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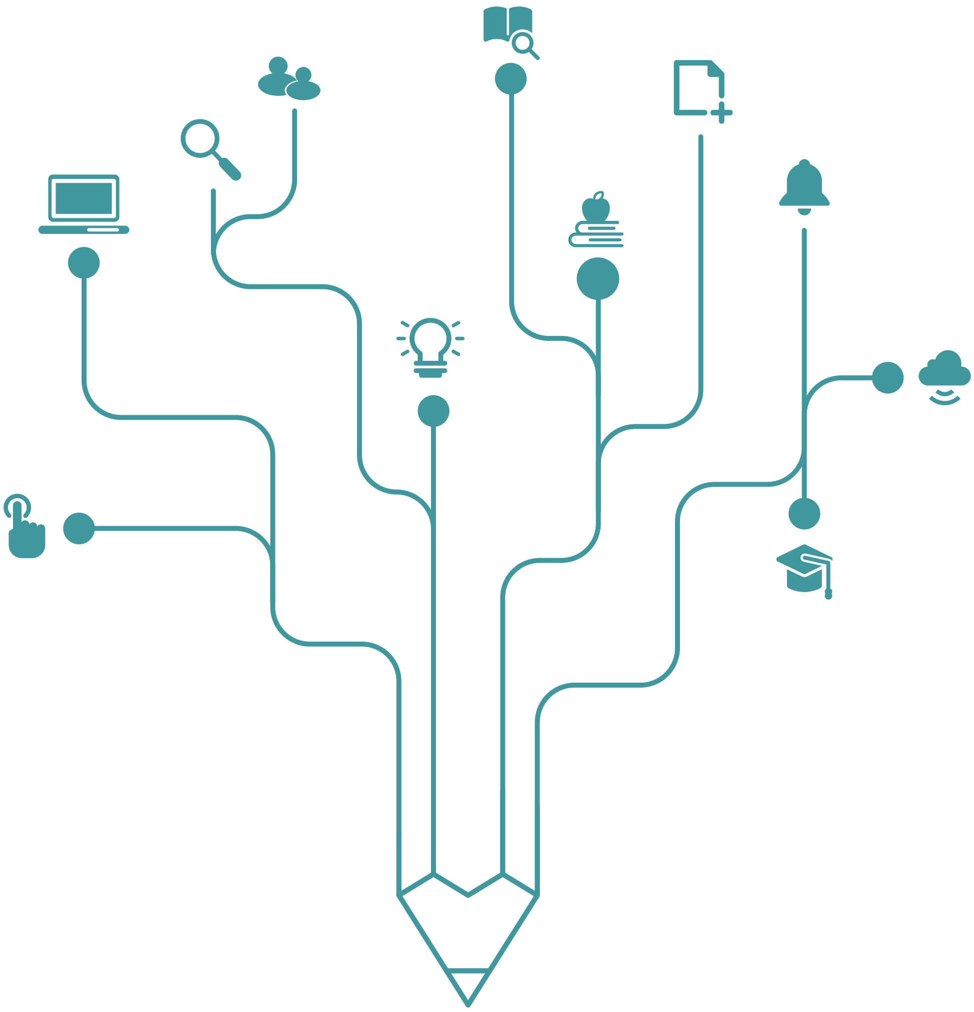

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Abstract

This paper aims to achieve two objectives. First, it compiles consistent labor input statistics for Korea spanning 1963–2023, based on available statistics including the Economically Active Population Survey (EAPS), to evaluate six decades of labor input trends. Second, it estimates labor input's contribution to Korea's economic growth using the growth accounting framework, considering four indicators: (i) the number of workers, (ii) human capital index based on schooling years, (iii) weekly working hours, and (iv) labor efficiency as a function of weekly working hours.

The total labor input grew annually by 5.1% during the first three decades but slowed to 0.9% in the next three, averaging 3.0% during 1963-2023. During the same period, real GDP grew at 7.0%, with labor input contributing 28.8% (2.0 percentage points). The respective contributions of the four indicators were 74.6%, 34.2%, -11.0%, and 2.2%. Finally, we obtained GDP and capital stock data and analyzed the sources of economic growth using conventional growth accounting methodology.

JEL Classifications: J21, J24, O40

Keywords: Labor input, labor statistics, long time-series, contribution to economic growth, growth accounting.

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1. Introduction

The goal of this paper is two-fold. The first goal of the paper is to provide consistent and comprehensive time series of labor input statistics of Korea which are as long as possible. Economically Active Population Survey, the most important source of labor input statistics in Korea, was approved in 1962, and 1963 was the first year from which coherent and reliable labor input statistics became available. Researchers now have access to annual labor input data for 61 years, 1963-2023, and can study the roles of labor input in Korean society for six decades.

The second goal is to assess the contribution of the growth of labor input to the economic growth of Korea during the same period, based on conventional growth accounting framework. This is the reason why the previous paragraph mentioned that the goal of the paper is not to provide comprehensive 'labor statistics' but 'labor input statistics.' We will not try to offer a comprehensive set of labor statistics for six decades, which is not even a possible or meaningful task. We will instead try to collect available labor input statistics which are important in the context of growth accounting or 'accounting for economic growth.'

Most studies dealing with the source of economic growth have used two variables, the number of workers and human capital as the indicators of quantitative and qualitative indicators of labor input, respectively. Also, education and health conditions have been used as indicators of human capital, while the former has been more extensively used due to the wider availability of statistics. In fact, the education statistics of Korean workers could be collected for 1963-2023, while most health conditions statistics are available only for limited years.

This paper provides additional variables as the indicators of labor input, the average weekly working hours of workers and the efficiency of labor as the indicators of quantitative and qualitative indicators of unit amount of work, respectively. This paper followed the methodology by Denison and Chung (1976) to estimate the efficiency of labor, which has been used in many empirical studies in Korea.

The paper is organized as follows. Section 2 will describe methodology and literature and will explain the data availability in Korea. Section 3 will provide the labor input statistics in Korea for 1963-2023 in detail, and Section 4 will estimate the contribution of the growth of labor input to the economic growth of Korea for 1963-2023. Section 5 will briefly mention the future of labor input and will conclude the paper.

2. Methodology, Data Availability and Literature

2-1. Number of Workers

The number of workers employed in the production process, denoted 'L' in almost every literature, is the major component of aggregate labor input, and the Economically Active Population Survey (EAPS) supplies the official statistics regarding the number of workers in Korea. EAPS is a monthly survey statistic which collects data from household members aged 15 or older. Currently, there are 36 thousand households in the sample. As depicted in Figure 1, the population aged 15 or older is classified into economically active and inactive populations, of which the former is classified into employed and unemployed persons.[1]

The following three ratios are frequently used in academic studies, policymaking and journalism in studying labor market situations.[2]

$$\text{Labor Force Participation Rate (LFPR, \%)} = \frac{\text{Economically Active Population}}{\text{Population Aged 15 or Older}} \times 100,$$

$$\text{Employment to Labor Force Ratio (ELFR, \%)} = \frac{\text{Number of Workers}}{\text{Economically Active Population}} \times 100,$$

$$\text{Employment to Population Ratio (EPR, \%)} = \frac{\text{Number of Workers}}{\text{Population Aged 15 or Older}} \times 100.$$

There are about fifty questions in the questionnaire of EAPS, and the number of workers can be classified according to various criteria such as gender, age, education, weekly working hours, employment status, industry, and so on. This will be a major topic in the next section.

Unfortunately, however, some items were not included in the questionnaire in early or later years, and some classification criteria were changed, and thus some time series are not available for early or later years or are available with time series discontinuity to some extent. For instance, education levels of workers have been available since 1980, and the industry classification of the workers experienced several changes. In these cases, we will utilize supplementary sources of data or will use the time series in such a way that time series discontinuity is minimized or relieved.[3]

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[1] We will us the terms 'economically active population' and 'labor force' interchangeably. We will use the terms 'employed persons' and 'workers' interchangeably.

[2] EPR is the product of LFPR and ELFR. ELFR is sometimes referred to as 'employment rate.'

[3] One more official source of labor input statistics is the Employment Table, an attachment to input-output tables. Employment Tables provide the number of workers by industry, employment status and gender, and total working hours by industry. Unlike EAPS, Employment Tables have been compiled irregularly, and Korea has produced 21 Employment Tables since 1975. EAPS and Employment Tables follow different principles in counting the number of workers. In EAPS, a person is counted as one worker if she/he worked for more than one hour during the survey week for income purpose or for more than 18 hours per week as an unpaid family worker. Employment Tables, on the other hand, publish the numbers of workers on 'full-time equivalent' basis, which is why these two statistics reveal considerable differences.

2-2. Human Capital

In growth accounting literature, the term 'human capital' refers to the 'quality of labor', and the ideal indicator of human capital would be multiplied to the number of workers, for example, as $Y_t = AK_t^{\alpha}(h_t L_t)^{1-\alpha}$ in the production function, where Y_t, K_t and L_t denote the aggregate value-added, physical capital stock and the number of workers in time t, h_t the average human capital stock, and α the income share of physical capital.

Education level is the most frequently used indicator of human capital, and has been utilized in a large number of theoretical and empirical studies. There are two methods to measure the aggregate human capital level by utilizing the education data of workers. The first method classifies all workers into a number of groups according to such criteria as education level, gender, age, etc., and estimates the aggregate human capital level as the weighted average of per-worker relative wage levels, that is,

$$(1) \qquad h_t = \sum_g w_{g,t} s_{g,t}$$

where h_t is the aggregate human capital level in time t, $w_{g,t}$ is the average relative wage levels of the workers in group g, and $s_{g,t}$ is the share of the group g in total employment. Kim and Hong (1997), Kim et al. (2002) and Han et al. (2002) are a few studies utilizing the first method. This method requires two sets of data, the wage levels and the numbers of workers in the groups. In Korea, systematic wage statistics, Survey Report on Wage Structure, became available in 1990s, and education statistics of workers, as mentioned above, became available in 1980 as a part of EAPS.

The second method directly estimates the aggregate human capital level as a function of average schooling years of workers, and many studies in recent decades take advantage of the work by Psacharopoulos (1994). He collected the survey data from many countries, and estimated the return to education from Mincerian wage regressions for various regions in the world. His estimates were 13.4% for Sub-Saharan Africa, 10.1% for World, and 6.8% for OECD countries. Hall and Jones (1999) assumed that these three estimates are the return-to-school rates for elementary education (first four years), middle school education (next four years) and higher education (after eight years), respectively. This implies that the human capital index can be estimated as a function of schooling years as in the following equation.

$$(2) \qquad h_0 = 1 \quad \text{and} \quad h_E = \begin{cases} 1.134^E & \text{if } 0 \le E < 4, \\ 1.134^4 \cdot 1.101^{E-4} & \text{if } 4 \le E < 8, \\ 1.134^4 \cdot 1.101^4 \cdot 1.068^{E-8} & \text{if } 8 \le E, \end{cases}$$

where E denotes the average schooling years of workers. Weil (2013) used this equation to explain the relationship between education and human capital. Kang and Park (2022) applied this equation in explaining the slowdown of Korea's economic growth. This paper will also employ this equation to estimate the human capital level of Korean workers.

Barro-Lee Educational Attainment Dataset is a widely known source of schooling years data, which is available from DataBank, the World Bank's website for statistics. The average schooling years of all workers aged 15 or older can be downloaded from this dataset. Unfortunately, however, the dataset provides the schooling years data only for the years ending with '0' or '5' for 1960~2010. The schooling years in in-between years can be estimated by linear or exponential interpolation.

The average schooling years of workers after 2010 where Barro-Lee dataset is not available, can be estimated using the education level data from EAPS and/or census data. First, we can find the education levels of workers in categorical levels such as elementary school, middle school, etc. Education data became available in 1980, and, furthermore, the educational categorization changed several times afterwards. The only way to obtain a time series without discontinuity is to classify the education levels into four categories (i) elementary school or less, (ii) middle school, (iii) high school, (iv) college or higher, and we arranged the dataset with four categories for 1980-2023.

Second, Korea began modern population censuses since 1925, and we obtained the numbers of workers in these four categories from the Population Census in 1960-1980. There were five Censuses in this period, 1960, 1966, 1970, 1975 and 1980, and they have sample data on economically active populations with sampling rates of 5~20%.[4] From the sample data, we can obtain the education level data of workers in the above four categories. I obtained the time series of the four shares by combining the census and the EAPS data.

