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The Change in Quality of the Labor Force and Its Effect on the Economic Growth of Korea

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Ⅰ. Introdution

It is common knowledge that the development of human resources is critical in the struggle for economic development. In particular, its abundant, high quality labor force has been cited as fundamental to Korea's sustained economic growth. The objective of this study is to investigate the relationship between the productivity of the labor force and its educational attainment and experience. Determining the connection between this educational attainment and productivity seems to be very important to establish both long-term development policy and manpower policy. Examining the relationship between the change in the labor force quality due to improved educational achievement and changing age structure and the growth of the economy at the macroeconomic level is an additional objective of the study.

There are many facets to Korea's remarkable economic progress during the past 17 years(1963-1979) that are of considerable interest to the student of development, but none more interesting than the country's success in reducing its population growth rate in attaining a high educational level and expanded stock of skills, and in absorbing labor into productive employment. For such a densely populated country with very limited natural resources, there can be little doubt that Korea's achievement in these respects has contributed very greatly to its rapid, and relatively egalitarian, economic growth.

With a gross national product growth rate of 7.7 percent a year for the period 1954-1979, Korea has established a record matched in that period by only a few countries. The annual per capita income growth rate between 1954 and 1979, 5.2 percent, was equalled or surpassed by only a few countries such as Iran, Japan, Libya, Singapore, and Rumania. Among the Third World nonpetroleum exporting countries, only Singapore has a growth record to match Korea's.

At this point we might ask the following questions. First, as we mentioned earlier if the Korean economic growth rate was rapid compared with that of other developing countries, were Korea's accumulation and allocation patterns, distinctly different from those in a typical developing country's economy? Secend, what factors were the main contributors to this successful economic growth? A number of alternative explanations have been offered to explain why Korea could achieve such rapid economic growth. Many researchers have argued that it

was the existence of an abundance of relatively well educated workers that enabled Korea to develop its economy very rapidly. Some observers have indicated that it was the choice of technology for exports that allowed Korea to grow so rapidly. Others have emphasized the massive capital aid and technical assistance that Korea received from more developed countries (MDCs). Other explanations have focused on foreign trade, exchange rate and monetary policy ; on political organization ; and on the uniqueness of the Korean people's character. Among all these possible reasons, this study will focus on the contribution of human resources to Korean development. Korean emphasis on education is clearly demonstrated by the substantial amount of public and private resources devoted to education and by the remarkable improvement in the educational attainments of the labor force and the population. if we take a look at the statistics on educational achievement we see that Korea has an exceptionally high rate of enrollment at almost all levels of education compared with other countries with similar national per capita income. Since 1950 the increase in enrollment at all levels has been dramatic. Primary schools expanded rapidly, and secondary and higher education were also built up. The six years of primary education were made compulsory in 1949, and essentially, full enrollment at the primary level was achieved by the early 1960s. In the 1960s the increase in three-year middle schools was particularly fast, and in the late 1960s and early 1970s vocations at institutions of higher learning also showed a steadily increasing trend.

How was Korea able to increase these enrollment rates and thus educational attainment of the general public and the labor force so rapidly? Among the factors often mentioned as having been important in this improvement are : 1) the unusually high social demand for education in Korea compared with other developing nations, 2) the maintenance of a relatively low unit cost of education, and 3) the role of the private financing of education.

The first factor, the unusually high social demand for education is explained by the centuries old tradition of respect for the educated man and by the recognition that social and economic positions in modren Korea are for most persons closely linked with educational attinment.

The second factor often mentioned is the maintenance of educational unit costs at a relatively low level in comparison with other countries with similar per capita incomes.

The third factor is the importance of the private financing of education. The willingness of households to pay high fees reflects Korean culture' s traditional respect for education and appreciation of the fact that private rates of return from education have until recently been high.

The result of extensive improvement in educational attainment in Korea, as elsewhere, is likely to be that the formal qualifications for all jobs will increase steadily and the opportunity cost of remaining in school will fall correspondingly. Therefore, students reaching their previously specified educational target may find their job expectations unfulfilled, and, as a result, may choose to continue their educations even longer. This phenomenon explains the growing number of unsuccessful college applicants who stay out of the regular labor market and reapply for admission the following year. This situation has elicited considerable concern on the part of government authorities as well as individual households. One policy response has been the government's move to increase the student acceptance quota dramatically as indicated in Note.[1]

The study is composed of four parts : 1) re-

1. In Korea, the student acceptance quota (total number of enrollments) in colleges or universities is allocated by the central government (Ministry of Education) on the basis of educational facilities, number of professors etc. In 1980, to relieve the problem of too much competition in the entrance examination for colleges and universities, and to prevent the waste of money spent by parents on hiring private tutors for their children, the government increased the student acceptance quota a drastic 30 percent. According to the new regulatons, teachers are strictly forbidden to work as private tutors outside school hours.

view of literature, 2) investigation of the relationship between the productivity of the lavbor force and schooling and experience, using cross-sectional data, 3) estimation of a production function, using aggregate time series data with special emphasis on the change in the quality of labor input due to improvements in educational achievement and experience, and 4) examination of the impact of the labor force's quality change on the growth of the economy by changing the level of effective labor input due to improved educational attainment and the changing age structure of the labor force over the next fifty years.

Ⅱ. Theoretical Background

Korea has adopted an outward looking development strategy in which well-educated human resources provide a comparative advantage in the international market and a growth stimulus in the domestic market. The importance of education has been emphasized since days of old. Education is often regarded as the single most important determinant of a person's economic and social success at the individual level. Furthermore the improvement in educational attainment of the labor force is often cited as one of the most influenctial contributing factors to economic growth at the national economic level.

1. Education and Economic Growth

There is ample evidence that educational investments are profitable both to the individual and to society. It would appear, therefore, that investment in education should foster economic growth. The question that needs to be answered is : How does investment in education affect economic growth? The answer to this question is needed if a policy prescription is to be formulated regarding the use of educational investment as an instrument for growth. The research work done in the past on this question is generally descriptive in nature. In what ways could education affect economic growth? Several answers to this question have been offered by a number of economists.

Here the discussion of education's contribution to national economic progress will focus on the following channels : 1) improving the quality of labor by improving skills, efficiency and discipline, 2) increasing labor mobility through increased information on finding jobs and on migration, promoting the division of labor through a rational allocation of the labor force, and increasing labor force participation by increasing wages, 3) increasing entrepreneurial ability to improve management and the allocation of factors of production, 4) increasing scientific and technical progress through invention, discovery, and the swift adaption of automation, and 5) making people more responsive to economic change, removing social and institutional barriers to econornic growth through building up modern or productive attitudes in the minds of the general public.

Let us examine the above points one by one.

(1) Education is said to improve the quality of the labor force through improved skills, efficiency and discipline, i.e., through the improvement of human capital. According to the human capital theory, education as possessed by workers, is treated as analogous to the accumulation of physical capital. Central to the theory is the assumption of a competitive labor market that rewards increments of production contributed by the more productive types of labor at the market value of those increments. Thus, the human capital theory asserts that more educated workers receive higher incomes because they are more productive, and that their higher productivity is recognized in a competitive market. The returns on education are known, and individuals, their families, and society as a whole forgo consumption to meet the direct and indirect costs of education, and are rewarded by higher earnings during the working life of the educated individual. Employers rely on educational credentials as important proofs that an in dividual possesses the skills and knowledge necessary for

economic production.

(2) Education increases labor mobility through increased information, promotion of the division of labor, and increased labor force participation. That is, education promotes adaptability to monetary changes, especially in jobs which require quick evaluation of new information and in general, fast reaction and increased capability to move to more productive occupations when opportunities arise. Thus, with more education, the rate of adjustment to geographical migration and in the division of labor is higher. Especially, the improved education of women results in increased wages, new job opportunities, and rising income aspirations, thus increasing women's participation in the labor force.

(3) Education increases the allocative efficiency in production. This capacity emphasizes the development of complementary resources for factors of production that are relatively plentiful and substitutes for comparatively scarce factors. For example, the use of natural resources is augmented by education as the latter provides meaningful talents that can then exploit resources more efficiently and effectively.

(4) Education increase scientific and technical progress and also aids in the increase and preservation of technical knowledge. Augmentation of this knowledge reduces dependence upon the natural resource base. By reducing the burden of diminishing returns and opening new markets, the increased knowledge helps maintain or raise the marginal efficiency of investment in material capital thereby encouraging its accumulation. In a modern economy with complex technology, large scale operations require innovative abilities, as well as flexibility, skills, and a large information network. Since education enhances innovative ability, it contributes to the maintenance of a large scale economy.

