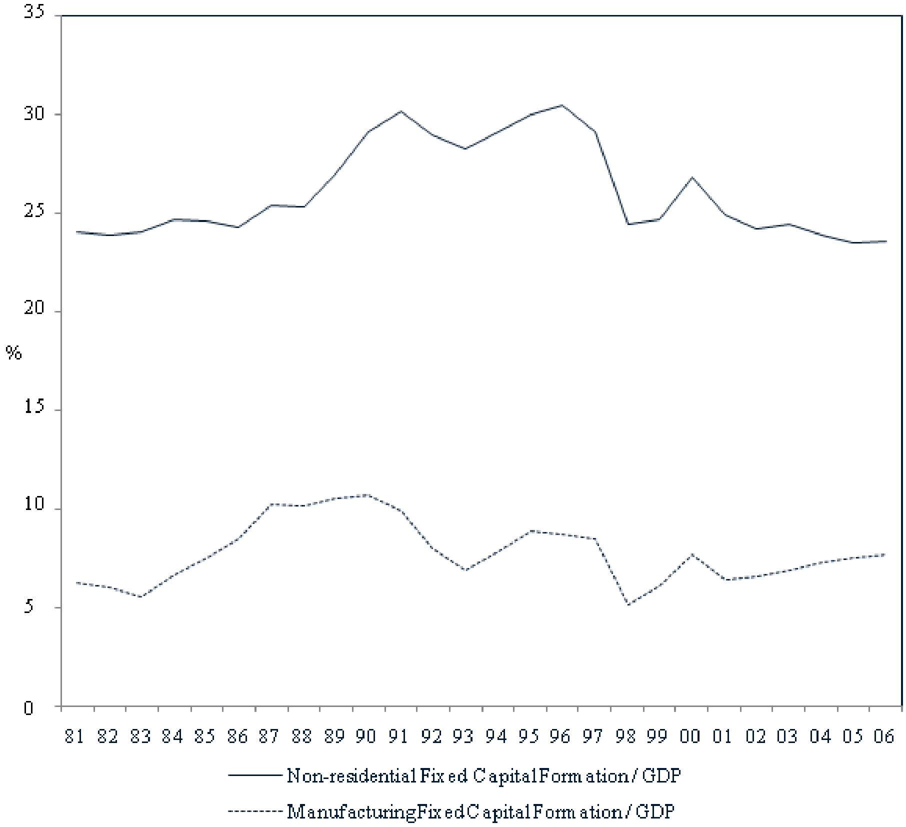


Figure 2. Annual Growth Rates of TFP



Note: GDP figures are adjusted in 2000 prices.
Source: OECD.Stat

Figure 3. Annual Growth Rates of GDP in Korea



Source: OECD.Stat, OECD STAN

Figure 4. Fixed Capital Formation in Korea

This unusually high growth of TFP in 1999 appears to have been largely driven by a steep slowdown of fixed capital formation in the preceding year in the midst of economy-wide restructuring. For example, non-residential fixed capital formation contracted by 25 percent in 1998. Following the exceptionally high level in 1999, TFP growth of the next three years fell back to levels which were much more modest than the 1999 level but as yet comparable to their previous peak during 1993-1996. Over 1992-2002, therefore, strong TFP growth considerably above the OECD average appears to have induced the Korean economy to manage to grow continuously, instead of falling a victim to diminishing marginal returns resulting from input-driven growth for more than a decade, by shifting out Korea's production function and hence expanding room for capital accumulation.

Following TFP growth on a rollercoaster ride during and immediately after the Asian economic crisis, Korea's TFP growth began to stabilize from 2003, albeit around a lower level than those for most of the past decade. For example, TFP grew an average of about 2.7 percent per year during 2003-2006 whereas its average annual growth rate over the period of 1993-2002 (when the two unusual rates for 1998 and 1999 due to economic crisis are not included) is more than 3.1 percent. During 2003-2006, Korea's real GDP growth also visibly slowed down as shown in Figure 3, and non-residential fixed capital investment as a share of GDP fell to the lowest level since the beginning of the 1980s as well (Figure 4). The sluggish TFP growth during the period appears to have created only limited room for additional investment in fixed capital by failing to sufficiently increase the gap between the current and steady-state levels of capital stock, thereby slowing down economic growth.