Third, the average schooling years of all workers is the weighted average of the average schooling years of the workers in individual groups

(3) $$E_t = E_{1t}\, s_{1,t} + E_{2t}\, s_{2,t} + E_{3t}\, s_{3,t} + E_{4t}\, s_{4,t}$$

where $E_{i,t}$ denote the average schooling years of the workers with the education level i in time t and $s_{i,t}$ is their share. The equation can be regarded as a regression equation if $E_{i,t}$ is constant during a certain period, and we can estimate E_i using the data of E_t and $s_{i,t}$ for a period where the data of E_t and $s_{i,t}$ are available and $E_{i,t}$ is assumed to be stable.

Health condition is also an important component of human capital, but this paper does not explicitly consider it as a component of labor input, mainly due to the insufficient availability

[4] The sampling rates for economically active population were 20% in 1960, 10% in 1966 and 1970, 5% in 1975, and 15% in 1980.

of statistics. A brief explanation of the topic and the data availability can be found in the Appendix.

2-3. Weekly Working Hours

Weekly working hours are also an important quantitative indicator of labor input even though it has not been extensively used in growth literature. Unlike many economic variables, however, weekly working hours do not always show an increasing trend. In fact, it is expected that in the early stage of economic growth, weekly working hours will show an increasing trend because the economy does not have sufficient jobs in terms of total working hours. As the income level exceeds a certain level, however, weekly working hours are likely to enter a decreasing phase for various reasons, for example, the increasing value of leisure. In conclusion, the relationship between weekly working hours and income level might show an inverted-U shape. The scatter diagram of the average weekly working hours and the real GDP of Korea, as given in Figure 2, confirms this conjecture. At the same time, if weekly working hours are not taken into consideration, the contribution of labor would be underestimated during low-income period when weekly working hours increase at the same time, and vice versa.

2-4. Efficiency of Labor[5]

It is important to take into consideration the impact of working hours on the efficiency of labor for various reasons, e.g., the physical impact of fatigue. For example, the efficiency of labor would stay at a certain level until weekly working hours reach a certain number of hours but will begin deteriorating as working hours extend beyond that level.

The specific form of efficiency as a function of weekly working hours must be estimated by empirical studies. Let x be the weekly working hours of a worker. Denison and Chung (1976) assumed that in the non-agricultural sector in Japan, the efficiency of labor (i) is constant when $0 \le x \le 42.7$ for male workers and $0 \le x \le 39.0$ for female workers, (ii) decreases linearly when $42.7 \le x \le 52.7$ for male workers and $39.0 \le x \le 49.0$ for female workers, and (iii) is zero otherwise.

Kim and Hong (1997) assumed that these two critical values are 44 and 70 for both male and female workers in all sectors in Korea. The efficiency of weekly working hours under this assumption is depicted in the upper graph in Figure 3,[6] which, rigorously speaking, should be interpreted as the marginal efficiency (ME) of labor. The total efficiency (TE) of labor is derived by integrating the ME curve from 0 in terms of x, and is depicted in the lower graph

[5] Estimation method explained in this part is from Kim (2004).
[6] Without loss of generality, we can normalize the marginal efficiency level before it deteriorates at 1.

in Figure 3. TE can be interpreted as the 'effective' working hours without loss of efficiency.

$$TE(x) = \begin{cases} x, & 0 \le x < 44, \\ 57 - (70-x)^2 / 26, & 44 \le x < 70, \\ 57, & 70 \le x < 100. \end{cases}$$

It must be noted that the efficiency of labor of a group of workers is distinct from that of a single worker. The ME curve in Figure 3 predicts that when the weekly working hours (x) of a single worker increase, the efficiency of labor would stay unchanged (if $x < 44$) or decrease (if $x > 44$). When there are many workers, however, the 'average' efficiency of labor could increase when the 'average' weekly working hours increase.

Suppose, for example, there are two workers whose weekly working hours are 20 and 49.2. These two workers' efficiency levels are 1 and 0.8, respectively, and the average weekly working hours is 34.6 and the average efficiency level is 0.9. Assume that these workers' weekly working hours changed to 40 and 46.6 so that their efficiency levels change to 1 and 0.9, respectively. Then the average weekly working hours increase to 43.3 while the average efficiency level also rises to 0.95. Roughly speaking, this can happen when the increase in the weekly working hours of those with $x < 44$ is bigger than the decrease in the weekly working hours of those with $x > 44$. Similarly, the average weekly working hours and the average efficiency level can decrease simultaneously. More importantly, this example demonstrates that when estimating the average efficiency of labor in an economy, the distribution of weekly working hours of workers matters.

We need to introduce an estimation strategy for the distribution of weekly working hours of workers and the aggregate total efficiency. Let $\psi(t)$ be the probability density function (PDF) of $N(\mu, \sigma^2)$, the normal distribution with mean μ and standard deviation σ, and let $\Psi(t)$ be the distribution function (DF) of $N(\mu, \sigma^2)$. Also, let $\phi(t)$ and $\Phi(t)$ denote the PDF and the DF of $N(0,1)$, respectively.

Let the random variable X denote the weekly working hours of the representative worker. While the theoretical maximum of X is 168 hours ($= 24 \times 7$), we assume that X cannot exceed $K = 100$.[7] Define the new random $U = \log(K - X)$ and assume that U follows the truncated normal distribution $N(\mu, \sigma^2)$, i.e., assume that $g(u)$ and $G(u)$ in (4) are the PDF and the DF of U, respectively. This assumption can be justified by the fact the empirical distribution of weekly working hours is skewed to the left.

$$(4) \qquad g(u) = \frac{\psi(u)}{\Psi(\log K)} \text{ and } G(u) = \frac{\Psi(u)}{\Psi(\log K)}, \qquad -\infty < u \le \log K.$$

The DF and the PDF of X can be derived as follows.

[7] This assumption is introduced for computational convenience.

(5) DF: $F(x) = P[X < x] = P[U > \log(K - X)] = 1 - \dfrac{\Psi(\log(K-x))}{\Psi(\log K)}$,

PDF: $f(x) = \dfrac{d}{dx}F(x) = \dfrac{\exp\left\{-(\log(K-x)-\mu)^2/(2\sigma^2)\right\}}{\Psi(\log K)\cdot(K-x)\cdot\sqrt{2\pi\sigma^2}}$, $-\infty < u \le \log K$.

Mathematical expectation of X can be obtained as follows.

(6) $E[X] = \int_0^K [1 - F(x)]\,dx = \dfrac{1}{\Psi(\log K)}\int_0^K \Psi(\log y)\,dy$.

As mentioned previously, working hours data are frequently available in grouped data, that is, the numbers of workers whose weekly working hours belong to predefined intervals. Let n_i be the number of workers whose weekly working hours belong to the i th interval $[d_{i-1}, d_i)$, $i = 1,\ldots,m$, with $d_0 = 0$ and $d_m = K$. Let p_i denote the probability that X belongs to the i th interval. Then

(7) $p_i = P[d_{i-1} \le X < d_i] = G(\log(K - d_{i-1})) - G(\log(K - d_i))$, $i = 1,\ldots,m$.

The likelihood function and the log-likelihood function of the parameters (μ, σ^2) are

(8) $L(\mu,\sigma) = \prod_{i=1}^{m} p_i^{N_i}$ and $\log L(\mu,\sigma) = \sum_{i=1}^{m} N_i \log p_i$

respectively, and the maximum likelihood estimates (MLE) of μ and σ are the values of μ and σ at which the log-likelihood function is maximized. The total efficiency of all workers in the economy can be estimated as the mathematical expectation of $TE(X)$,

(9) $E[TE(X)] = \int_0^K TE(x)\, f(x)\,dx$,

and finally, the average efficiency of all workers in the economy can be estimated by

(10) $EI = \dfrac{E[TE(X)]}{E[X]} = \dfrac{\int_0^K TE(x)\, f(x)\,dx}{\int_0^K x\, f(x)\,dx}$.

Denison (1974), Denison and Chung (1979), Kim and Park (1979), Kim and Hong (1997), Kim et al. (2002), Kim (2004), and Kim et al. (2012) followed this method to estimate the aggregate efficiency of labor. Kim (2023) emphasized that the shares of the self-employed and part-time workers could affect the average working hours and that we should be careful when dealing with cross-country working hours statistics. Park and Park (2017) introduced literature regarding the effect of reducing working hours on labor productivity and performed an empirical study on Korea's manufacturing sector.

In EAPS, the respondents are asked the number of hours worked during the survey week and the average weekly working hours of workers by various criteria are published. Obviously, the number of workers multiplied by the weekly working hours is the total weekly working hours of workers and becomes the monthly and yearly working hours when multiplied by proper numbers. In principle, this is equivalent with the number of workers reported in the Employment Tables.

While each respondent in EAPS reports the number of weekly working hours in an integer, KOSIS, the official website of Korea's statistics authority, publishes the numbers of workers in six intervals; 1~18 hours, 19~29 hours, 30~34 hours, 35~39 hours, 40~49 hours, and 50 hours or longer in 1963-1968, and 1~17 hours, 18~26 hours, 27~35 hours, 36~44 hours, 45~53 hours, 54 hours or longer since 1969.

2-5. Additional Indicators of Labor Input

Many of previously mentioned studies such as Denison and Chung (1979), Kim and Park (1979), Kim and Hong (1997), Kim et al. (2002), and Kim et al. (2012) estimated an additional indicator of the quality of labor, the gender-age composition of all workers. This indicator classifies all workers into gender-age groups, computes their shares out of all workers and the normalized average wage levels,[8] computes the average of the normalized average wage levels in the first and the second half of the whole period, and finally the indicator of the gender-age composition is computed as the weighted average of the normalized average wage levels using the shares. The above studies selected the male workers in their 30s as the reference group when computing the normalized average wage levels.

The idea of this indicator is that gender-age composition would affect the productivity of one hour's work. In fact, the above studies computed the human capital index in a similar way, which is basically the same as equation (1). This paper, however, did not consider the gender-age composition in the next section for various reasons. First, it is possible that some of the effects of this indicator overlap with that of education indicator because both indicators are based on the wages of all workers. Also, the selection of the sub-periods can be arbitrary, and the availability of wage data is not sufficient.

Denison and Chung (1976) included one more indicator of labor quality, the status-sector composition of all workers. They classified all workers into three status-sector groups: paid

[8] For example, the average wage level of male workers in their 30s is normalized at 100.

workers in the non-agricultural sector, non-paid workers in the non-agricultural sector, and all workers in the agricultural sector, and applied a similar procedure for the gender-age composition indicator. The above-mentioned studies in Korea did not estimate this indicator for Korea because this indicator did not exhibit a significant change over time.

Finally, we can find the statistics of the number of idle days caused by various reasons, which is a quantitative indicator of labor input. In Korea, Labor Dispute Statistics provides the number of days unworked due to labor dispute. However, the number of idles days is very small, mostly between 0.01% and 0.03% of all working days. This paper also did not include these two indicators in the next section.

3. Labor Input in Korea in 1963-2023

3-1. Number of Workers

Total number of workers in Korea was 7,563 thousand persons in 1963, which increased to 28,416 thousand in 2023, 3.76-fold in 60 years. See Figure 4. While the average annual growth rate (AAGR)[9] during the entire period was 2.2%, decadal AAGRs show significant differences as seen in Figure 5. Decadal AAGRs in the first three decades were almost 3% or higher with the AAGR in the first 30 years being 3.2%. This dropped to slightly over 1% in the last three decades with the AAGR being 1.3%.

Total employment can be expressed as the product of three factors as follows. This implies that the growth rate of total employment can be analyzed using (i) the growth rate of population aged 15 or older, (ii) labor force participation rate (LFPR), and (iii) the employment to labor force ratio (ELFR).

$$\begin{aligned}\text{No. of Workers} &= \text{Population (age 15+)} \times \frac{\text{EAP}}{\text{Population (age 15+)}} \times \frac{\text{No. of Workers}}{\text{EAP}} \\ &= \text{Population (age 15+)} \times \text{LFPR} \times \text{ELFR}.\end{aligned}$$

Table 1 shows that the AAGR of the population aged 15 or older was 1.9% during the entire period, 0.3%p lower than that of total employment, 2.2%. We also observe that the pattern of decadal AAGRs of working-age populations closely resembles that of total number of workers. To better understand the growth of total employment, we need to decompose the total employment into those of male and female workers, and we find a big difference between the patterns of the numbers of male and female workers. Even though the AAGR of male working-age population during 1963-2023, 2.0%, was higher, if marginally, than that of

[9] In this paper, the AAGR of a time series variable x_t between years s and t, is defined as $(x_t / x_s)^{1/(t-s)} - 1$.

female population, 1.9%, the AAGR of the number of female workers, 2.6% was significantly higher than that of male workers, 2.0%.[10]

On the other hand, it is expected that the ERs of female and male workers would not show a difference big enough to cause a significant difference in the AAGRs of the numbers of workers, as witnessed in Figure 6.[11] In consequence, this implies that the significant difference between the AAGRs of the numbers of female and male workers has been caused mainly by the difference in the time-series patterns of LFPRs. Figure 7 shows that the LFPR of male population consistently declined from 78.4% in 1963 to 73.3% in 2023, while that of female population rose consistently and more rapidly from 37.0% to 55.6% during the same period.