(5) Education helps build up productive attitudes. Individuals in a modernizing society need not only skills and knowledge, but also attitudes and values that dispose them to use their new abilities in ways that contribute to more rapid economic growth. Studies have shown an association in many countries between the level of education and modern attitudes. Schooling provides for better citizenship, the ability to appreciate a wider range of cultural and other services, and a chance to give the next generation a better education, and therefore a better future.

The second theory which is used to explain the existence of differences in earnings is credentialism or the screening theory. Spence(1973) and Stiglitz(1975) have argued that educational attainment or acquisition of training may not have a significant effect on productivity. They further argue that since persons selected for an educational program possess the kinds of attributes sought by employers, higher earnings are paid even if no productivity effect is discernible. Education thus becomes merely a selection or signaling device, and a correlation between education and earnings is no proof of the human capital theory. Although we cannot refute the theories presented by credentialism, the evidence in support of the conventional human capital theory is so overwhelming that we think it proper to adopt the theory for our theoretical background of the empirical analysis in Chapter 3.

2. Methodologies for Estimating the Contrbibution of Education of Economic Growth.

One of the earliest responses to the appearance of a large "residual" in the works of Kendrick (1961, 1973), Solow (1957), and others was the proposition that improvements in the quality of the labor force could provide some explanation. Studies investigating the contribution of education to economic growth at the macroeconomic level have employed various methodologies. They are 1) the productivity ratio approach, 2) the

factor shares or growth accounting approach, and 3) the aggregate production function approach. Education's contribution to economic growth can also be estimated at the microeconomic level using the direct earnings function and the rate of return on education approach. Here we will only mention the aggregate production function approach which we used for our empirical analysis in Chapter 4.

A production function expresses the relationship between the maximum output and input required to produce it, and the relationship between the inputs themselves. With the application of statistical techniques to the data on output and factor inputs, we can estimate the parameters of a particular form of producton function. Basically, this approach consists of estimating a production function that incorporates education among its explanatory variables.

The advantage of the aggregate production function approach is that it requires no direct information on the weights needed to combine the factor inputs. A major objection to the factor share or growth accounting approach is their inability to capture the contribution of externalities because these approaches are always subject to constant returns to scale. On the contrary, the existence of substantial economies of scale is captured by the aggregate production function analysis. Whereas the concept of the production functions serves only as an organizing device in other approaches, in this approach it is explictly applied to determine the role of education.

A representative approach consists of estimating an aggregate production function of the Cobb-Douglas type that introduces the education variable into the estimating equation. The functional form in a multiplicative form is as follows :

$$\begin{aligned} Y &= Ae^{\beta_1 t}K^{\beta_2}\ L^{*\beta_3}u \\ &= Ae^{\beta_1 t}K^{\beta_2}(L \cdot QIL)^{\beta_3}u \\ &= Ae^{\beta_1 t}K^{\beta_2}\beta_3 QIL^{\beta_3}u \quad \cdots\cdots (1) \end{aligned}$$

where Y : output
e : constant whose approximate value
t : time
K : capital input
L : labor input
QIL : quality index of the labor force
L^* : effective labor input($L^*=L \cdot QIL$)
β_1 : technical change index
β_2 : capital share or elasticity of output with respect to capital input
β_3 : labor share or elasticity of output with respect to labor input
u : disturbance term

Taking natural logarithms in equation (1) we can express the production function as follows :

$$\log Y = \log A + \beta_1 t + \beta_2 \log K + \beta_3 \log L^* + \log u \quad \cdots\cdots (2)$$

and if we differentiate equation (2) with respect to time :

$$\frac{\dot{Y}}{Y} = \beta_1 + \beta_2 \frac{\dot{K}}{K} + \beta_3 \frac{\dot{L}^*}{L^*} \quad \cdots\cdots (3)$$

3. Empirical Estimation of Education's Contribution to Economic Growth

The most complete analysis of the sources of economic growth and education's contribution to it has been made by Denison (1962, 1964, 1967, 1974). His analysis shows that education has been an important factor in national economic growth of the United States. During the period 1929-1969 education acounted for 21.7 percent of the GNP growth. A number of studies have appeared in recent years extending Denison's original study to other countries. One of these as conducted by Denison himself (1967), in which the contribution of education to economic growth was calculated for eight northwest European countries and Italy for the period 1950-1962. The role of education in past economic growth in

Europe appears to have been much more limited than in the United States. This may, of course, be due in part to the large amount of physical capital required in Europe following the Second World War. The results of a similar analysis for Latin America that was performed by Correa (1970) show that except for Argentina, Latin American countries appear to reflect an even lower contribution of education to economic growth than was shown by Denison for Europe.

Ⅲ. Productivity and the Change in the Labor Force's Quality

In this chapter, we will construct an index of the Korean labor force that includes changes in the quality of labor associated with changes in educational attainment and experience. This index depends on two factors : 1) changes in the educational attainment of workers, and 2) changes in the age distribution of workers over time. Before constructing the index, we will describe how educational attainment has changed. Second, we will examine changes in the age distribution of the labor force. Third, we will estimate the relationship between education and worker productivity, and last we will integrate the various parts and examine how the labor force measured in quality units has changed.

1. Basic Characteristics of the Labor Force

Official statistics on the labor force are available only for the period 1963-1979. Because there were no reliable statistical data on the labor force for the period 1955-1962, approximate calculations are made on the basis of existing complementary statistics which appear in various issues of the Statistical Yearbook of Korea (1961-1963) and census data (1955, 1960). Changes in the labor force are caused both by changes in population and by changes in labor force participation rates by sex, age, and education groups.

Table 3.1 Composition and Growth of Total Labor Force by Sex

(Unit:in thousand persons and percent)

Year	Labor Force			Composition		
	Male	Female	Total	Male	Female	Total
1955	3,792	2,257	6,049	62.7	37.3	100.0
1959	4,081	2,522	6,603	61.8	38.2	100.0
1960	3,973	2,445	6,418	61.9	38.1	100.0
1965	5,326	2,880	8,206	64.9	35.1	100.0
1969	6,091	3,323	9,414	64.7	35.3	100.0
1970	6,168	3,577	9,745	63.3	36.7	100.0
1975	7,489	4,341	11,830	63.3	36.7	100.0
1979	9,143	5,628	14,771	61.9	38.1	100.0
Growth Rate (1955~1979)	(3.7)	(3.9)	(3.8)			

Sources : Bureau of Statistics, Economic Planning Board.

a) Korea Statistical Year book 1961, pp. 223~231.

b) Korea Statistical Year book 1962, pp. 214~217.

c) Korea Statistical Year book 1963, pp. 220~221.

d) Korea Statistical Year book 1964, pp. 202~203.

e) Hand book of Korean Economy 1979, p. 347, pp. 352~353.

1) Sex

As can be seen in Table 3.1, the male labor force grew at an annual rate of 3.7 percent, while the female labor force recorded an annual growth rate of 3.9 percent during the period 1955-1979. Consequently, their total grew at 3.8 percent per annum during the period. As a result of the difference in growth by sex, the male labor force's share decreased slightly from 62.7 percent in 1955 to 61.9 percent in 1979, whereas the female labor force's increased form 37.3 percent to 38.1 percent.

2) Age Structure

Due to changes in population and labor force participation rates, the age structure of the labor force showed a drastic change during the period 1955-1979. As shown in Table 3.2, workers age 10 to 19 increased only 0.7 percent annually, whereas the other age groups showed rapid increases. That is, workers age 20 to 29 increased 3.4 percent per year, those 30 to 39 at 4.5 percent, and those 50 to 59 at 4.4 percent ; the biggest growth was registered for workers age 40 to 49 and 60 and over with annual rates of 5.0 percent and 5.3 percent, respectively.