The decomposition of Malmquist indexes into technical changes and efficiency changes shown in Table 1 enables us to examine the nature of each year's productivity change. In particular, efficiency changes illustrate how much Korea closed (or widened if the index is less than 1) its efficiency gap with the prevailing OECD best practice. In the early 1980s, Korea appears to have been briefly successful in narrowing its gap with the OECD, but soon begun to move away from the OECD best performance continuously from the mid-1980s. The country's gap with the OECD in technical efficiency is found to have particularly widened in the late 1980s and early 1990s. However, Korea appears to have begun to close the gap consistently from the mid-1990s. According to our calculations, this catch-up in fact continued from 1994 to 2006 – except for 1997 and 1998 when the country suffered from the economic crisis – and was often of a substantial extent.

4.2. Manufacturing

The manufacturing sector has assumed particular importance in Korea's economic development as the sector includes most of the country's key exporting industries. The value added in manufacturing was less than 17 percent of GDP at the beginning of the 1970s, but the share continued to increase throughout the 1970s and 1980s until it reached almost 28 percent in 1988. During the 1990s, manufacturing's share of GDP became stabilized at a level a little below 25 percent, and still hovers around the level. However, the sector traditionally accounts for more than its share of the total output in generating fixed capital investment since it is more capital intensive than any other sectors. As shown in Figure 5, gross fixed capital formation in manufacturing as a share of the sector's value added tends to be consistently higher than the share of non-residential fixed capital formation in GDP. Given the sector's particular importance in capital accumulation and hence economic growth in Korea, therefore, we examine TFP in manufacturing by using the Malmquist index approach again.

For the period 1994-2005, the best-practice frontier in manufacturing was constructed using a sample of 12 OECD countries for which data on the sector's value added, fixed capital formation, and total employment are available in all years from OECD STAN. They include: Australia, Austria, Finland, Germany, Iceland, Italy, Korea, the Netherlands, Norway, Spain, Sweden, and the United States. Aggregate output is constant price – adjusted in 2000 prices – value added in manufacturing; total employment and fixed capital stock in manufacturing are the two aggregate inputs. Total employment is defined as the number of workers, and fixed capital stock is the cumulated and depreciated sum of past investment adjusted in 2000 prices. The figures expressed in individual national currencies are all converted to U.S. dollars using the PPP exchange rate from the OECD.Stat. In line with our previous calculations for the entire economy, the best-practice frontier was estimated using the DEA approach with CRS as underlying technology.

Table 2 shows Malmquist indexes and their decomposed indexes for manufacturing in Korea over 1994-2005. Lee and Kim (2006) also investigated TFP growth in the

SOURCE: OECD.Stat, OECD STAN

Figure 5. Fixed Capital Intensity

manufacturing sector of OECD countries, and calculated Malmquist indexes and decomposed indexes for 1983-1993. Their calculation results for Korea are included in Table 2 as well. It should be noted that the calculations of Lee and Kim (2006) are not directly comparable to our calculations. For one, the construction of their best-practice frontier is based on a different sample of OECD countries.[5] In addition, the perpetual inventory method in Lee and Kim (2006) employed the depreciation rate of 15 percent, whereas the depreciation rate of 10 percent was used in our calculations. Nonetheless, Table 2 enables us to identify the general trend of TFP growth in Korea's manufacturing sector during 1983-2005.

Korea is found to show historically robust TFP growth in its manufacturing sector. According to estimates of the Malmquist index shown in Table 2, the country's TFP in

[5] The sample in Lee and Kim (2006) consists of 14 countries including Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, the Netherlands, Norway, Spain, Sweden, the United Kingdom, and the United States.