In summary, total employment in Korea recorded a sizeable growth rate of 2.2% per annum during 1963-2023. This was made possible by (i) fast growth of the working-age population and (ii) rise of the LFPR, in particular the rapid rise of the LFPR of female population. This resulted in a rapid change in the gender-wise composition of all workers. The share of female workers in the total employment was 34.8% in 1963, which rose to 43.9% in 2023. See Figure 8.

The change in the composition of total employment by age has been more dramatic as shown in Figure 9. The workers aged 15-19 occupied about 12.5% of total employment in the first decade, which rapidly decreased in the next decade and became less than 2.0% since 1996 and 1.0% since 2007. The share of the workers aged 20-29 fluctuated around 25% until the early 1990s, and then decreased steadily afterwards to around 13% in recent years. The share of the workers aged 30-39 fluctuated between 25% and 30% until late 2000s, and then decreased steadily arriving at around 19% in 2023. The shares of the older workers show different patterns. The share of the workers aged 40-49 stayed between 20% and 25% until 2000, then began increasing for a decade to about 28% and then decreasing to 22.0% in 2023. The share of the workers aged 50-58 increased almost monotonically during the whole period, but with a sluggish increase until 2003 and then a rapid growth afterwards. The share was only 12.0% in 1963, but it almost doubled in six decades, recording 23.5% in 2023. The share of the workers aged 60 or higher also increased almost monotonically during the entire period, but with a more rapid rise. It was only 4.3% in 1963, but it increased to 21.9% in 2023, an increase more than five times.

Male and female workers have experienced different age compositions as exhibited in Figures 10 and 11, respectively. The shares of the workers aged 15-19 and 20-29 were significantly higher in the female group in the first half and in the second half, respectively, while the share of the workers aged 30-39 has been higher in the male group for the entire

[10] The difference 0.6% is not small for the AAGR for 60 years. The composite growth rates of male and female employment during 1963-2023 were 224% and 373%, respectively, and male and female employment increased 3.24- and 4.73-fold, respectively.
[11] In this paper, thinner curves in graphs represent the Hodrick-Prescott (HP) filtered series.

period. Two groups showed very similar shares of the workers aged 30 or older.

Composition of all workers by education level reveals another aspect of labor input in Korea, and we obtained the composition for the whole period by the following procedures. First, we collected the annual data of the numbers of workers with four levels of education in 1980-2023, and computed the shares for this period. Second, we collected similar data in 1960, 1966, 1970, 1975 and 1980 and computed the shares in these years using census data. Third, we compared the shares in 1980 from census with those from EAPS, and determined that the difference between these two sets were ignorable. For this reason, we decided to choose the shares in 1980 from EAPS. Fourth, we computed the shares in the in-between years between 1960 and 1980, finally obtaining the shares for the entire period as given in Figures 12 to 14.

The share of all workers with the education of elementary school or less was 79.4% in 1963, which rapidly and monotonically decreased, recording 5.9% in 2023. The share of the workers with middle school education increased for the first two decades because of expanding primary education. However, it steadily declined in the later decades according to the fast improvement of education levels of the general population. The share of the workers with high school education consistently expanded in the first decades. However, it began decreasing slowly in the early 2000s, this time because of the expansion of college education. The share of the workers with the education of college or higher was only 3.3% in 1963, which increased monotonically for the entire period, recording 50.5% in 2023. Workers with college education became the majority in 2011 in Korea.

Figure 13 and Figure 14 depict the compositions of male and female workers by education level, respectively, from which we can find a remarkably similar pattern and a significant difference at the same time. First, the shares of the workers with elementary school education kept decreasing steadily in both groups. However, the share was much higher in the female group in all years although the gap contracted from about 18%p in 1963 to less than 5%p in 2023. Second, the share of the workers with middle school education was higher in the male group in early decades but began decreasing and became lower than in the female group. Third, the shares of the workers with high school education in both groups exhibit highly similar patterns of all workers. However, the share in the male group has been higher in all years although the gap became negligible in recent years. Finally, the shares of the workers with college-or-higher education in both groups have increased monotonically in the entire period and the share in the male group has always been higher than in the female group. The gap was around 3.7% in 1963, reached about 10% in 1990s, then decrease to 3.7% in 2023.

Figure 15 describes the classification of workers by status defined in EAPS. All workers are divided into wage & salary workers and self-employed workers. Wage & salary workers consist of regular employees, temporary employees and daily workers,[12] while non-wage

[12] Wage and salary workers are classified according to the duration of employment contract; (i) regular

workers consist of self-employed and non-paid family members. While the numbers of all categories of workers for 1963-2023 are provided by EAPS, the numbers of regular and irregular workers are not available until 1989. See Figure 16.

The share of non-wage workers was 68.5% in 1963, more than two thirds of total employment, of which 37.3% were self-employed workers and 31.2% were non-paid family members. The extremely big share of non-wage workers was due to the big portion of the agricultural sector where almost all workers were self-employed or family members. The share of regular workers was 32.4% in 1989, which increased to 56.9% in 2023. On the other hand, the share of irregular workers has been considerably stable around 20%, but has slowly decreased in recent years, recording 16.2% in 2023. The share of daily workers also has been stable around 10%, but began decreasing in the early 2000s, recording 3.7% in 2023. The composition of workers by status implies that overall job security has improved during 1963-2023.

Finally, composition of workers by industry is given in Figure 17, in which the entire economy is classified into five industries: agriculture, forestry and fishery, mining, manufacturing, construction and service sectors. This is the finest industry classification encompassing the changes in the industry classification system during 1963-2023. Also, you can easily recognize several 'jagged' parts in Figure 17. These are likely to be the time-series discontinuities due to the changes in the industry classification system, which need to be taken into consideration when interpreting the graph.

The story behind Figure 17 is highly obvious: (i) rapid decrease in the share of employment in the agricultural sector, from 63.0% to 5.3%, (ii) expansion of employment in the manufacturing sector in the first two decades, from about 8% to 26%, followed by gradual contraction arriving at about 16% in 2023, (iii) slow expansion of the employment in the construction sector for three decades, from 2.5% to 8%, and the stability around 7.5% thereafter, and (iv) persistent increase in the share of the employment in the service sector, from 25.8% in 1963 to 71.5% in 2023.

3-2. Human Capital

In this paper, we used the human capital index suggested by Psacharopoulos (1994) and Hall and Jones (1999). We first obtained the average schooling years of all workers and female workers aged 15 or older for the years whose last digit is 0 or 5 during 1960-2010. We then estimated the average schooling years in the in-between years by exponential interpolation, obtaining the annual data in 1963-2010. Second, from the relationship that the average schooling years of all workers is the weighted average of those of male and female workers,

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employees if the duration is one year or longer, (ii) temporary employees if the duration is one month or longer and shorter than one year, and (iii) daily workers if the duration is shorter than one month.

we reverse-engineered the average schooling years of male workers for 1963-2010 using the numbers of male, female and all workers.

Third, we estimated the equation (3), separately for male and female workers to obtain the OLS estimates of E_i, in which the shares of the workers with various education levels, $s_{i,t}$, were used as the explanatory variables. Unfortunately, the equation (3) with four education levels did not produce satisfactory estimation result. The values of some $\hat{E}_{i,t}$ were not acceptable, e.g., $\hat{E}_2 = 24.6$, or even negative. For this reason, we decided to estimate the equation (3) with three education levels by combining middle school and high school education. Considering the assumption that E_i s are time-invariant, we limited the estimation period to the recent two decades, i.e., 1990-2010. The following are the estimation results,[13] in which $s_{1,t}$, $s_{23,t}$ and $s_{4,t}$ denote the shares of the workers with education of (i) elementary school or less, (ii) middle and high school, and (iii) college or more, respectively.

$$\text{Male:} \quad E_t = \underset{(3.17)}{3.91}\, s_{1,t} + \underset{(25.84)}{11.14}\, s_{23,t} + \underset{(41.32)}{15.43}\, s_{4,t}, \qquad n = 21,\ adj\,\mathrm{R}^2 = 0.9444,$$

$$\text{Female:} \quad E_t = \underset{(12.77)}{5.56} \cdot s_{1,t} + \underset{(33.13)}{10.39} \cdot s_{23,t} + \underset{(47.76)}{15.39} \cdot s_{4,t}, \qquad n = 21,\ adj\,\mathrm{R}^2 = 0.9444.$$

Fourth, we estimated E_t for 2010-2023 using the estimated coefficients, and then computed the annual growth rates of $\hat{E}_t$ for 2011-2023. We then applied these annual growth rates to the actual E_{2010} to obtain $\hat{E}_t$ for male and female workers in 2011-2023. The average schooling years of all workers in 2011-2023 were computed as the weighted average of those of male and female workers. Finally, the human capital indices of male, female and all workers were calculated using the transformation (2) suggested by Psacharopoulos (1994) and Hall and Jones (1999).

Average schooling years of male, female and all workers during 1963-2023 are displayed in Figure 18. Average schooling years of all workers was 5.0 years in 1963 and 12.9 years in 2023, with AAGR being 1.6%. While the average schooling years of male and female workers appear very similar, the growth rate of female workers is much higher: the AAGRs of schooling years of male and female workers are 1.4% and 2.0%, respectively. On the other hand, the average schooling years in Figure 18 are smooth and concave, and the decadal growth rates of both groups have decreased monotonically.

The growth rate of schooling years in Korea has been higher than in most countries. Figure 19 depicts the average schooling years in five selected countries during the period 1963-2010. During this period, average schooling years increased by 7.1 years in Korea, while those in USA, Japan, China and France by 3.5, 3.7, 4.9 and 6.2 years, respectively.

[13] The numbers in the parentheses are the t statistics of the coefficient estimates.

AAGRs of human capital index of all, male and female workers for various periods are summarized in Figure 20 and Table 2, which were computed by applying the transformation formula (2) to schooling years. AAGRs of the human capital indices of all, male and female workers were 1.1%, 0.9% and 1.2%, respectively. Human capital indices are concave because the transformation (2) as well as the schooling year curves in Figure 18 are also concave.

3-3. Weekly Working Hours

While EAPS provides the weekly working hours data for the entire period, there was a time-series discontinuity in early decades. Specifically, the weekly working hours data were collected for the workers aged 14 or older during 1963-1985, while the data were collected for the workers aged 15 or older since 1980. In other words, we have two separate datasets with different age criteria, 14+ and 15+ for six years in 1980-1985.[14] During this overlapping period, the average working hours of the workers aged 14 or older was slightly longer than those aged 15 or older by 0.1~0.2 hours per week. The average ratio of the latter to the former in these six years was 0.9979, and we multiplied this ratio to the weekly working hours of the workers aged 14 or older in 1963-1979 to estimate the weekly working hours of the workers aged 15 or older for the period.

Weekly working hours of all workers during 1963-2023, along with the HP filtered series, are displayed in Figure 21, which complies with the inverted-U shape in Figure 2. The maximum value in the HP-filtered trend curve was in 1984, implying the weekly working hours increased for two decades and then decreased for the next four decades. The AAGR during the entire period was -0.3%, while the AAGRs in the three two-decade periods were 0.8%, -0.6% and -1.2%.

In this paper weekly working hours and efficiency of labor were estimated for agricultural and non-agricultural sectors separately. This was because the agricultural sector was the major sector in Korea in the early decades as was witnessed in Figure 18 and the distributions of weekly working hours in agricultural and non-agricultural sectors were highly heterogeneous. Weekly working hours in the agricultural sector have always been shorter than those in non-agricultural sectors although the gap has consistently decreased.

3-4. Efficiency of Labor

Efficiency of labor index was estimated following the procedures explained in the previous section. We collected the numbers of workers whose weekly working hours belong to the six intervals according to which the EAPS provides the data. Numbers of workers by weekly

[14] This was the transition period for EAPS for changing the definition of working-age population from 14 to 15 years old, and the statistics authorities published both datasets.

working hours in both sectors in selected years are summarized in Table 3. We then computed the estimates of the model parameters of the underlying distribution by MLE method (8). While the log-likelihood function appears to be highly complicated and nonlinear, the estimation was very smooth and fast. In all 122[15] estimations, the convergence of MLE estimates was attained in less than 13 iterations and the statistical significances were sufficient. A plain desktop computer was used, and the computing time was less than 0.05 second in each estimation. Table 4 summarizes the MLE estimation results for selected years.