As a result of the different growth rates for each age group, the share of each in the total labor force changed. The share of those 10 to 19 showed a continuously declining trend from 20.1 percent in 1955 to 9.8 percent in 1979. The share of those 20 to 29 marked a slight decline from 26.8 percent in 1955 to 24.5 percent in 1979, while all the other age groups recorded gradual

Table 3.2 Composition and Growth of Total Labor Force by Age Group

(Unit:in thousand persons and percent)

Year	Age Group 1 (10~19)	Age Group 2 (20~29)	Age Group 3 (30~39)	Age Group 4 (40~49)	Age Group 5 (50~59)	Age Group 6 (60 and over)	Total
1955	1,216 (20.1)	1,621 (26.8)	1,301 (21.5)	1,016 (16.8)	659 (10.9)	236 (3.9)	6,049 (100.0)
1959	779 (11.8)	1,789 (27.1)	1,327 (20.1)	1,407 (21.3)	951 (14.4)	350 (5.3)	6,603 (100.0)
1960	770 (12.0)	1,739 (27.1)	1,258 (19.6)	1,361 (21.2)	937 (14.6)	353 (5.5)	6,418 (100.0)
1965	1,169 (14.2)	2,051 (25.0)	2,032 (24.8)	1,664 (20.3)	969 (11.8)	321 (3.9)	8,206 (100.0)
1969	1,219 (12.9)	2,103 (22.3)	2,621 (27.9)	1,863 (19.8)	1,124 (11.9)	484 (5.2)	9,414 (100.0)
1970	1,415 (14.5)	2,051 (21.0)	2,645 (27.2)	2,063 (21.2)	1,133 (11.6)	438 (4.5)	9,745 (100.0)
1975	1,526 (12.9)	2,716 (22.9)	3,061 (25.9)	2,396 (20.2)	1,533 (13.0)	598 (5.1)	11,830 (100.0)
1979	1,453 (9.8)	3,625 (24.5)	3,704 (25.1)	3,306 (22.4)	1,870 (12.7)	813 (5.5)	14,771 (100.0)
Grwoth Rate (1955~1979)	(0.7)	(3.4)	(4.5)	(5.0)	(4.4)	(5.3)	(3.8)

Sources : a) Same as Table 3.1.

b) Bureau of Statistics, Economic Planning Board, 1960 Population and Housing Census of Korea 1963, pp. 44~47.

c) Bureau of Statistics, Ministry of Home Affairs, 1955 Population Census of Korea 1959, pp. 18~19.

Note : 1) Figures in parentheses give the percentage share of each age group.

increases. The share of those 40 to 49 showed the biggest increase, from 16.8 percent to 22.4 percent.

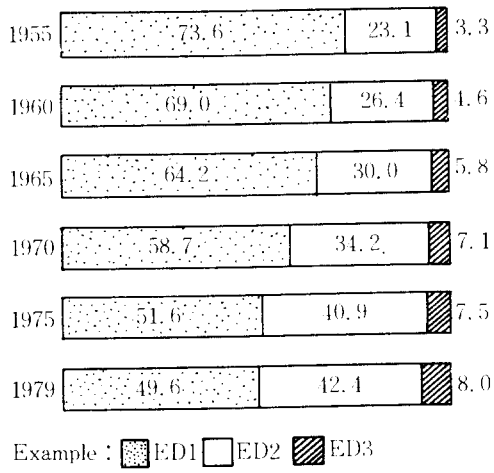
Due to a rapid decline in mortality rate and a moderate decline in fertility, the age structure of the population changed very rapidly during the postwar period. The crude death rate fell from 40 per thousand persons in 1955 to 24 per thousand persons in 1975[1] due to the improved standard of living and modernized medical treatment. According to the estimate of Coale, Cho, and Goldman, the total fertility rate has also declined significantly from 5.46 in 1955 to 3.14 in 1979.[2] Consequently, the share of population age 0 to 9 increased until 1960 but has gradually declined since. The shares of the other age groups have increased gradually. The changing age composition of the labor force can also be summarized by the change in the average age of the labor force. In 1955 the average age of workers was 33, but by 1979 it had increased to 37, presumably due to increased schooling for the population between the ages of 10 and 19 and 20 and 29.

If we look at the labor force participation rates we can see clearly that the labor force participation rate of the population between 10 and 19 has declined rapidly, that is, from 24.2 percent in 1955 to 15.2 percent in 1979. The labor force participation rates of all other age groups recorded significant increases. Workers age 40 to 49 showed the biggest increase, from 50.7 percent to 94.1 percent.

3) Educational Attainment.

The educational composition of the labor force has also changed significantly in the postwar period, as shown in Table 3.3. Workers with a primary school education or less showed the lowest growth rate, 2.1 percent per annum, during the period 1955-1979, while workers with a secondary school education and workers with some college education recorded growth rates of 6.4

Fig. 3. 1 Total Labor Force by Educational Attainment



1. Crude death rate is defined as follows :

$$CDR = \frac{D}{P} \times 1{,}000$$

where CDR : crude death rate
D : total number of deaths in a particular year
P : total population

The CDR data quoted here are from Sawon Hong, *Population Status Report : Korea*, Korea Development Institute, Seoul, 1978, p. 136.

2. The total fertility rate is another age-sex adjusted measure of fertility which takes into account the age detail of the childbearing ages. In theory, the total fertility rate represents simply the sum of the age-specific fertility rates over all ages of the childbearing period. Hence the age-specific rates are given equal weight and the resulting measure of fertility is an approximation of completed family size, i.e., the total number of children 1,000 women would bear in their life times, if they were to bear children at the current age-specific rates. The TFR data quoted here are from Ansley J. Coale, Lee-Jay Cho, and Noreen Goldman, *Estimation of Recent Trends in Fertility and Mortality in the Republic of Korea*, National Academy of Sciences : Washington, D.C., 1980, p.2.

percent and 7.7 percent, respectively, during the same period.

These differing growth rates have resulted in a drastic change in the educational composition of the labor force. The share of workers with an elementary education or less has decreased sharply from 73.6 percent in 1955 to 49.6 percent in 1979. The share of workers with a secondary school education has almost doubled, increasing from 23.1 percent in 1955 to 42.4 percent in 1979. This reflects the strong policy emphasis placed upon secondary education not only by the government but also by individual households.

As the economy grew, the demand for highly skilled technologists or technicians increased, and as a result, enrollment in institutions of higher education also went up as we saw in the introductory chapter. Thus, as shown in Table 3.3 and Figure 3.1, the share of workers with some college education increased from 3.3 percent in 1955 to 8.0 percent in 1979.

If we measure the improvement in the educational attainment of the labor force in terms of the average number of years of education, there was significant increase from 1955 to 1979, from 7.3 years to 8.6 years. The dimension of the change reflects the fact that it takes a long time to improve the educational attainment of the labor force as a whole. It is perhaps this aspect of human capital accumulation that has attracted the attention of scholars who are interested in

Table 3.3 Composition and Growth of Total Labor Force by Educational Attainment

(Unit: in thousand persons and percent)

Year	Total Labor Force				Composition			
	ED 1	ED 2	ED 3	Total	ED 1	ED 2	ED 3	Total
1955	4,452	1,397	200	6,049	73.6	23.1	3.3	100.0
1959	4,617	1,704	282	6,603	69.9	25.8	4.3	100.0
1960	4,430	1,695	293	6,418	69.0	26.4	4.6	100.0
1965	5,270	2,457	479	8,206	64.2	30.0	5.8	100.0
1969	5,612	3,158	644	9,414	59.6	33.6	6.8	100.0
1970	5,725	3,332	688	9,745	58.7	34.2	7.1	100.0
1975	6,105	4,834	891	11,830	51.6	40.9	7.5	100.0
1979	7,331	6,254	1,186	14,771	49.6	42.4	8.0	100.0
Growth Rate (1955~1979)	(2.1)	(6.4)	(7.7)	(3.8)				

Sources : a) Same as Table 3.1.
b) Bureau of Statistics, Economic Planning Board, 1960 Population and Housing Census of Korea, Vol. 2, 1963, pp. 64~67.
c) 1966 Population Census Report of Korea, Vol. 12~1, 1969, pp. 74~79.
d) 1970 Population and Housing Census of Korea, Vol. 12~1, 1972, pp. 162~167.
e) 1975 Population and Housing Census of Korea, Vol. 12~1, 1977, pp. 166~169.
f) Bureau of Statistics, Ministry of Home Affairs, 1955 Population Census of Korea, 1959, pp. 24~27.

Notes : 1) ED1 includes those workers with a primary school education or less.
2) ED2 includes those workers with a secondary education.
3) ED3 includes those workers with higher education (junior college, college, university, or graduate school).
4) It was assumed that the distribution of the labor force's educational attainment is not significantly different from that of the population as a whole in calculating this data.

development planning. As the Korean experience indicates, it takes many years and is very costly to modernize the educational system and its facilities

2. Productivity, Educational Attainment, and Age Structure of the Labor Force

Given the basic characteristics of the labor force by sex, age structure, and educational attainment, we are prepared to describe the relation of worker productivity to the educational attainment and age structure of the labor force. As was mentioned in the first chapter, a positive relationship between the educational attainment and productivity is widely accepted as existing. In addition to the improvement in educational attainment, the experience of the labor force is considered by many to constitute one of the most important factors affecting productivity. So our first objective is therefore to investigate the relationship between educational attainment, experience which is often approximated by age, and productivity of the Korean labor force.