Table 2. TFP Growth, Technical Change, and Efficiency Change in Korea: Manufacturing

	Malmquist Index	Technical Change	Efficiency Change
1983	1.135	1.064	1.067
1984	1.081	1.056	1.024
1985	0.998	1.020	0.979
1986	1.041	1.019	1.021
1987	1.007	1.042	0.967
1988	1.093	1.064	1.027
1989	1.083	1.040	1.042
1990	1.102	1.037	1.063
1991	1.124	1.030	1.091
1992	1.127	1.055	1.068
1993	1.045	1.047	0.997
1994	1.085	1.033	1.050
1995	1.066	1.003	1.063
1996	1.022	1.015	1.007
1997	1.023	1.036	0.987
1998	1.054	1.046	1.007
1999	1.184	1.066	1.111
2000	1.097	1.040	1.055
2001	1.020	0.989	1.031
2002	1.068	1.079	0.989
2003	1.039	1.041	0.998
2004	1.073	1.069	1.004
2005	1.085	1.022	1.061

manufacturing grew every year during 1983-2005 with its slight deterioration in 1985 being the only exception, whereas TFP for the entire economy appears to have often experienced substantial regress rather than growth particularly in the 1980s as clearly illustrated in Figure 2. Furthermore, Korea’s TFP growth in manufacturing is found to have consistently outperformed the OECD average growth. This was not the case for the entire economy yet again.

TFP in manufacturing grew particularly strongly in the late 1980s and early 1990s, suggesting that the sector increasingly expanded room for capital accumulation during the period. In fact, gross fixed capital formation in manufacturing as a share of GDP increased substantially in those years as shown in Figure 4. However, this strong TFP growth in manufacturing appears to have been swamped by gross deterioration of TFP in the rest of the economy, resulting in Malmquist indexes for the entire economy far below 1 during the period. It also appears that Korea’s manufacturing sector rapidly closed its efficiency gap with the OECD in the late 1980s and early 1990s when productive efficiency of the entire economy continued to move away from OECD best practices as mentioned in the above.

Following the country’s economic crisis, the manufacturing sector is found to have led a sharp rebound in TFP in the midst of economy-wide restructuring. According to our calculations of Malmquist indexes, TFP in manufacturing even grew more than 5 percent in

1998 when the country's real GDP contracted by almost 7 percent, and accelerated even further in the following year at a rate of more than 18 percent that was considerably above the year's relatively high TFP growth rate for the entire economy. A brisk pace of TFP growth in manufacturing is found to have more or less continued until 2005 in contrast to TFP growth of the entire economy which began to show signs of a visible slowdown from 2003 (Figure 2). During 2003-2005, therefore, the manufacturing sector is expected to have been able to afford relatively greater room for capital accumulation than the rest of the economy by expanding gap between the current and steady-state levels of the capital stock more rapidly than other sectors. As shown in Figure 4, gross fixed capital formation in manufacturing as a share of GDP was in fact on a consistent growing path from 2003 against the backdrop of a continued fall in the share of economy-wide non-residential fixed capital investment over the same period. However, the extent of technical inefficiency in Korea's manufacturing sector appears to have remained largely unabated during the period despite the sector's robust TFP growth as efficiency changes in manufacturing are found to have stagnated around 1 in most years (Table 2).

5. CONCLUDING REMARKS

This paper develops a standard neoclassical growth framework to examine the recent history of economic growth in Korea. In our framework, TFP change is a key to understanding a country's economic growth, and is assumed to reflect technological progress exogenously given to the country in the form of improving OECD best practices as well as the country's changing capacity to absorb the prevailing best practice. Our estimate of TFP growth of Korea based on this notion of productivity change offers a number of interesting implications for the country's past and also future economic growth.