Using the MLE estimates of the model parameters, we computed the mathematical expectation of the weekly working hours, effective weekly working hours and the efficiency index for both sectors using the equations (6), (9) and (10), respectively. Finally, we computed the aggregate efficiency index as the weighted efficiency index of both sectors using the numbers of workers as the weights. Efficiency indices in both sectors and the aggregate index in selected years are summarized in Table 5. Also, the estimated indices for the entire period are displayed in Figure 22. The estimation results indicate that (i) efficiency of labor has been higher in the agricultural sector and that the efficiency in the two sectors have converged to each other.

It should be mentioned that weekly working hours and efficiency of labor do not necessarily change in the opposite direction. In 1990s, for example, efficiency of labor in the agricultural sector declined even though average weekly working hours decreased. In fact, it is possible that weekly working hours and efficiency of labor can increase or decrease at the same time. For example, it is possible to increase the average weekly working hours of workers and improve the average efficiency of labor at the same time when there are many workers working for extended hours. The AAGR of weekly working hours and efficiency of labor in various periods are given in Table 6, where the periods in which these two indicators move in the same direction are shaded in gray.

4. Contribution of Labor Input to Economic Growth in Korea during 1963-2023

Finally we will estimate the contribution of labor input to economic growth of Korea during 1963-2023 using conventional growth accounting framework. We obtained the constant GDP of Korea in 2015 Korea won during 1963-2023 from ECOS, the statistics portal of the Bank of Korea. The AAGR of Korea's constant GDP during the entire period was 7.0%, as seen in Table 7, and Korea's income level became 57-fold during this period. Korea maintained rapid growth in the first three decades, which remarkably slowed down in the next three decades. The AAGR in the first three decades was 9.7%, which was even higher than double the AAGR in the second three decades, 4.3%. See Table 7.

Total labor input is obtained by multiplying the four labor input components estimated in

[15] There are 61 years in the period and there are two sectors.

the previous sections, and the AAGRs of the four individual components and the total labor input are summarized in Table 7. Table 7 is surprising for two reasons, extremely fast growth of labor input in early decades and extremely fast deceleration of labor input growth during the later decades. The AAGR of total labor input was 6.1% in the first decade, which decreased monotonically reaching 0.2% in the last decade. The AAGR of total labor input during the entire period was 3.0%, while the AAGRs in the first and the second three decades were 5.1% and 0.9%, respectively.

The contribution of labor input to economic growth is obtained by multiplying the labor income share to the AAGR of labor input. The frequently used or assumed labor income share in the field of growth accounting is between $1-\alpha=0.6$ and 0.7, implying that the capital income share is between $\alpha=0.3$ and 0.4. For instance, Hall and Jones (1999) 'assumed' that the capital income share is $\alpha=\frac{1}{3}$, mentioning that it is "broadly consistent with national income accounts data for developed countries." Weil (2013) collected the national account data of 53 countries and found that the average capital income share was $\alpha=0.35$, and used the value $\alpha=\frac{1}{3}$ throughout his book. Kim and Hong (1997), Kim et al. (2002) and Kim et al. (2012) all estimated the labor income share in the non-residential business sector in Korea for various periods; 1963-1995, 1963-2000 and 1970-2010, respectively, and their estimates of labor income share for the respective periods were 0.62, 0.65 and 0.70. The estimate by Kim and Hong (1997) during 1979-1995 was 0.65, and Han et al. (2002) used this value in their growth accounting for Korean economy for 1981-2000. Considering these studies, we also assumed that the share of labor income is $1-\alpha=\frac{2}{3}$.

The AAGRs of the four individual components and the total labor input multiplied with $1-\alpha=\frac{2}{3}$ are given in the columns (3)~(7) of Table 8, which are the contributions of labor input components to economic growth in terms of GDP growth rate. During the entire period 1963-2023, for example, the AAGR of real GDP was 7.0%, of which 2.0% was the contribution of total labor input. The contributions of total labor input to economic growth in six decades are also displayed in column (7) of Table 8.

Recent decades witnessed increasing attention to the labor income share, and many studies reported the possibility of decreasing labor income share. See e.g. Cho et al. (2017). For this reason, we computed the contributions of labor input components to economic growth under the assumption that the labor income share has decreased. Specifically, we assumed that $1-\alpha$ was 70% in the first decade, which lowered by 2% point each decade, reaching 60% in the last decade, as in column (1) of Table 9. Remembering that the AAGR of total labor input decreased monotonically, the contribution of labor input would decrease more rapidly when the labor income share is constant than when it decreases. This is confirmed by columns (8) in Tables 8 and 9 and Figure 23.

Contribution of labor input to economic growth can also be expressed in terms of the share of economic growth rate, which is obtained by dividing the contribution of labor input expressed in terms of growth rate, i.e., by dividing columns (3)~(7) by column (2), and are given in the lower panels in Table 8. During the entire period, for example, the contribution of total labor input was 2.0%, which was 28.8% of the AAGR of GDP, 7.0%. In other words, 28.8% of the economic growth of Korea was made possible by the increase in labor input. We observe from Table 8 that the contribution of total labor input decreased rapidly in each decade, from 37.7% in the first decade to a mere 6.4% in the last decade. See Table 9 for similar results when the labor income share is decreasing.

Sources of Economic Growth of Korea during 1973-2023

We obtained the capital stock data of Korea and analyzed the sources of economic growth of Korea using the conventional growth accounting methodology. Specifically, we obtained the constant produced capital stock data for 1970-2023 in 2015 Korean won from the National Balance Sheet account, of which we only used the data for 1973-2023 considering the availability of labor input data.[16]

The AAGR of capital stock during 1973-2023 was 8.4%, and the contribution of capital stock to economic growth during the same period was obtained by multiplying the capital income share, $\alpha = \frac{1}{3}$, at 2.8%. The contributions of capital stock in individual decades can be similarly computed, from 4.9% during 1973-1983 to 1.1% during 2013-2023, and are given in column (8) of Table 8. The residual of the AAGR of GDP, that is, the AAGR of GDP less the contributions of labor and capital, which is called total factor productivity (TFP), is interpreted as the contribution of technology and efficiency to economic growth. See column (9) of Table 8 for the contribution of TFP during 1973-2023 and during individual decades.

The contributions of labor, capital and TFP in five decades are summarized in Figure 24. We observe that while the contributions of both labor and capital have decreased monotonically, the former decreased more rapidly. The contribution of TFP was almost negligible at 0.4% in 1970s, but it leaped to 2.9% in 1980s and then gradually decreased. It is worth observing that the speed of decrease was lowest for TFP and highest for labor, which implies that the contribution of TFP has increased, as can be confirmed in the lower panel of Table 8. See Table 9 for similar results under the assumption that the labor income share has decreased from 70% in 1960s to 60% in 2010s.

5. Conclusion

[16] The constant produced capital stock data in 2015 Korean won are available only for 1970-2022. The same data are also available in 2020 Korean won for 2000-2023. The annual growth rates of the latter are higher than those of the former by 0.16% point on average, and we estimated the growth rate of the former in 2023 by applying this difference to the growth rate of the latter in 2023 and applied it to estimate the constant capital stock in 2015 won in 2023.

Reliable labor input statistics with satisfactory consistency and time-series continuity became available in 1963, and we collected various statistics to study numerous aspects of labor input in Korea for six decades. The period 1963-2023 is the longest period for which we can study various aspects of labor input in Korea and its contribution of economic growth with reliability and rigor.

In this paper, we considered four components of labor input: two quantitative and two qualitative indicators of labor input. The first indicator is the number of workers, and it is the most important component of labor input, occupying the biggest share of the total contribution to economic growth. The number of workers grew at 3.2% per annum during the first three decades, and it explained 74.6% of the growth of total labor input. Rapid growth of education level was the second most important component of labor input. Its AAGR was 1.0% during the entire period, explaining 34.2% of the growth of total labor input.

Weekly working hours also increased in the first two decades, with the AAGR of 0.8%, which was an important component of the increasing man-hours. However, working hours kept decreasing thereafter for various reasons, e.g., increasing value of leisure. The AAGR of working hours was -0.3% in the whole period. We considered the efficiency of labor as a function of weekly working hours, and explicitly included the indicator by estimating the distribution of weekly working hours of workers. We showed that while the negative relationship between working hours and efficiency of labor is likely, both indicators can increase or decrease simultaneously.

We obtained the constant GDP and capital stock data of Korea and analyzed the sources of economic growth for 1973-2023. The AAGR of GDP during this period was 6.2%, of which the contributions of labor, capital and TFP were 1.6%, 2.8% and 1.8%, respectively. We also analyzed the sources of economic growth for five decades and showed that the contributions of labor, capital and TFP have decreased, of which the decrease was fastest for labor and slowest for TFP.

Finally, it would be useful to mention, if briefly, the future of the contribution of the growth of labor input to economic growth by studying the future of individual components. First, we showed that the number of workers can be expressed as the product of three components: (i) the size of working-age population, (ii) labor force participation rate (LFPR), and (iii) employment ratio (ER).

Population Projections, the official forecast of Korean population by the statistics authority, forecasts that Korea's working age population will begin decreasing in the 2030s, even according to the 'high scenario.' This implies that the contribution of the growth of the working-age population will disappear in about a decade and will begin to have negative contribution. Second, the employment to labor force rate has already stayed at a saturated level, at about 97%. A significant rise is not likely, and even in that case, its effect on the growth of total labor input could be negligible. On the other hand, a significant rise in LFPR is possible. The LFPR of male workers has declined for various reasons, and could be improved by favorable changes in economic environments combined with proper labor-market policies. Above all, there could be much room for improving the LFPR of female workers. Although the LFPR of female workers has consistently risen, it is still at a low level compared to that of male workers as well as those of foreign countries.

It is not easy to expect sizeable increases in the other three indicators. (i) While it is true that the average schooling years of Korean workers have arrived at high levels, they are still lower than in some developed countries even though the increases would not be significant. (ii) It is likely that weekly working hours will keep decreasing. It has already entered a decreasing trend in 1980s. However, the average weekly working hours is already shorter than 40 hours, and the decrease is expected to slow down shortly and the negative contribution to economic growth will also slow down. (iii) On the other hand, it is expected that the efficiency of labor would improve as working hours decrease.

Appendix. Health Condition as an Indicator of Human Capital

Health condition is also an important component of human capital. The contribution of improved nutrition and health conditions to economic growth was highlighted in the work by Fogel (1997). He showed that during the period 1780-1980, the contribution of improved nutrition to the economic growth of the United Kingdom was "at least 20% … and … could be as high as 30%."[17]

There are two barriers to evaluating the contribution of improved health to economic growth rigorously; theoretical difficulty in incorporating health condition into the production function and insufficient data availability. Many indicators have been proposed as proxies of health condition. For instance, life expectancy, per capita calory intake, per capita preventive medical expenditure, etc. would obviously affect health conditions.

However, it is not easy to specify the dependence of marginal productivity of labor on such indicators. While, for example, Korea's Life Tables provide the life expectancy at each age from 0 to 100, it is not clear which age should be considered to properly reflect the health condition of workers.[18] On the other hand, per capita calorie intake and preventive medical expenditure are flow variables and can be interpreted as 'investment' while health condition is a stock variable. These are a few questions which weaken the validity of the above-mentioned variables as the indicators of workers' health condition.

Also, we could try to estimate the Mincerian wage equation using micro data. However, not only the availability of the micro data of those variables but also the statistical significance of the estimated coefficients would be insufficient. Furthermore, the data of the above variables are not available for the entire period 1963-2023. In Korea, the life expectancy data are available for 1970-2022. World Bank's DataBank provides the international data of the aggregate current health expenditure (as % of GDP), per-capita health expenditure (in current US dollar), and per-capita health expenditure (in International dollar) for 2000-2023, and the life expectancy at age 0 for 1960-2022.

For these reasons, this paper considered only the human capital index derived from the workers' schooling years as the indicator of human capital. Considering that the health condition of Koreans workers has improved dramatically, the estimated contribution of labor input to Korea's economic growth would be significantly underestimated if the improvement of health condition is not included in the estimation.

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[17] Fogel (1997) p.470.

[18] A few candidates would be 0, 15, 20 and 40. (i) The life expectancy at age 0 would reflect the health condition of the general population. (ii) Persons aged 15 or older are the working-age population, thus we could say that the life expectancy at age 15 reflects the health condition of the working-age population. (iii) The workers aged 15-19, however, occupies only a small portion, and the life expectancy at age 20 could be a better indicator. (iv) The middle age of the interval 15-64 is about 40, and the life expectancy at age 40 would be another candidate.