1) The Data

In the estimation of productivity, data from the 1971 Survey Report on Occupational Wages were used. The sample size for the original survey was approximately 193,000 individuals. A

Table 3.4 Wage Level by Age and Educational Attainment (Cross Tabulation Results)

(Unit : won(₩))

	(10~19)	(20~29)	(30~39)	(40~49)	(50~59)	(60 and over)	(All ages)
Elementary							
Male	10,479	16,853	26,484	29,347	35,676	35,000	23,147
Female	7,679	9,760	9,778	12,126	15,000	–	9,111
Total	8,248	12,530	24,938	26,525	33,659	35,000	17,602
Secondary	13,129						
Male	11,202	22,823	31,524	38,249	42,586	41,667	28,676
Female	11,632	14,515	16,753	15,667	5,000	–	13,598
Total		18,771	30,635	37,561	41,333	41,667	23,354
Higher							
Male		– 39,229	52,400	71,974	77,800	–	53,602
Female		– 31,400	20,000	95,000	55,000	–	31,970
Total		– 38,363	51,946	72,124	76,923	–	52,746
$h_2 = W_2/W_1$							
Male	1.2530	1.3545	1.1903	1.3031	1.1935	1.1904	1.2390
Female	1.4588	1.4870	1.7141	1.2920	0.3333	–	1.4925
Total	1.4103	1.4981	1.2284	1.4161	1.2280	1.1904	1.3268
$h_3 = W_3/W_1$							
Male	–	2.3284	1.9786	2.4520	2.1830	–	2.3160
Female	–	3.2172	2.0463	7.8347	3.6672	–	2.5089
Total	–	3.0617	2.0830	2.7191	2.2854	–	2.9966

Notes : 1) All the statistics are calculated on the basis of 1971 Survey Report on the Occupational Wages of Korea conducted under the sponsorship of the Office of Labor Affairs.

2) W_1 is the wage of the workers with an elementary education or less, W_2 of those with a secondary education, and W_3 of those with some higher education.

five percent subsample was selected randomly from the original survey to reduce computation costs. Our subsample is, therefore, 10,375 individuals of whom 6,489 are male workers and the remaining 3,886 are female. The 1971 Occupational Wags Survey was conducted under the sponsorship of the Office of Labor Affairs.[3] It collected such types of information of individual workers, as : sex, age, educational attainment, professional classification of the job description, years of experience, years of employment, number of days worked, number of hours worked, total salary, regular salary, special salary or bonuses, location of the firms or enterprises in which the respondent was employed, industry classification of the firm, size of the firm, and th number of respondents in each firm. Data on total salary, age, and educational attainment of the individual workers was used to estimate productivity. Table 3.4 shows the results from cross tabulations of the data. There is a non-linear relationship between wages and the age of the worker. The wages of those with higher educational levels rise faster as they obtain additional experience than the wages of those with lower educational attainment. There is no systematic pattern of relative wages by age group with different educational attainments.

2) Estimation Procedure

Scrutiny of the cross-tabulations clearly indicates an additive specification is not appropriate. That is, the wages of more educated workers rise more rapidly with age than do the wages of less educated workers. An interactive specification appears to yield a satisfactory approximation, however. The ratio of the wages of more educated workers to those of less educated worker (h_2 and h_3 in Table 3.4) does not appear to vary systematically with age. Thus, an interactive specification is used to estiamte the earnings function. Because the non-linear nature of the relationship between age and average wage is clear, the following functional expression is suggested for estimating the productivity of workers :

$$W^* = G(age) \cdot F(E) \quad \cdots\cdots (1)$$

where W^* : wage level (proxy for productivity index)

$G(age)$: age earnings function

$F(E)$: education dummy function

The non-linear relationship between age and wages is estimated using the cubic spline function :[4]

$$G(age) = \beta_0 + \beta_1 A + \beta_2 A^2 + \beta_3 A^3 + \beta_4 (A-25)^3 + \beta_4 (A-25)^3 D_1 + \beta_5 (A-35)^3 D_2 + \beta_6 (A-45)^3 D_3 \quad \cdots\cdots (2)$$

where A : age

D_1 : 1 iff. $A \geqq 25$

D_2 : 1 iff. $A \geqq 35$

D_3 : 1 iff. $A \geqq 45$

The education dummy function is :

$$F(E) = (E_1 + h_2 E_2 + h_3 E_3) \quad \cdots\cdots (3)$$

where E_1 : 1 iff. educational attainment is ele-

3. The data from the 1971 wage survey are used in the analysis because that is the only information readily available. The main purpose of the wage servey was to learn the wage level of individual workers along with the other background information on them. The statistical special emphasis on the improvement of their social welfare.

4. "Spline functions are a device for approximating the shapes of a curvlinear stochastic function without the necessity of prespecifying the mathematical form of the function... It is unnecessary to restrict the estimate to a straigh line, a polynomial of prespecified degree, an exponential, or any other particular form." The above quotation is from "Spline Functions Fitted by Standard Regression Methode" by Daniel B. Suits, Andrew Mason, and Louis chan, *The Review of Economics and Statistics*, Vo. 60, no.1, February 1978, p. 132.

mentary education or less

E_2 : 1 iff. educational attainment is secondary education

E_3 : 1 iff. educational attainment is higher education

h_2 : the ratio of wages of workers with a secondary education to wages of workers with an elementary education or less : W_2 / W_1

h_3 : the ratio of wages of workers with higher education to wages of workers with an elementary education or less : W_3 / W_1

W_1 : wages of workers with an elementary school education or less

W_2 : wages of workers with a secondary school education

W_3 : wages of workers with higher education.

If we substitute equations (2) and (3) into equation (1), we get the following functional form :

$$W^* = G(age) \cdot F(E) \cdots\cdots (4)$$
$$= (\beta_0+\beta_1 A+\beta_2 A^2+\beta_3 A^3+\beta_4 (A-25)^3 D_1 + \beta_5 (A-35)^3 D_2+\beta_6 (A-45)^3 D_3) \cdot (E_1+h_2 E_2+h_3 E_3)$$

Equation (4) cannot be estimated using OLS because of its multiplicative form. Consequently, an interactive procedure is used to estimate the parameters of the equations. The first round estimate of G(age) is obtained using the simple means of relative wages, h_2 and h_3, for each of the age groups given in Table 3.4. Substituting for h_2 and h_3 into equation (1) and rearranging terms gives :

$$W^* / (E_1+1.2390E_2+2.3160E_3) = G(age) \cdots (5)$$

for the male labor force.G(age) is given in equation(2). Equation(5)is estimated using ordinary least squares. Female and total labor force equations are estimated in similar fashion by substituting the appropriate wage ratios, h_2 and h_3. Second round estimates of h_2 and h_3 are obtained by substituting G(age) into equation (1) and rearranging the terms, giving :

$$W^* / G(age) = (E_1+h_2 E_2+h_3 E_3) \cdots\cdots (6)$$

applying ordinary least squares, we get estimates of the education dummy function.

This procedure could be repeated so long as the statistical result is improved in terms of the R^2 and F values, but after several regression runs, the statistical result do not improve substantially and parameter estimated are relatively stable.

As can be clearly seen from the above process, we can obtain the following values from the regression analysis : 1) the predicted values of G(age), the wages of workers with an elementary education or less, 2) the predicted values of h_2 G(age), the wages of workers with a secondary education, and 3) the wages of workers with some higher education, the predicted values of h_3 G(age). This estimation procedure was done for the male and the female labor forces separately.

3) Results of the Estimation

The following results were obtained from the successive regression runs : 1) in the case of the male labor force, the estimates of h_2 and h_3 are stable and their values are 1.27 and 2.16 respectively ; 2) in the case of female labor force, the estimates of h_2 and h_3 are also stable and their values are 1.38 and 2.67 respectively ; 3) in the case of the total labor force, the estimates of h_2 and h_3 are also stable and their values are 1.35 and 2.33 respectively ; and 4) for both the female and male labor force the R^2 and the f value for the F(E) and G(age) functions appear reasonable given the sample size.