First, our findings provide evidence that Korea's extraordinary economic growth during the 1980s and early 1990s was achieved mainly through massive mobilizations of fixed capital investment. Our analytical framework clearly indicates that this type of economic growth is not sustainable due to diminishing marginal returns to capital. In fact, our results provide a direr picture than most of the previous findings that tend to resonate with ours. For example, the most frequently cited studies of Alwyn Young use the growth accounting approach and find Korea's TFP growth until 1990 to be similar to – not particularly higher or lower than – contemporaneous TFP growth in a number of developed or developing countries with much slower economic growth.[6] According to our findings, however, Korea's TFP generally deteriorated rather than improved during the 1980s with its growth rate considerably below the OECD average.

Nevertheless, Korea's economic growth has never wound down except for a brief depression in 1998 in the middle of the economic crisis. How has the Korean economy managed to sustain its growth under the gravity of diminishing marginal returns following input-driven growth for more than a decade? One may find the answer to this question again in the country's TFP that appears to have begun to grow strongly from 1992. According to our analytical framework, this robust TFP growth considerably above the OECD average is expected to have enabled the Korean economy to defy the gravity of diminishing marginal returns and sustain its growth by creating ample additional room for capital accumulation.

[6] See Young (1992, 1995).

In addition, a number of Korean exporters emerged as globally competitive companies during the 1980s and early 1990s when economy-wide efficiency is found to have suffered a continuous deterioration. Were they just a few outliers of grossly inefficient peers? On the contrary, we find Korea's exporting industries were much more productive than the rest of the economy during that time. Lee and Kim (2006) show that TFP in the country's manufacturing sector improved substantially at a pace faster than the OECD average during the 1980s and early 1990s in contrast to mostly deteriorating productivity of the entire economy. This relatively strong productivity performance of manufacturing in Korea during the period is in line with most previous findings.[7]

One of the latest issues in relation to economic growth in Korea is how to make sense of a persistent growth slowdown from 2003. Many tend to blame sluggish capital investment as its major cause, but we find TFP growth also became noticeably stagnant from 2003. This finding in fact has interesting policy implications. The fiscal measures targeted solely at the demand side would have only limited effects unless they are accompanied by other measures that would truly enhance the country's level of TFP. We also find that TFP growth in Korea's manufacturing sector tended to keep up quite strongly even after 2003 unlike the country's lagging overall productivity growth during the period. This strongly suggests that much closer attention should be paid to industries outside manufacturing, particularly services, in the government's efforts at improving productive efficiency and hence fostering future economic growth.

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[7] For example, see Moon, Jo, Whang, and Kim (1991) and Dollar and Sokoloff (1990) among others.

<Appendix>

	Malmquist Index	Technical Change	Efficiency Change
1981	0.955	0.958	0.997
1982	0.988	0.944	1.046
1983	1.020	0.955	1.068
1984	0.984	1.012	0.973
1985	0.961	0.971	0.990
1986	1.006	1.029	0.978
1987	1.009	1.030	0.980
1988	0.985	1.011	0.974
1989	0.961	1.004	0.957
1990	1.013	1.016	0.996
1991	1.036	1.046	0.990
1992	1.013	1.031	0.982
1993	1.029	1.032	0.997
1994	1.039	1.025	1.014
1995	1.047	1.005	1.042
1996	1.033	1.008	1.025
1997	1.015	1.023	0.993
1998	0.968	1.008	0.960
1999	1.077	1.021	1.055
2000	1.043	1.017	1.026
2001	1.012	0.987	1.026
2002	1.039	1.005	1.034
2003	1.026	1.003	1.023
2004	1.025	1.026	0.999
2005	1.025	1.017	1.008
2006	1.034	1.004	1.029
Mean	1.013	1.007	1.006

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Jeong-Yeon Lee, Associate Professor, Graduate School of International Studies, Yonsei University, 262 Seongsanno, Seodaemun-gu, Seoul 120-749, Korea. Tel: +82-2-2123-4645. Fax: +82-2-2123-8653. E-mail address: leejy@yonsei.ac.kr