References

Cho, Taehyung, Soobin Hwang, and Paul Schreyer, OECD Statistics Working Papers 2017/01, OECD, 2017.

Denison, F. Edward, *Accounting for the United States Economic Growth 1929-1969*, Washington, D.C.: The Brookings Institution, 1974.

Denison, F. Edward, William K. Chung, *How Japan's Economy Grew So Fast*, Washington, D.C.: The Brookings Institution, 1976.

Fogel, W. Robert, "New Findings on Secular Trends in Nutrition and Mortality: Some Implications for Population Theory," in Mark R. Rosenweig and Oded Stark (eds.), *Handbook of Population and Family Economics*, Vol. 1A. Amsterdam: North Holland, 1997.

Hahn, Chinhee, Kyungsoo Choi, Dongseok Kim, and Kyungmook Lim, *Forecast of Korea's Potential Growth Rate: 2003~2012*, KDI Policy Study 2002-07, Korea Development Institute Press, 2002 (in Korean).

Hall, Robert, and Charles Jones, "Why Do Some Countries Produce So Much More Output per Worker than Others?" *Quarterly Journal of Economics* 114 (February): 83.116, 1999.

Kang Dooyong, and Sungkeun Park, *Long-term Slowdown of Korean Economy and Its Causes*, Korea Institute for Industrial Economics and Trade Press, 2022 (in Korean).

Kim, Dongseok, "Changes in the Weekly Working Hours and the Efficiency of Labor, 1963~2003," *KDI Journal of Economic Policy*, Vol. 26, No. 2, pp.143~178, 2004 (in Korean).

Kim, Dongseok, Minsoo Kim, Youngjoon Kim and Seungju Kim, *Accounting for Economic Growth in Korea: 1970~2010*, KDI Research Monograph 2012-08, Korea Development Institute Press, 2012 (in Korean).

KIM, Dongseok, Jinmyeon Lee and Minsoo Kim, *Accounting for Economic Growth in Korea: 1963~2000*, KDI Research Monograph 2002-06, Korea Development Institute Press, 2002 (in Korean).

Kim, Minsub, “OECD Average Annual Hours Worked: Comparative Analysis and Implications,” KDI Focus, 2003 Vol. 128, Korea Development Institute Press, 2023 (in Korean).

Kim, Kwang-Suk and Sung Duk Hong, *Accounting for Rapid Economic Growth in Korea, 1963-1985*, Korea Development Institute Press, 1997.

Kim, Kwang-Suk, and Joon-Kyung Park, *Sources of Rapid Economic Growth in Korea*, Korea Development Institute Press, 1979 (in Korean).

Park Yoonsoo, and Wooram Park, Effect of Reduced Working Hours on Labor Productivity, KDI Policy Forum 2017-03, Korea Development Institute Press, 2017 (in Korean).

Psacharopoulos, George, “Returns to Investment in Education: A Global Update,” *World Development*, XXII, 1325-1343, 1994.

Weil, N. David, Economic Growth, Third Edition, Pearson, 2013.

Statistics

Bank of Korea, Input-Output Tables, http://ecos.bok.or.kr/.
________, National Account Statistics, http://ecos.bok.or.kr/.
________, National Balance Sheet Account, http://ecos.bok.or.kr/.

Statistics Korea, Economically Active Population Survey, https://kosis.kr/.
________, Life Tables by Province, https://kosis.kr/.
________, Population Census, https://kosis.kr/.
________, Population Projections, https://kosis.kr/.

World Bank, Education Statistics, https://databank.worldbank.org/.

________, Health Nutrition and Population Statistics, https://databank.worldbank.org/.

Population, Ages 15 or Older	Economically Active	Employed Persons
		Unemployed Persons
	Economically Inactive	