The predicted wages of workers by educational attainment and age are shown in Table 3.5 and figures 3.2 and 3.3. The predicted wages of male workers increase smoothly up to age 50, whereas the predicted wages of female workers show

Table 3.5 Predicted Wages by Age and Educational Attainment

(Unit : won(₩))

Age	Elementary Education G(age)		Secondary Education h_2 G(age)		Higher Education h_3 G(age)	
	Male	Female	Male	Female	Male	Female
15	4,281	6,837	5,433	9,421	9,242	18,223
20	12,431	9,371	15,775	12,912	26,837	24,977
25	16,961	11,355	21,524	15,646	36,617	30,264
30	21,151	11,287	26,841	15,552	45,663	30,083
35	24,595	10,873	31,211	14,982	53,098	28,980
40	26,529	11,844	33,665	16,320	57,273	31,568
45	28,301	13,691	35,914	18,865	61,099	36,491
50	39,749	15,049	39,020	20,736	66,384	40,110
55	30,401	13,609	38,579	18,752	65,633	36,272
60+	22,714	6,817	28,824	9,393	49,037	18,169

Fig. 3.2 Predicted Wages of Male Workers by Age and Educational Attainment

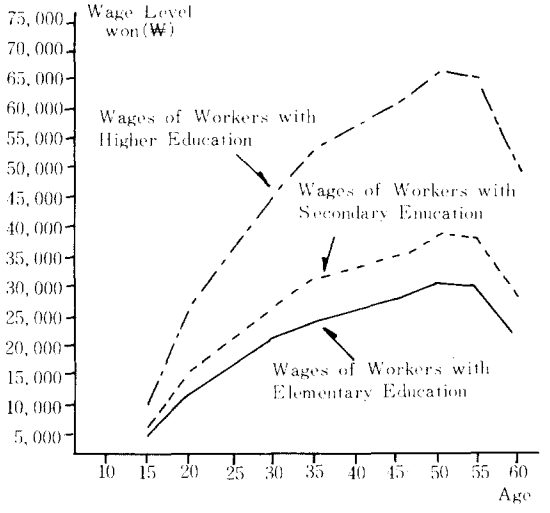
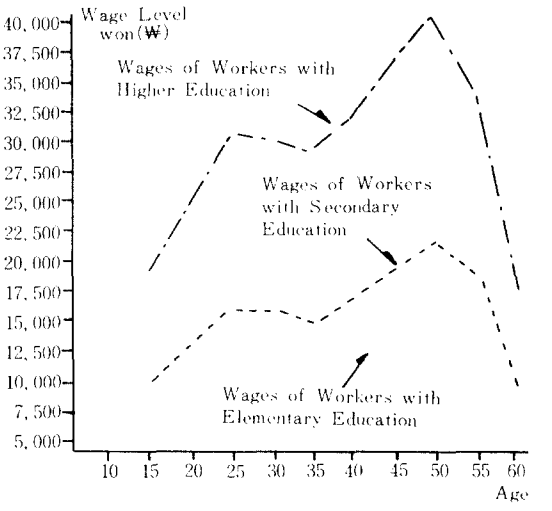


Fig. 3.3 Predicted Wages of Female Workers by Age and Educational Attainment



rather strange curvatures, probably due to child-bearing and its relation to labor force activities. According to Figure 3.3, the predicted wages of female workers increase up to 25, but between the ages of 25 and 35, the prime child-bearing period, the predicted wages decline slightly. The predicted wages of female workers increase again between the ages of 35 and 50, reach a peak at age 50, and decline thereafter.

It used to be the case that the majority of Korean women quit working after getting married, but recently their labor force participation has been increasing whether as formal employment in the market or as non-formal employment such as knitting or making toys at home for sale.

However successful we may be in estimating the productivity (W*) of the labor force, we must keep in mind that we may be overestimating the effect of education on productivity,

because there could be a significant correlation betwen ability (intelligence), social position (family background), contact, political clout, and education. Consequently, wage differentials between education groups generally overestimate the contribution of education to productivity.

In the course of estimating the contribution of education to the economic growth of the United States, Denison makes a 40 percent reduction in the yield on education as an allowance for unmeasurable factors such as ability or family background. The reasons we could not consider the effect of abilities, etc. satisfactorily when we dealt with the relationship between schooling and productivity are ; 1) there are no scientific criteria on the size of the adjustment factor ; 2) as mentioned in the introductory chapter, the traditional Korean social class system was all but destroyed in the upheavals created by foreign military occupation, war, and national partition, leaving education as a uniquely important means of individual advancement, and, as a result, the educational attainment of the Korean labor force can be regarded as a suitable means of evaluating its productivity of the labor force.

3. Effective Labor Input and the Labor Force Quality Index

1) Derivation of Effective Labor Input

In the previous section a procedure was demonstrated for estimating the productivity of the male and female labor force on the basis of age and educational attainment. The estimated productivity index (predicted wage level of the labor force) will be used in this section to calculate the effective labor input and a labor force quality index. Effective labor input is defined as follows :

$$L^* = \sum_{i=1}^{6} W^* \cdot L_i \quad \cdots\cdots (1)$$

where L^* : effective labor input

L : pure labor input

W^* : labor force productivity index (wages)

i : age group index(1-6)

Age Group 1 : workers age 10-19
Age Group 2 : workers age 20-29
Age Group 3 : workers age 30-39
Age Group 4 : workers age 40-49
Age Group 5 : workers age 50-59
Age Group 6 : workers age 60 and over

Because the data on wages can be obtained only for the above age groups, a mid-value wage for each group, W^*(15 years, 25 years, 35 years, 45 years, 55 years, and 60 years) was used and it was multiplied by the corresponding value of L to get L^*. This calculation was done for male and female labor forces separately and these were then added together to get the total value of L^* for each year assuming that the relationship between workers' wages and educational attainment and age does not change in the relatively short period we are interested in.

Effective labor input increased by 4.7 percent annually during the period 1955-1979, due to the rapid improvement in educational attainment and the significant change in the age structure of the labor force. The growth rate of the effective labor input can be decomposed into two parts, namely, a 3.5 percent annual rate or 74 percent of the growth due to the improvement in educational attainment and the remainder, a 1.2 percent annual rate or 26 percent of the growth due to the change in the age structure.

2) Derivation of the Quality Index of the Labor Force

The quality index of the labor force is defined as follows :

$$QIL = L^* / L \quad \cdots\cdots (2)$$

where QIL : quality index of the labor force

L^* : effective labor input

L : pure labor input

Table 3.6 Effective Labor Input and Quality Index of Labor Force, (1955~1979)

Year	Effective Labor Input	Quality Index of Labor Force		
		Male	Female	Total
1955	100.0	100.0	100.0	100.0
1956	98.0	101.0	100.2	100.9
1957	109.3	110.0	104.2	108.7
1958	116.3	110.6	104.1	106.7
1959	119.5	111.9	104.3	109.5
1960	116.5	112.3	104.2	109.8
1961	125.9	105.9	101.2	103.3
1962	137.0	111.3	103.3	109.7
1963	142.7	112.7	104.3	112.7
1964	145.5	112.8	104.5	112.9
1965	153.4	113.3	104.8	113.1
1966	159.6	114.9	105.3	114.6
1967	167.4	116.9	105.9	116.2
1968	176.9	118.5	106.6	116.9
1969	182.5	118.4	106.1	117.3
1970	186.8	117.9	107.2	116.0
1971	196.3	120.2	108.1	117.9
1972	203.6	118.7	107.9	116.6
1973	213.6	118.8	108.2	116.0
1974	226.4	120.7	109.4	118.2
1975	235.6	122.5	111.0	120.5
1976	248.0	123.1	111.3	119.5
1977	260.2	124.2	112.6	121.8
1978	273.8	126.3	113.8	122.8
1979	301.5	127.1	114.2	123.5

We can derive QIL for each year simply by dividing L^* by L. After making this calculation for each year, we only have to choose the base year and set the value for that year at 100. As shown in Table 3.6, the quality index of male labor force increased at a rate of 1.0 percent per annum during the period 1955-1979, whereas that of the female labor force increased at a rate of 0.55 percent per annum. Thus, the quality index for the total labor force increased by 0.88 percent annually.

Ⅳ. Production Function Estimation

In this chapter we will discuss the empirical use of the specific form of the production function, the Cobb-Douglas type of production function. The popularity of the Cobb-Douglas function can be attributed largely to its basic consistency with the established body of economic theory, and to its computational simplicity.

1. The Data

The calculation of the basic data set needed to estimate the production function is the cornerstone for further research. Since the effective

labor input data was obtained from Chapter 3, it is possible now to proceed to get two more sets of data, namely, the capital stock data and GNP data. The capital stock data for the preiod 1955-1979 were derived using the 1977 National Wealth Survey[5] and adding or subtracting the net fixed capital formation figures obtained from the national income statistics. The resulting capital stock data is deflated to 1977 price using industrial level deflators (first digit level industry of Korean Standard Industrial Classification). Industrial deflators are used because they reflect the real price structure better than the deflator for capital formation as a whole. Gross national product data obtained from national income statistics is deflated to 1977 constant market prices using the deflator for the economy as a whole to calculate the GNP data on a basis comparable with other data.

2. Production Function Estimation

1) Specification

The production function estimated for Korea is :

$$Y = \beta_0 e^{\beta_1 t} K^{\beta_2} L^{*\beta_3} \quad \cdots\cdots (1)$$

where Y : GNP in 1977 constant market prices
t : time
K : net capital stock in 1977 constant market prices
L^* : effective labor input

Taking the natural logarithms of both sides and differentiating with respect to time :

$$\frac{\dot{Y}}{Y} = \beta_1 + \beta_2 \frac{\dot{K}}{K} = \beta_3 \frac{\dot{L}^*}{L^*} \quad \cdots\cdots (2)$$

where the dot notation indicates the time derivative. In the course of estimating the co-efficient of the variables, we restricted the sum of values of β_2 and β_3 to 1.0 ($\beta_2+\beta_3 = 1.0$), since we are assuming constant returns to scale.

2) Estimation Results

The empirical results are :

$$\frac{\dot{Y}}{Y} = 0.021223 + 0.68949 \frac{\dot{K}}{K} + 0.31051 \frac{\dot{L}^*}{L^*} \quad \cdots (3)$$

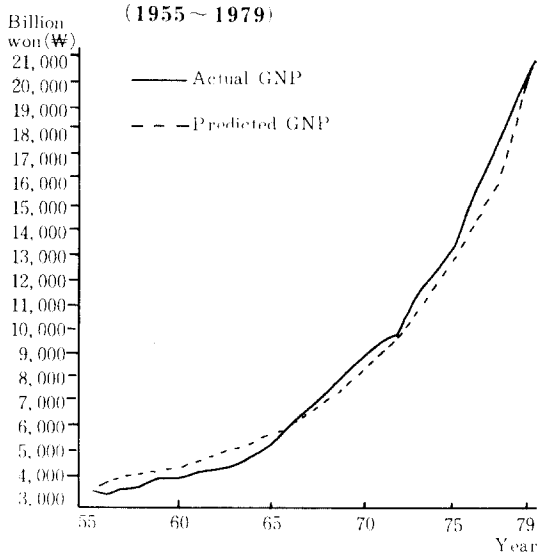
(S.E.) (0.0065512) (0.14660) (0.14660)
t 3.2395 4.7032 2.1181
$R^2 = 0.4117$ D.W.= 1.8315

The residual, often assigned to technical change, showed an annual growth rate of 2.1 percent during the period 1955-1979. It should, however, be remembered that the residual is a broader concept than simply technical change, and includes the effects of the advance of knowledge, improvement in managerial skills, and economies of scale (not only in the domestic market but also in the international market) as well. The reason there is such a large residual is that labor and capital, as traditionally measured, do not give the entire picture of the production process in a modern society. The capital share or the elasticity of output with respect to capital input was estimated to bo 0.68949, whereas the share of labor or the elasticity of output with respect to effective labor input turned out to be 0.31051. As shown in the above regression result, the statistical result shows that the estimates of the parameters are statistically significant at a five percent confidence limit.

In Figure 4.1 the actual value of the GNP and the predicted value of the GNP based on

5. The 1977 National Wealth Survey was conducted under the cosponsorship of the Bureau of Statistics of the Economic Planning Board, The Bank of Korea, The Korea Development Bank, The Ministry of Agriculture and Fisheries, The Medium Industry Bank, and the Citizens National Bank.

Fig. 4.1 Actual and Predicted GNP (1955~1979)



the estimation result of the production function are shown. (The mean value of the predicted GNP is set equal to the mean value of the actual GNP.)

3. Contribution of the Libor Force's Quality Change to Korean Economic Growth

To calculate the contribution of the labor force's quality chang to Korean economic growth, we assumed the following :

$$\frac{\dot{L}^*}{L^*} = \frac{\dot{L}}{L} + \frac{\dot{QIL}}{QIL} \quad \cdots\cdots (4)$$

where $\frac{\dot{L}^*}{L^*}$: growth rate of the effective labor input

$\frac{\dot{L}}{L}$: growth rate of pure labor input

$\frac{\dot{QIL}}{QIL}$: growth rate of the quality index of the labor force

If we substitute equation (4) into equation (2) we get :

$$\frac{\dot{Y}}{Y} = \beta_1 + \beta_2 \frac{\dot{K}}{K} + \beta_3 \left(\frac{\dot{L}}{L} + \frac{\dot{QIL}}{QIL} \right) \quad \cdots\cdots (5)$$

From euqation (5) we can derive the contribution of each factor of production to Korean economic growth (see Table 4.1).

If we consider the whole period of 1955-1979, the GNP grew by an annual rate of 7.62 per-

Table 4.1 Contribution of Labor Force, Capital Stock and Quality Change of Labor Force to Economic Growth of Korea

(Unit : percent)

		1955~1959	1959~1969	1969~1979	1955~1979
Contribution to GNP Growth	1) GNP	4.46	6.33	10.27	7.62
	2) Capital	0.94	2.88	6.56	4.05
	3) Labor Force	0.69	1.12	1.43	1.18
	4) Labor Force Quality Change	0.71	0.21	0.16	0.27
	5) Others	2.12	2.12	2.12	2.12
Composition of Contribution to GNP Growth	1) GNP	100.0	100.0	100.0	100.0
	2) Capital	21.1	45.5	63.9	53.2
	3) Labor Force	15.5	17.7	13.9	15.5
	4) Labor Force Quality Change	15.9	3.3	1.6	3.5
	5) Others	47.5	33.5	20.6	27.8

cent. The increase in capital is estimated to have contributed 4.05 percentage points, or 53.2 percent, to the GNP growth rate, and the increase in the labor force 1.18 percentage points, or 15.5 percent. Of the remaining 2.39 percentage points, 0.27 percentag points, or 3.5 percent of the GNP growth rate, was explained by labor's quality improvement.

The low level of the contribution ratio of the labor quality change to economic growth can be ascribed to the relatively high contribution ratio of technical change. Since a significantly high portion of the technical change is due to the labor force's quality improvement, it is not surprising to get such a high contribution ratio of technical change. We can, therefore, conclude that the improvement in the quality of the labor force not only contribute directly to economic growth but also indirectly through technical change.

4. Future Implications of the Alternative Target Rates of Graduation and Continuation

1) The Model

The effect of alternative levels of educational attainment on Korean economic growth over the next fifty years is assessed using an econometric model of Korea developed by Mason, Suits, et al. (forthcoming). The model was developed to estimate long-run relationships between demographic factors and economic development and is an extension of a more general model estimated from a cross section of approximately 70 countries throughout the world (Suits and Mason, 1978, Mason and Suits, 1981).

The education sector of this model is quite detailed. Using exogenously specified graduation and continuation rates for three educational levels (primary, secondary, and college), it is possible to update the educational attainment of adults by sex and five-year age groups every five years. Given age and sex specific population and labor force participation rates and the wage function estimated in Chapter 3, effective labor input is estimated every five years from 1975 to 2925. The gross national product is determined by effective labor input and net capital stock using the production function estimated above.

Change in eduction or schooling have two direct effects which bear on the income projections to be presented. First, as already mentioned, schooling determines the educational attainment of the adult population. Second, higher levels of schooling reduce labor force participation by members of the school age population. In particular, the ratio of workers to the non-enrolled population is held constant for each age and sex group.[6]

Education also affects the economy in a number of indirect ways through its effects on per capita and total income. Factors which will be at least partially influenced by changes in education include life expectancy, urban-rural distribution of the population and the domestic rate of saving. For the purposes of this analysis the effect of education on fertility has been excluded. The total fertility rate has been exogen-

6. The central feature of the labor force equations employed here is that the ratio of the labor force to the potential labor force is constant. The potential labor force is defined as the population minus the enrolled population.
   LFPR(i) : labor force participation rate of group i
   PLFPR (i) : ratio of labor force to non-school population for group i
   PENR (i) : proportion of group i currently enrolled in school
   Therefore, labor force participation rate is given by :
   LFPR (i) = PLFPR (i) · (1-PENR (i))

ously specified to decline from 2,902 per 1,000 women in 1975 to 2,117 in 2025 for urban areas, from 3,454 in 1975 to 2,116 in 2025 for rural areas. Therefore, from a practical point of view only labor force quality and labor force participation rates are affected in numerically important ways by the exogenously specified graduation and continuation rates.