Figure 1. Categorization of Population Aged 15 or older by EAPS

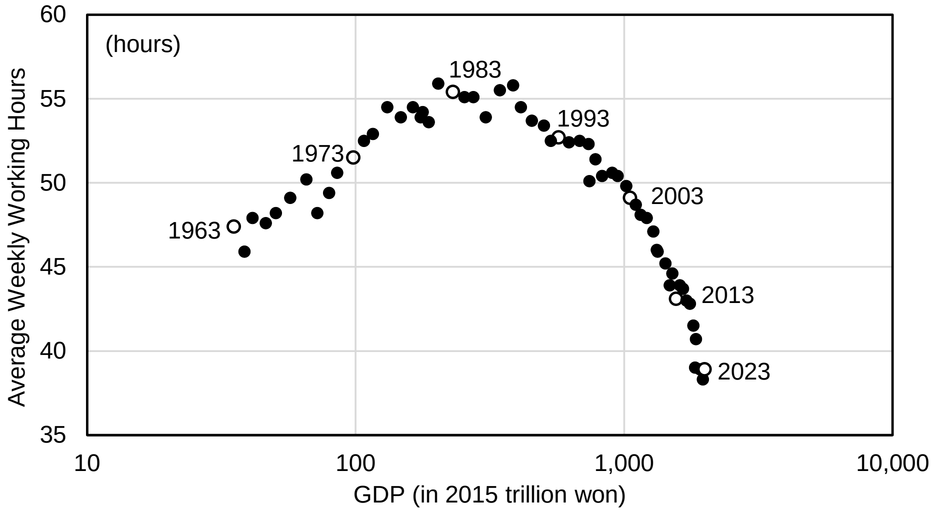

Figure 2. Average Weekly Working Hours and Real GDP of Korea

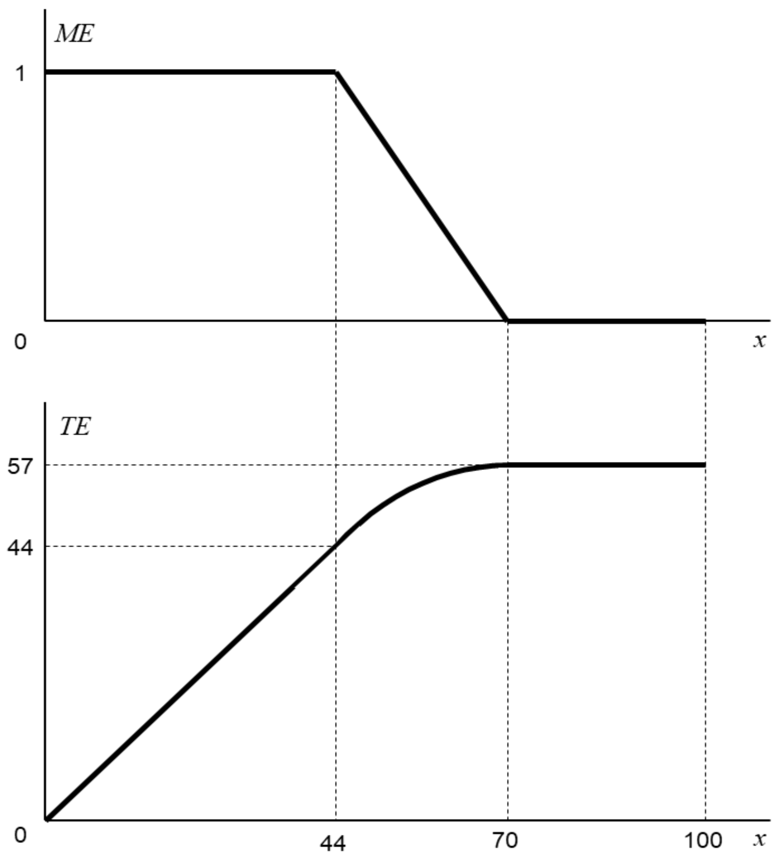

Figure 3. Marginal Efficiency and Total Efficiency of Weekly Working Hours

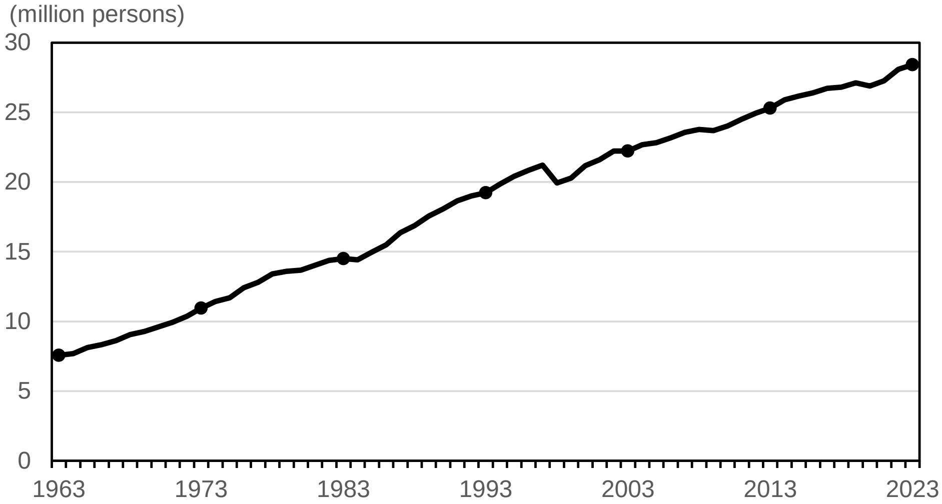

Figure 4. Total Number of Workers in Korea

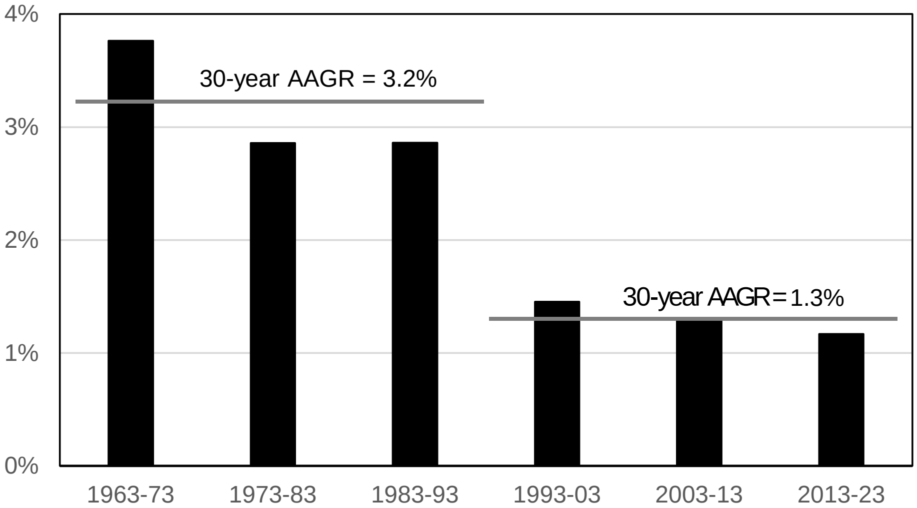

Figure 5. Decadal AAGR of Total Number of Workers in Korea

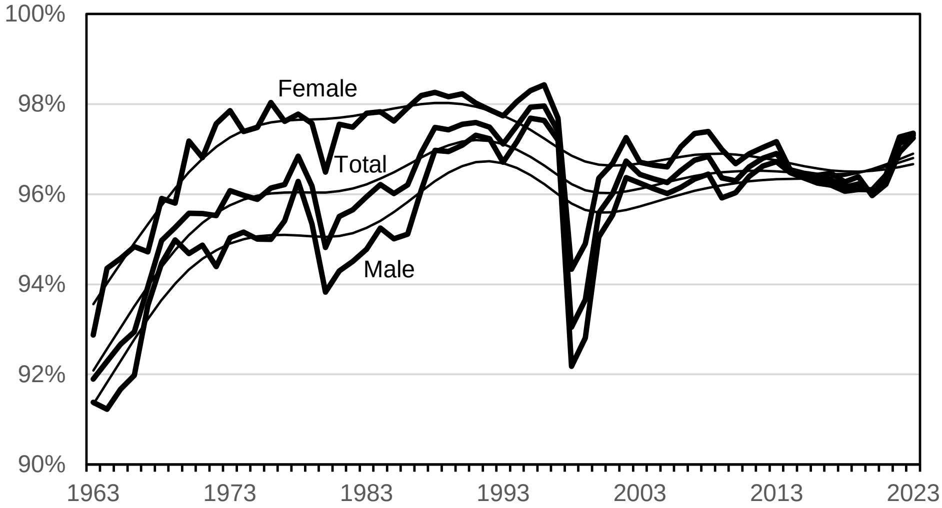

Figure 6. Employment to Labor Force Ratios by Gender

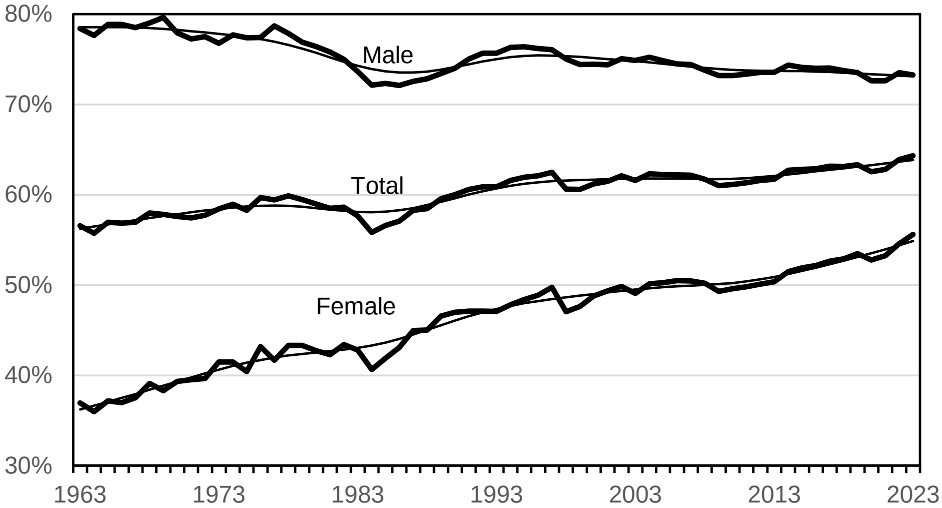

Figure 7. Labor Force Participation Rates by Gender

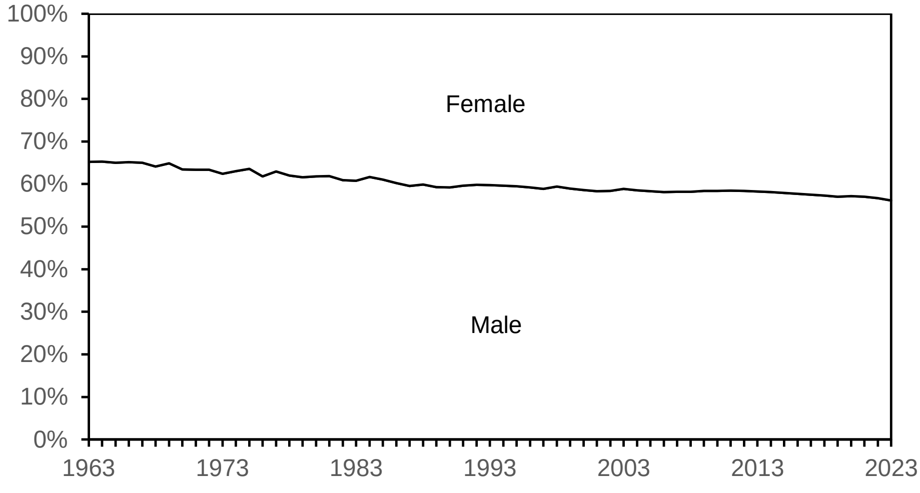

Figure 8. Composition of all Workers by Gender

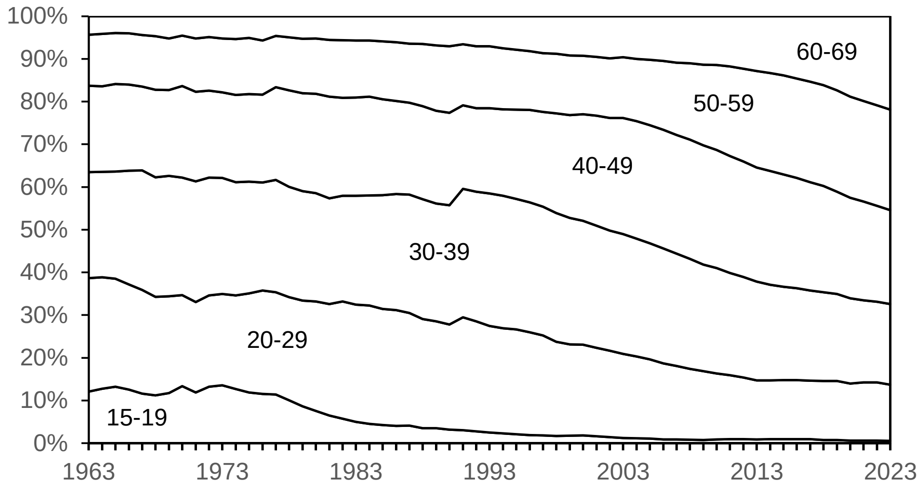

Figure 9. Composition of all Workers by Age Groups (All Workers)

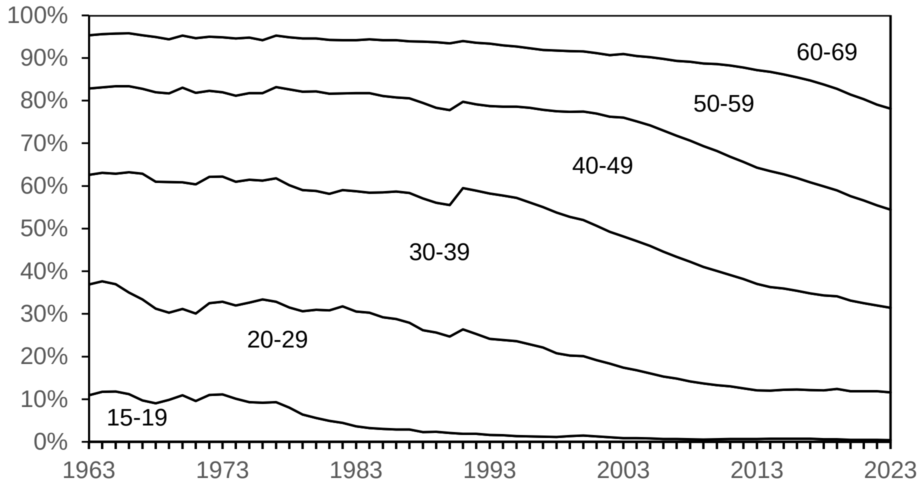

Figure 10. Composition of all Workers by Age Groups (Male Workers)

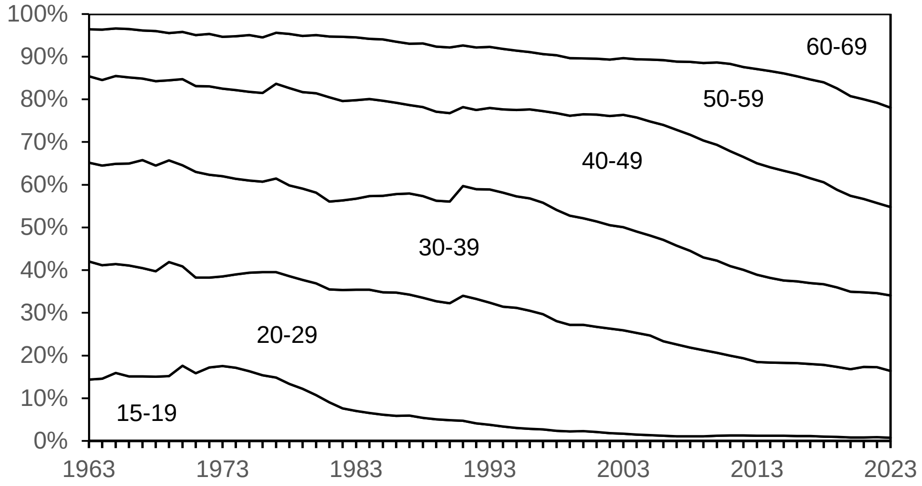

Figure 11. Composition of all Workers by Age Groups (Female Workers)

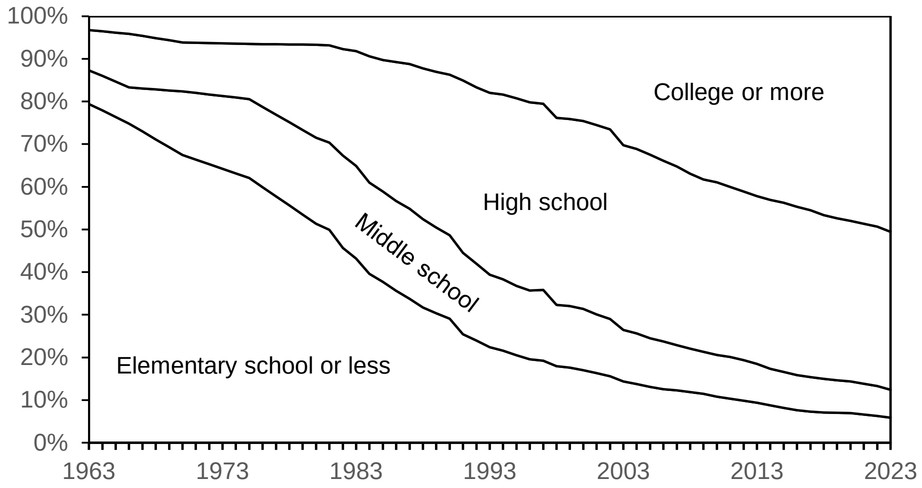

Figure 12. Composition of Workers by Education Level (All Workers)

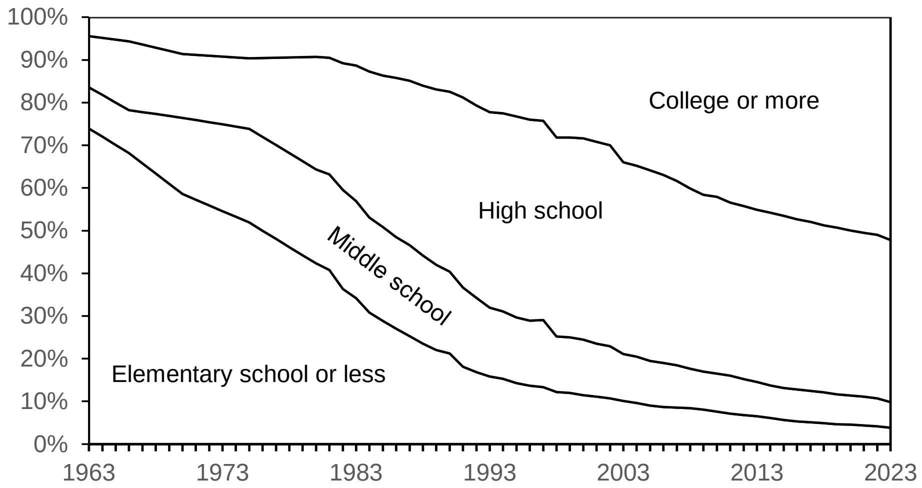

Figure 13. Composition of Workers by Education Level (Male Workers)

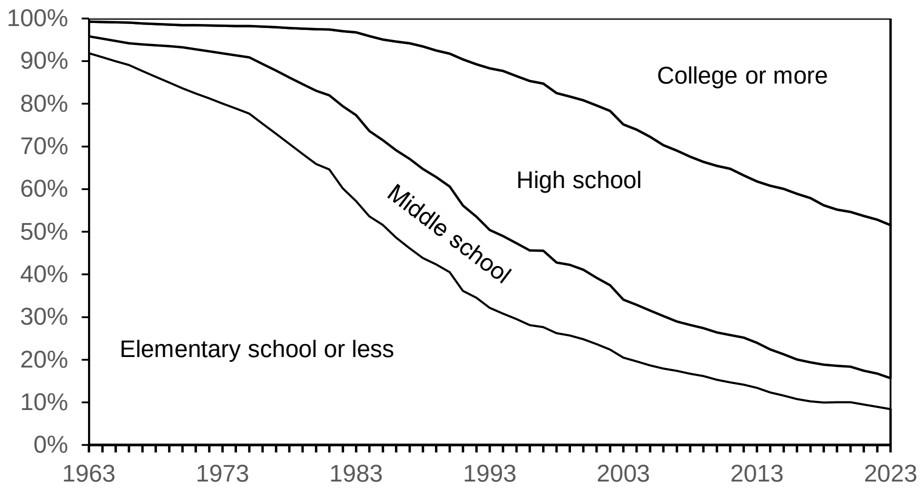

Figure 14. Composition of Workers by Education Level (Female Workers)

<table>
<tr><td rowspan="5">All Workers</td><td rowspan="3">Wage & Salary Workers</td><td>Regular Employees</td></tr>
<tr><td>Temporary Employees</td></tr>
<tr><td>Daily Workers</td></tr>
<tr><td rowspan="2">Self-Employed Workers</td><td>Independent Businessmen</td></tr>
<tr><td>Unpaid Family Workers</td></tr>
</table>