Also, in the course of deriving the projection results of the model, we did not consider the cost of the education needed to achieve the target level of graduation and continuation rates for various levels of educational institutions

2) Projection Results

To obtain the projections on GNP, per capita GNP, labor force by age group and educational attainment, effective labor input, quality index of the labor force, etc., we specified three alternative rates of graduation and continuation : a low target, a medium target, and a high target level. For the low target level(status quo level), the proportion entering primary school in 2025 is assumed to be 0.993 while the proportion graduating from primary school is set at 0.992. The proportion entering secondary school, or the continuation rate in secondary educational institutions is set at 0.700 while the proportion graduating from secondary school is set at 0.600. The proportion continuing on to college from secondary school is assumed to be 0.354 while the proportion graduating from college is taken as 0.750.

Let us see what these low level target ratios mean by taking an example. Of 1,000 persons 993 (1,000×0.993=993) will enter primary school and 985 (993×0.992=985) will graduate from primary school. Out of these 985,690 (985×0.7000=690) will enter secondary school and 414 (690×0.600=414) will graduate from secondary school. Finally, of the 414 secondary school graduates, only 147 (414×0.354=147) will enter college and 110 (147×0.750=110) will graduate from college.

In the case of medium and high target levels, gradually higher rates of graduation and continuation are assumed to prevail in 2025 (as seen in Table 4.2).

(a) Size and Growth of Labor Force

As the rates of graduation and continuation gradually increase from low to high, more and more people will be enrolled in various kinds of

Table 4.2 Alternative Graduation and Continuation Target Rates

Target Level	Primary			Secondary			College		
	1975	2000	2025	1975	2000	2025	1975	2000	2025
A. Low Level Target									
Proportion Entering (Continuation Rate)	0.993	0.993	0.993	0.700	0.700	0.700	0.354	0.354	0.354
Proportion Graduating (Graduation Rate)	0.992	0.992	0.992	0.600	0.600	0.600	0.750	0.750	0.750
B. Medium Level Target									
Continuation Rate	0.993	1.000	1.000	0.700	0.834	0.909	0.354	0.454	0.523
Graduation Rate	0.992	0.992	0.992	0.600	0.674	0.734	0.750	0.759	0.750
C. High Level Target									
Continuation Rate	0.993	1.000	1.000	0.700	0.961	0.995	0.354	0.592	0.600
Graduation Rate	0.992	0.992	0.992	0.600	0.869	0.957	0.750	0.750	0.750

Table 4.3 Size and Growth of Labor Force by Alternative Graduation and Continuation Target Rates

Year	Labor Force (million persons)			Growth of Labor Force (1980=100.0)		
	Low	Medium	High	Low	Medium	High
1980	15.54	15.53	15.47	100.0	100.0	100.0
1985	17.73	17.65	17.42	114.1	113.7	112.6
1990	19.87	19.72	19.34	127.9	127.0	125.0
1995	21.60	21.341	20.95	139.0	137.9	135.4
2000	23.12	22.87	22.35	148.8	147.3	144.5
2005	24.69	24.36	23.75	158.9	156.9	153.5
2010	26.24	25.83	25.16	168.9	166.3	162.6
2015	27.49	27.02	26.35	176.9	174.0	170.3
2020	28.20	27.71	27.08	181.5	178.4	175.1
2025	28.41	27.91	27.34	182.8	179.7	176.7
Annual Growth Rate (1980~2025)				(1.35%)	(1.31%)	(1.27%)

educational institutions, and, as a result, fewer people will be taking part in the labor market. Table 4.3 gives the size and growth of the labor force given alternative education targets. In the case of a low or status quo target level, the total labor force would grow at an annual rate of 1.35 percent during the period 1980-2025, whereas the medium level would show an annual growth rate of 1.31 percent during the same period. If we adopt the high target level, the labor force would record the lowest annual growth rate of 1.27 percent. With the quality of the labor force increasing gradually, relatively fewer people will be employed to produce a larger output as can be seen Tables 4.3 and 4.8.

(b) Labor Force by Age Group

According to the model, the age structure of the population and labor force participation rates by age group will change significantly over the next fifty years. Due to large declines in fertility and mortality rates, the populationaging phenomena will begin to become observable and more and more older people will be employed. In terms of the age structure of the population, the share of the population age 0-19 will decrease drastically from 45.7 percent in 1980 to 28.7 percent in 2025, whereas the share of population age 60 and over will increase significantly from 5.7 percent in 1980 to 16.2 percent in 2025. The share of the population age 20-59 will increase slightly from 48.6 percent in 1980 to 55.1 percent in 2025.

The labor force participation rates of the population age 10-19 and 20-29 will decrease significantly due to increased enrollment in secondary and higher educational institutions as we move from a low to a high target level for graduation and continuation rates. As a result, the age structure of the labor force will change dramatically over the next fifty years, as we can see clearly from Table 4.4. Thus, if we take the low graduation and continuation rate target, the share of workers age 10-19 and 20-29 decreases significantly from 13.8 percent and 30.3 percent in 1980 to 6.9 percent and 20.8 percent in 2025, respectively, whereas the share of all the other age groups show remarkable increases. One re-

Table 4.4 Age Group Labor Force Composition by Alternative Graduation and Continuation Target Rates

(Unit : %)

Age Group	1980	2000			2025		
	Low	Low	Medium	High	Low	Medium	High
10~19	13.8	8.4	7.7	6.3	6.9	5.8	4.6
20~29	30.3	22.9	22.9	22.7	20.8	20.6	20.0
30~39	21.5	27.8	28.2	28.8	23.3	23.7	24.2
40~49	18.9	22.1	22.3	22.8	19.1	19.5	19.9
50~59	10.9	12.3	12.4	12.7	18.9	19.2	19.7
60+	4.6	6.5	6.5	6.7	11.0	11.2	11.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
(thousand persons)	(15,543)	(23,120)	(22,872)	(22,354)	(28,416)	(27,911)	(27,344)

Table 4.5 Labor Force Educational Attainment Composition by Alternative Graduation and Continuation Target Rates

(Unit : percent)

	No Schooling	Primary	Secondary	College	Total
A. 1980				9.2	
Low	10.2	37.3	43.3	9.2	100.0
Medium	10.2	37.3	43.3	9.5	100.0
High	10.3	37.2	43.0		100.0
B. 2000					
Low	2.2	32.7	52.5	12.6	100.0
Medium	2.1	29.7	53.1	15.1	100.0
High	2.1	25.6	49.8	22.5	100.0
C. 2025					
Low	0.7	30.5	54.8	14.0	100.0
Medium	0.3	19.6	56.4	23.7	100.0
High	0.3	10.0	47.2	42.5	100.0

sult is that the average age of workers will increase from 37.6 years in 1979 to 40.9 years in 2025 if we adopt the low target and it will become 41.3 years and 41.7 years respecitvely in the medium and high target cases.

(c) Labor Force by Educational Attainment

Given any reasonable educational target the educational attainment of the labor force will increase substantially over the next fifty years. For the most part the education target adopted now will not begin to effect the labor force's educational attainment until the year 2000. As we gradually increase the graduation and continuation rate targets, however, the labor force's educational attainment will show a significant change during the period from 2000 to 2025. Consequently, if we take the low graduation and continuation rate target, the proportion of workers with a secondary education will increase from 43.3 percent in 1980 to 54.8 percent in 2025, whereas the proportion of workers with some

Table 4.6 Effective Labor Input Growth Rate by Alternative Graduation and Continuation Target Rates

(1975=277)

Year	Effective Labor Input			Growth Rate of Effective Labor Input (%)		
	Low	Medium	High	Low	Medium	High
1980	335	335	335	3.6	3.6	3.5
1985	399	399	397	3.3	3.2	3.2
1990	466	466	466	2.9	2.9	3.0
1995	528	530	537	2.4	2.5	2.7
2000	584	590	608	1.9	2.1	2.4
2005	636	648	678	1.7	1.8	2.1
2010	685	704	750	1.4	1.6	1.9
2015	723	752	818	1.1	1.3	1.7
2020	747	789	874	0.6	0.9	1.3
2025	758	814	916	0.3	0.6	0.9

Table 4.7 Labor Force Quality Index by Alternative Graduation and Continuation Target Rates

(1980=100.0)

Year	Quality Index of the Labor Force		
	Low	Medium	High
1980	100.0	100.0	100.0
1985	104.2	104.6	105.1
1990	108.8	109.3	111.1
1995	113.0	114.8	118.0
2000	117.1	119.4	125.4
2005	119.4	123.2	131.3
2010	120.8	126.4	137.3
2015	121.8	128.7	142.9
2020	122.7	131.9	148.9
2025	123.6	135.2	154.4
Annual Growth Rate (1980~2025)	0.47%	0.67%	0.97%

college education will go from 9.2 percent in 1980 to 14.0 percent in 2025. If we adopt the high target, the proportion of workers with a secondary education wil show a slight increase, from 43.0 percent in 1980 to 47.2 percent in 2025, but the proportion of workers with some college education will increase dramatically from 9.5 percent in 1980 to 42.5 percent in 2025. As a result, approximately 90 percent of the labor force will have at least a secondary education in 2025 when the per capita GNP will reach 27,964 dollars at 1975 constant prices. In he case of the United States in 1979, when the per capita GNP at 1975 constant market prices reached 8,300 dollars, 98 percent of the population had at least a secondary education.

(d) Effective Labor Input

Effective labor input, or the labor input in quality units, will increase at an annual rate of 1.83 percent if we adopt the low graduation and continuation rate target, whereas it will show an annual growth rate of 1.199 percent if we adopt the medium target. If we choose the high target, the effective labor input will increase at an annual rate of 2.26 percent during the period from 1980 to 2025.

As a result of continuous improvement in the labor force's educational attainment and its changing age structure, its quality index will increase at an annual rate of 0.47 percent at the low graduation and continuation target rate. This

index will go up at annual rates of 0.67 percent and 0.97 percent, respectively, for the medium and high target levels. If we take the low target, the labor force quality in the year 2000 will, therefore, be approximately 17 percent higher than in 1980, but it will be 19 and 25 percent higher, respectively, if the medium and high target levels are used.

(e) GNP and per capita GNP

Given any education target, the econometric model predicts a gradual rise in the GNP and per capita GNP growth rate to the end of the century and a slight decline thereafter as shown in Table 4.8. Given the low target (status quo) assumption, the GNP growth rate will be a little bit higher than 8 percent until the year 2000. This is somewhat lower than the average GNP growth rate during he 1969-1979 period, which was approximately 10 percent, but considering the already high GNP, this should be considered a high growth rate. Consequently, in terms of the total and per capita GNP growth rate, there are no significant diferences between the alternative choices of graduation and continuation rates up to the year 2000 to 2025, higher GNP and per capita GNP growth rates can be seen in the medium and high target cases as compared with the low target as shown in Table 4.8.

Thus, no significant changes are observed in terms of the GNP growth rate or the per capita GNP in the short run even if we change the graduation and continuation target rate, but in the long run, there are important changes. In addition even if we do not change the graduation and continuation target rates drastically we will have continuing total and per capita GNP growth since the momentum for steady growth has already been built into the trend. We can, therefore conclude that it takes a long time to improve the labor force's educational attainment through changing the graduation and continuation rates.

(f) Contribution of the Labor Force's Quality Change to Economic Grwoth

The contribution of the labor force's quality

Table 4.8 GNP and per capita GNP by Alternative Graduation and Continuation Target Rates

Year	GNP (billion $)			Per Capita GNP ($)		
	Low	Medium	High	Low	Medium	High
1980	31.8	31.8	31.8	832	832	832
1985	51.6	51.5	51.4	1,247	1,247	1,244
1990	85.8	85.8	85.6	1,911	1,910	1,906
1995	142.8	142.9	143.3	2,940	2,943	2,951
2000	229.2	230.2	233.0	4,411	4,430	4,484
2005	352.9	356.3	356.3	6,435	6,495	6,659
2010	527.2	535.8	557.8	9,223	9,373	9,758
2015	769.8	789.5	836.5	12,996	13,327	14,122
2020	1,098.6	1,139.7	1,231.0	17,933	18,604	20,095
2025	1,525.6	1,604.2	1,765.5	24,165	25,410	27,964
1980~2000	(8.2)	(8.2)	(8.3)	(7.1)	(7.1)	(7.1)
2000~2025	(6.0)	(6.8)	(7.0)	(6.0)	(6.2)	(6.4)

Note : 1) Figures in the parentheses give the annual growth rates.

change varies according to the graduation and continuation target rates in various educational institutions. For instance, if we take the low target, the contribution of the labor force quality change will be 1.7 percent of GNP growth during the period 1980-2025, whereas it will be 2.3 percent of GNP growth during the same period if we use the medium target. In the case of the high target, the contribution of quality change will be 3.2 percent of the GNP growth, or in terms of the percentage growth rate of GNP, it will be 0.30 percentage points.

V. Policy Implications

In spite of the recent setback in economic growth caused mainly by rapid increases in the cost of imported oil, it seems quite likely that Korea will soon be able to restore its previous economic growth trend. Considering its poor natural resource endowment, Korea will have to rely on its abundant, high quality labor force to sustain its economic growth.

To have economic growth it will be necessary to increase either capital and labor input or to increase the labor force's quality more effectively. Poor in land and natural resources, Korea is rich in culture and education. In addition, its people exhibit a seemingly insatiable demand for education and seek higher educational attainment. The best solution to sustaining rapid economic growth seems, therefore, to be increasing the quality of the labor force by increasing enrollment in higher educational institutions and by increasing women's participation through increased wage rates, better working conditions, and the equal treatment of female and male workers. Improved labor force quality through increased enrollment in higher educational institution or increased on-the-job training is really needed since the korean exporters to improve the quality of their export products to developed economies.

The labor force's average number of years of education increased rather moderatively from 7.3 years in 1955 to 8.6 years in 1979. The size of the change reflects the fact that it takes a long time to improve the educational attainmet of the labor force as a whole. It is perhaps this aspect of human capital accumulation that has attracted the attention of the scholars who are interested in development planning. As the Korean experience indicates, it takes many years and is very costly to modernize the educational system and its facilities. The continuous increase of investment in educational facilities includes not only investment in class room building and educational equipment but also investment in policy change to improve faculty quality at colleges and universities as well as the high school teachers. Thus, a drastic change in the educational system must be given a serious consideration. In other words, the traditional 6 years of elementary school, 3 years of middle school, 3 years of high school, 4 years of college or university, and 2 or more years of graduate school educational system should be reevaluated taking into consideration its effectiveness in improving the quality of the labor force needed to continue rapid economic growth.

More diversified educational institutions, especially at the upper high school and college or university levels ought, therefore, to be established to meet the ever increasing demand for skilled technicians and technologists. This requires that the unit cost of education be increased to improve the quality of education at all levels, and that dependence of private education financing be reduced. From this point of view, recent government educational reform has proven most welcome. This policy change made it possible to increase the student quota dramatically to relieve the fierce college or university entrance examination competition.

Taxes exclusively for educational investment should be levied soon, in spite of the increasing burden on the general public to give financial support to this educational reform.

To achieve rapid economic development and to improve the quality of the labor force, therefore, not only government but also the private sectors must plan ahead from a long term point of view so that they can respond to changing world economic situations as quickly as possible. Although it takes a long time to improve labor force quality by investing time and money, the accumulated human capital does not deteriorate or depreciate quickly. It is for this very reason that people wish to be educated in spite of the relatively low rate of return on educational investment. Labor force quality improvement through increased education induces lower fertility by raising female labor force's wages. Since higher wages mean higher opportunity costs for women, with their wage expectations higher, they will substitute child quality for quantity. This further motivate people to invest more in the educational sector since they now have fewer people to employ. Hence labor force quality improvement will be further accelerated through increased education, and this process will go on as long as the rate of return on education remains comparable to the rate of return on physical investment.

Consequently, labor force quality improvement through increased education of the general public should not be evaluated only on the basis of the visible or quantifiable benefits of education, because there are many other externalities closely related to increased schooling. The importance of the vocational or on-the-job training in addition to formal education can not be too greatly emphasized from the employer's practical efficiency point of view.

Considering the fact that the labor force is gradually becoming older, the present retirement system should be evaluated thoroughly based on a rational allocation of the resources for production at the national economy level. So long as the fertility rate continues to decline, the Korean economy will face a labor shortage in the foreseeable future, so, the labor force's retirement age should be raised and at the same time a modified social security system suited to Korea's rapidly developing economy should be devised and adopted.

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