Figure 15. Classification of Workers by Status

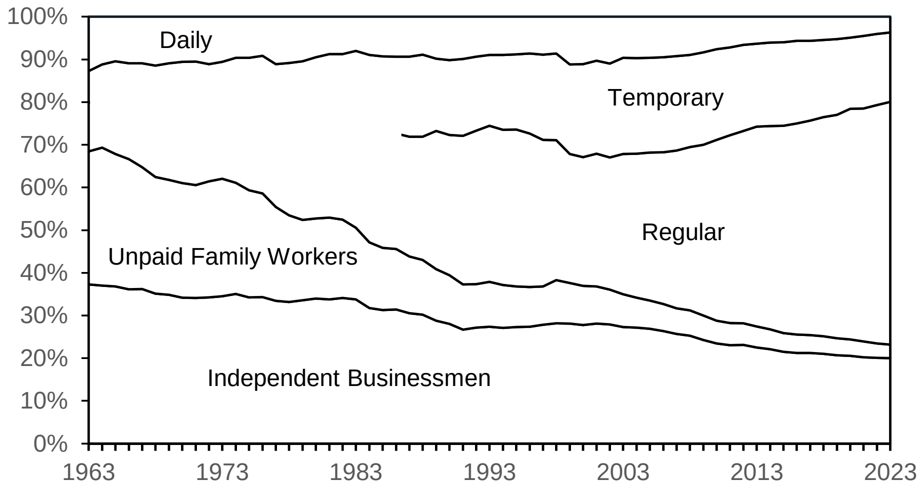

Figure 16. Composition of Workers by Employment Status (All Workers)

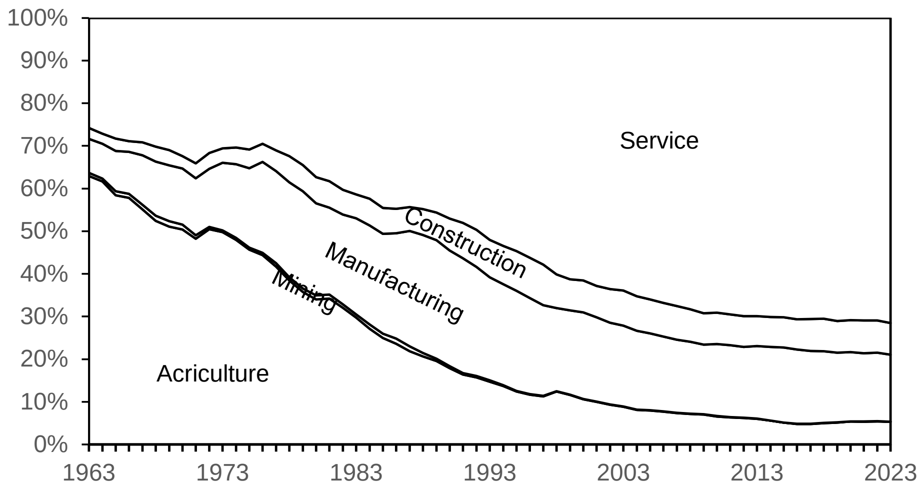

Figure 17. Composition of Workers by Industry (All Workers)

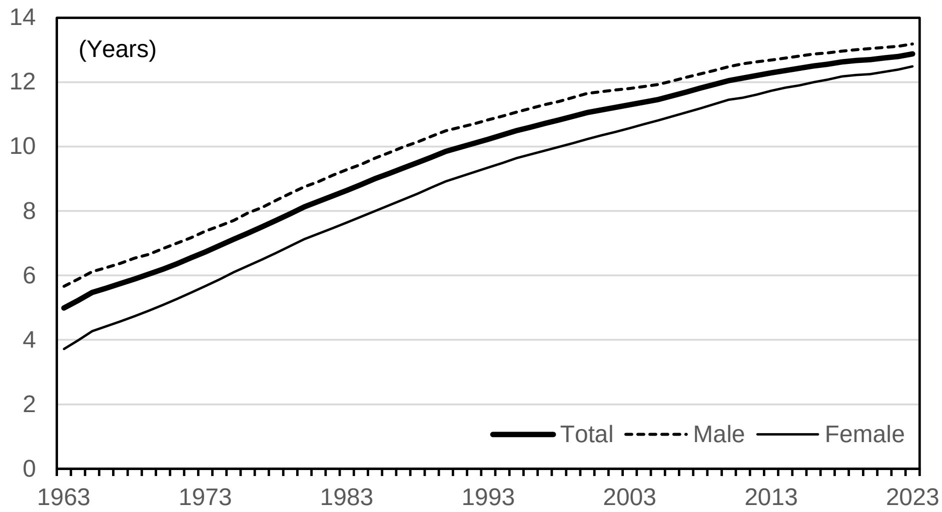

Figure 18. Average Schooling Years by Gender

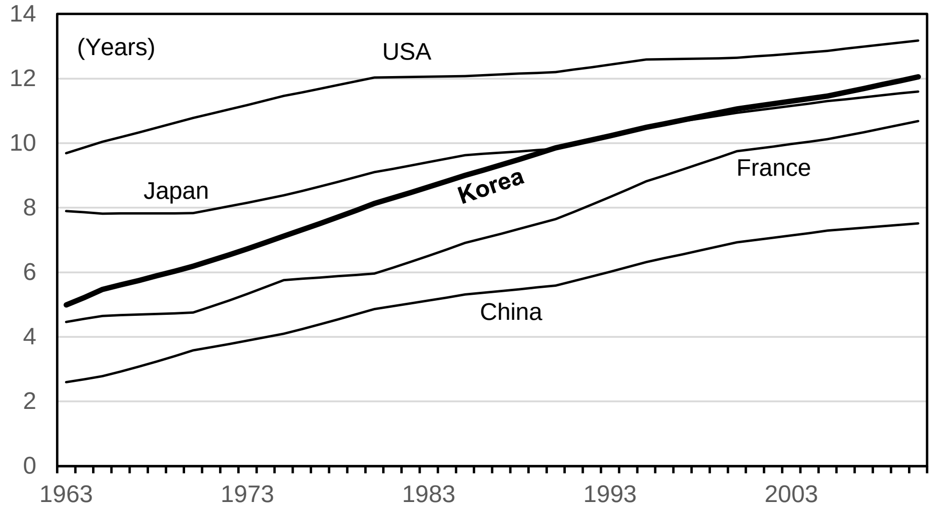

Figure 19. Average Schooling Years in Five Selected Countries during 1963-2010

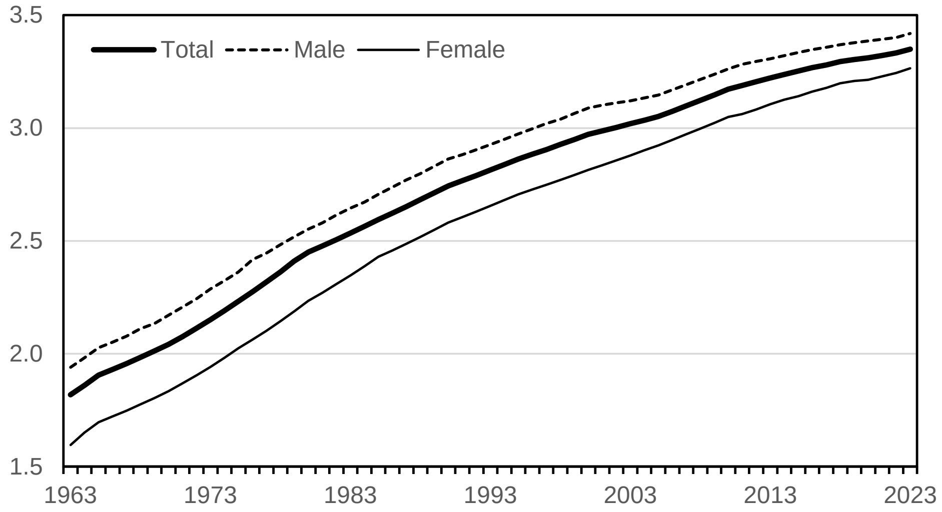

Figure 20. Human Capital Index by Gender

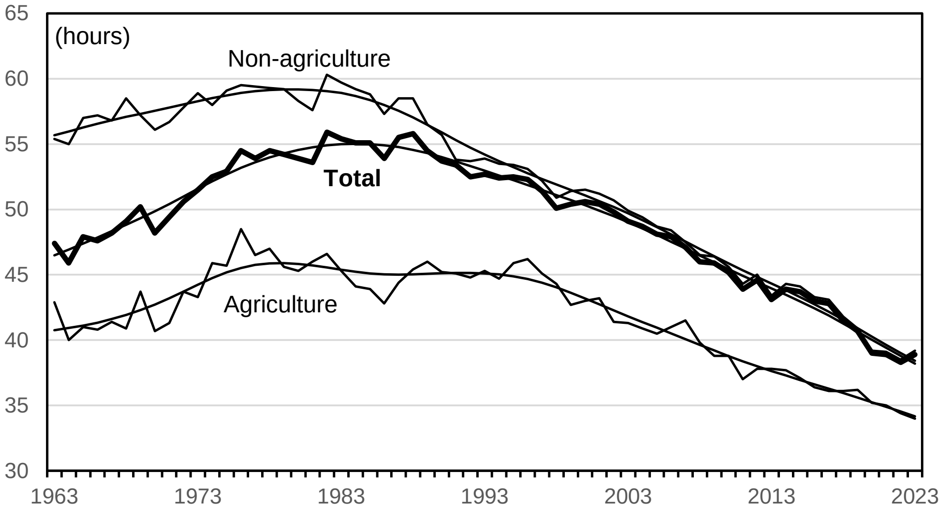

Figure 21. Weekly Working Hours

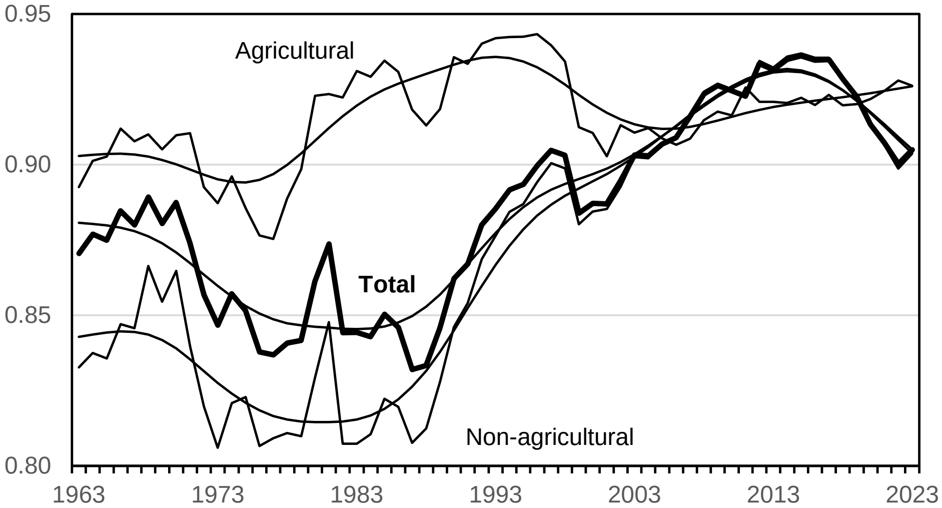

Figure 22. Estimated Efficiency Index

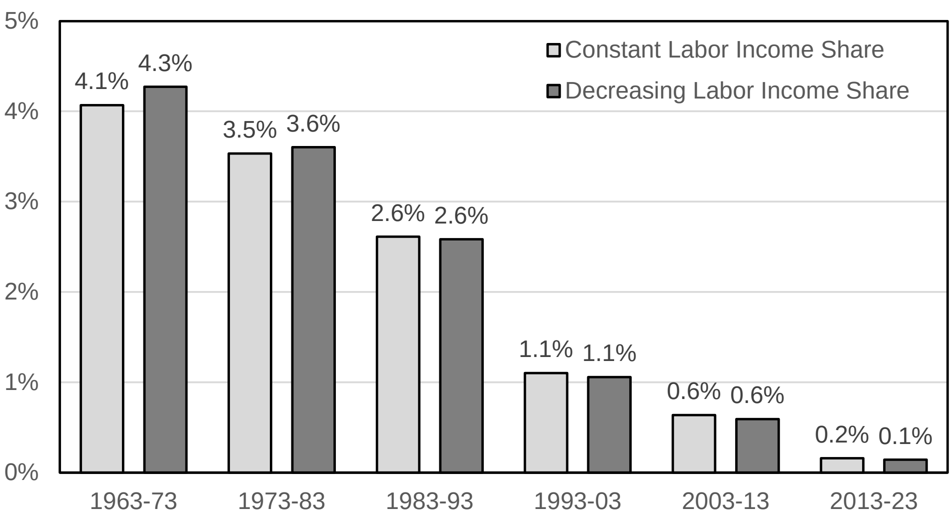

Figure 23. Contribution of Labor Input to Economic Growth

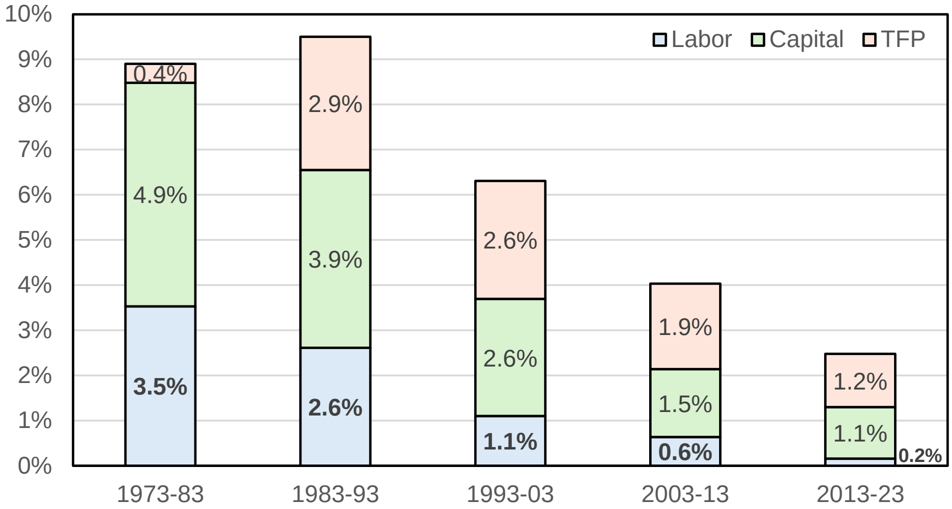

Figure 24. Sources of Economic Growth in Korea

Table 1. AAGR of Total Number of Workers and Working-Age Population

		All Workers	Male Workers	Female Workers
AAGR of Total Number of Workers (%)				
Entire Period	1963-2023	2.2	2.0	2.6
Three decades	1963-1993	3.2	2.9	3.7
	1993-2023	1.3	1.1	1.6
Decades	1963-1973	3.8	3.3	4.6
	1973-1983	2.9	2.6	3.3
	1983-1993	2.9	2.7	3.1
	1993-2003	1.5	1.3	1.7
	2003-2013	1.3	1.2	1.5
	2013-2023	1.2	0.8	1.7
AAGR of Population Aged 15 or Older (%)				
Entire Period	1963-2023	1.9	2.0	1.9
Three decades	1963-1993	2.7	2.8	2.7
	1993-2023	1.1	1.2	1.1
Decades	1963-1973	3.0	3.1	2.8
	1973-1983	3.0	3.0	3.0
	1983-1993	2.2	2.2	2.2
	1993-2003	1.4	1.5	1.4
	2003-2013	1.2	1.3	1.1
	2013-2023	0.7	0.8	0.7

Table 2. AAGR of Human Capital Index (%)

		All Workers	Male Workers	Female Workers
Entire Period	1963-2023	1.1	0.9	1.2
Three decades	1963-1993	1.5	1.4	1.7
	1993-2023	0.6	0.5	0.7
Decades	1963-1973	1.7	1.7	2.0
	1973-1983	1.7	1.5	1.9
	1983-1993	1.1	1.0	1.2
	1993-2003	0.7	0.6	0.8
	2003-2013	0.7	0.6	0.8
	2013-2023	0.4	0.3	0.5

Table 3. Numbers of Workers by Weekly Working Hours in Selected Years

	1~17	18~26	27~35	36~44	45~53	54~
Agricultural Sector (thousand persons)						
1963	535	703	409	435	930	1,823
1973	360	489	589	1,291	1,049	1,785
1983	41	319	529	1,344	923	1,156
1993	30	171	216	902	609	662
2003	127	252	172	581	344	460
2013	158	219	145	464	238	271
2023	189	291	202	451	203	162
Non-agricultural Sector (thousand persons)						
1963	132	169	113	123	620	1,666
1973	65	126	202	730	989	3,432
1983	39	126	257	1,124	1,920	6,687
1993	210	297	314	2,330	4,718	8,640
2003	521	603	741	4,364	5,706	7,982
2013	1,011	1,102	2,096	8,266	5,730	5,186
2023	2,080	1,651	2,383	12,466	5,096	2,818

Table 4. Estimation Results of Distribution Parameters in Selected Years

	Agricultural Sector				Non-agricultural Sector			
	$\hat{\mu}$	$\hat{\sigma}$	SE($\hat{\mu}$)	SE($\hat{\sigma}$)	$\hat{\mu}$	$\hat{\sigma}$	SE($\hat{\mu}$)	SE($\hat{\sigma}$)
1963	4.0680	0.3695	2.31E-04	2.99E-04	3.8476	0.3369	2.76E-04	3.40E-04
1973	3.9986	0.3142	1.52E-04	1.72E-04	3.7504	0.3032	1.90E-04	1.93E-04
1983	3.9944	0.2220	1.14E-04	1.05E-04	3.7333	0.2636	1.32E-04	1.24E-04
1993	3.9902	0.2085	1.38E-04	1.23E-04	3.8224	0.2312	7.24E-05	6.88E-05
2003	4.0531	0.2786	2.25E-04	2.30E-04	3.8971	0.2395	6.11E-05	5.85E-05
2013	4.1141	0.2838	2.80E-04	2.76E-04	4.0110	0.2165	4.75E-05	4.23E-05
2023	4.1785	0.2569	2.62E-04	2.38E-04	4.0859	0.1955	3.99E-05	3.33E-05

Table 5. Estimation Results of Efficiency Indices in Selected Years

	Agricultural Sector			Non-agricultural Sector			Efficiency Index		
	Actual	Estimated	Effective	Actual	Estimated	Effective	Agri	Non-agri	Total
1963	42.9	41.9	37.4	55.4	51.2	42.6	0.893	0.833	0.871
1973	43.3	44.3	39.3	58.9	55.6	44.8	0.887	0.806	0.847
1983	45.3	44.5	41.4	59.7	56.7	45.8	0.931	0.807	0.844
1993	45.3	44.8	42.2	53.9	53.1	46.5	0.942	0.876	0.885
2003	41.3	41.4	37.7	49.9	49.4	44.6	0.911	0.902	0.903
2013	37.8	38.4	35.4	43.4	43.6	40.7	0.921	0.932	0.932
2023	34.0	34.8	32.2	39.2	39.5	35.7	0.926	0.904	0.905

Table 6. AAGR of Weekly Working Hours and Efficiency of Labor (%)

		Weekly Working Hours			Efficiency of labor		
		Agri	Non-agri	Total	Agri	Non-agri	Total
Entire Period	1963-2023	-0.4	-0.6	-0.3	0.1	0.1	0.1
Decades	1963-1973	0.1	0.6	0.8	-0.1	-0.3	-0.3
	1973-1983	0.5	0.1	0.7	0.5	0.0	0.0
	1983-1993	0.0	-1.0	-0.5	0.1	0.8	0.5
	1993-2003	-0.9	-0.8	-0.7	-0.3	0.3	0.2
	2003-2013	-0.9	-1.4	-1.3	0.1	0.3	0.3
	2013-2023	-1.1	-1.0	-1.0	0.1	-0.3	-0.3

Table 7. AAGRs of GDP and Labor Input Components

	GDP	L_1	L_2	L_3	L_4	L_T
1963-2023	7.0%	2.2%	1.0%	-0.3%	0.1%	3.0%
1963-1993	9.7%	3.2%	1.5%	0.4%	0.1%	5.1%
1993-2023	4.3%	1.3%	0.6%	-1.0%	0.1%	0.9%
1963-1973	10.8%	3.8%	1.7%	0.8%	-0.3%	6.1%
1973-1983	8.9%	2.9%	1.7%	0.7%	0.0%	5.3%
1983-1993	9.5%	2.9%	1.1%	-0.5%	0.5%	3.9%
1993-2003	6.3%	1.5%	0.7%	-0.7%	0.2%	1.7%
2003-2013	4.0%	1.3%	0.7%	-1.3%	0.3%	1.0%
2013-2023	2.5%	1.2%	0.4%	-1.0%	-0.3%	0.2%

Note: L_1 = number of employees, L_2 = human capital, L_3 = weekly working hours, L_4 = efficiency of labor, L_T = total labor input.

Table 8. Growth Accounting: Constant Labor Income Share

	$1-\alpha$ (1)	Y (2)	L_1 (3)	L_2 (4)	L_3 (5)	L_4 (6)	L (7)	K (8)	TFP (9)
In terms of growth rate									
1963-2023	66.7%	7.0%	1.5%	0.7%	-0.2%	0.0%	2.0%		
1973-2023	66.7%	6.2%	1.3%	0.6%	-0.4%	0.1%	1.6%	2.8%	1.8%
1963-73	66.7%	10.8%	2.5%	1.1%	0.6%	-0.2%	4.1%		
1973-83	66.7%	8.9%	1.9%	1.1%	0.5%	0.0%	3.5%	4.9%	0.4%
1983-93	66.7%	9.5%	1.9%	0.7%	-0.3%	0.3%	2.6%	3.9%	2.9%
1993-03	66.7%	6.3%	1.0%	0.5%	-0.5%	0.1%	1.1%	2.6%	2.6%
2003-13	66.7%	4.0%	0.9%	0.4%	-0.9%	0.2%	0.6%	1.5%	1.9%
2013-23	66.7%	2.5%	0.8%	0.3%	-0.7%	-0.2%	0.2%	1.1%	1.2%
In terms of share									
1963-2023	66.7%	100.0%	21.4%	9.8%	-3.1%	0.6%	28.8%		
1973-2023	66.7%	100.0%	20.7%	9.6%	-6.0%	1.4%	25.7%	45.0%	29.3%
1963-73	66.7%	100.0%	23.2%	10.5%	5.1%	-1.7%	37.7%		
1973-83	66.7%	100.0%	21.4%	12.4%	5.5%	-0.2%	39.7%	55.6%	4.8%
1983-93	66.7%	100.0%	20.1%	7.4%	-3.5%	3.3%	27.5%	41.5%	31.0%
1993-03	66.7%	100.0%	15.4%	7.5%	-7.5%	2.1%	17.5%	41.1%	41.5%
2003-13	66.7%	100.0%	21.6%	10.8%	-21.4%	5.1%	15.8%	37.2%	46.9%
2013-23	66.7%	100.0%	31.5%	10.6%	-27.5%	-7.8%	6.4%	46.0%	47.6%

Table 9. Growth Accounting: Decreasing Labor Income Share

	$1-\alpha$ (1)	Y (2)	L_1 (3)	L_2 (4)	L_3 (5)	L_4 (6)	L (7)	K (8)	TFP (9)
In terms of growth rate									
1963-73	70%	10.8%	2.6%	1.2%	0.6%	-0.2%	4.3%		
1973-83	68%	8.9%	1.9%	1.1%	0.5%	0.0%	3.6%	4.8%	0.6%
1983-93	66%	9.5%	1.9%	0.7%	-0.3%	0.3%	2.6%	4.0%	2.9%
1993-03	64%	6.3%	0.9%	0.5%	-0.5%	0.1%	1.1%	2.8%	2.5%
2003-13	62%	4.0%	0.8%	0.4%	-0.8%	0.2%	0.6%	1.7%	1.7%
2013-23	60%	2.5%	0.7%	0.2%	-0.6%	-0.2%	0.1%	1.4%	1.0%
In terms of share									
1963-73	70%	100.0%	24.4%	11.0%	5.4%	-1.8%	39.6%		
1973-83	68%	100.0%	21.8%	12.6%	5.6%	-0.2%	40.5%	53.4%	6.2%
1983-93	66%	100.0%	19.9%	7.3%	-3.5%	3.3%	27.2%	42.3%	30.5%
1993-03	64%	100.0%	14.8%	7.2%	-7.2%	2.0%	16.8%	44.4%	38.9%
2003-13	62%	100.0%	20.1%	10.0%	-19.9%	4.8%	14.7%	42.5%	42.8%
2013-23	60%	100.0%	28.3%	9.5%	-24.7%	-7.0%	5.8%	55.1%	39.1%