Issues in S&T Human Resources Development in Korea

Sangwon Ko

1. Educational Expansion in Korea

Presently, to our surprise, Korea has too many highly educated workers relative to other nations - the surplus of unemployed university graduates is expected to exist for some foreseeable future. Korea has experienced a significant rise of educational attainment rates among the adult (25 to 64 years of age) population. Educational attainment rate is defined as the percentage of population that has achieved a predefined minimum level of high education. The percentage of adult population with higher education has increased from 4.9% in 1970 to 14.1% in 1990.

The enrollment rate, defined as the percentage of enrolled students classified for different age cohorts, has been increasing dramatically. The enrollment rate for primary education has been over 100% since 1970 while the enrollment rate for secondary education has increased from 40.8 per cent in 1970 to 94.1% in 1994.[1] The enrollment rate for higher education shows dramatic increase from 16% in 1980 to 49.3% in 1994. As demonstrated in Table 1, the enrollment rate for higher

* Science and Technology Policy Institute(STEPI), Senior Researcher

1) The enrollment rate greater than 100 per cent implies that some primary school students are over or under the typical age.

education in Korea is higher than those of Japan and Germany.

<Table 1> Enrollment Indicator for Education

	Primary Education			Secondary Education			Higher Education		
	total	men	women	total	men	women	total	men	women
Korea									
1970	100.7	101.1	100.2	40.8	44.9	32.0	8.8	12.9	4.5
1980	102.9	102.1	103.7	79.1	83.7	74.2	16.0	23.4	8.1
1990	101.4	103.5	103.2	92.0	94.3	90.7	38.1	55.6	24.3
1994	100.5	100.0	101.0	94.1	94.2	93.9	49.3	63.8	34.4
Japan									
1980	101.0	101.0	101.0	93.0	92.0	94.0	30.5	40.6	20.2
1991	102.0	102.0	102.0	97.0	96.0	98.0	31.5	36.6	26.1
Germany									
1980	99.0	99.0	99.0	94.0	96.0	92.0	26.2	29.9	22.3
1989	105.0	104.0	105.0	104.0	106.0	103.0	33.3	38.5	27.8
United States									
1980	99.0	100.0	99.0	89.0	88.0	90.0	56.0	54.0	58.1
1990	104.0	104.0	104.0	89.0	87.0	90.0	71.7	64.1	79.6

Source : Korea Educational Development Institute, Educational Indicators of Korea, 1994
UNESCO, Statistical Yearbook, 1975, 1994
quoted from, Jinhwa-Jung, Educational Expansion and Human Resource Development Policy Directions, mimeo, KIET, 1996. 4

The *explosion* of education in Korea can be confirmed once again by the number of degrees awarded by Korean universities. Table 2 shows the number of degrees awarded each year in Korea compared to other countries.

The number of degrees awarded each year more than tripled during the 1980s. There has been a public concern over producing too few highly educated workers in the field of science and engineering relative to other fields of study. The graduation quota system, which replaced the admission quota system from 1981 to 1987, enabled an increased number of high school graduates to enter universities. The program, however, required that the surplus number of students

<Table 2> International comparison of the size of degrees awarded

	the size of degrees awarded in a particular year			the number of degree awarded per 100,000 persons		
	Bachelors.	Masters	Doctoral	Bachelors	Masters	Doctoral
Korea						
1970	23,515(5,975)	1,978(234)	172(14)	72.9(18.5)	6.1(0.7)	0.5(0.04)
1980	49,735(16,046)	5,028(1109)	524(132)	130.5(42.1)	13.2(2.9)	1.4(0.3)
1990	165,916(43,601)	19,788(5,361)	2,481(696)	387 (101.7)	46.2(12.5)	5.8(1.6)
1994	179,519(54,822)	25,787(7,410)	3,818(1,131)	403.8(123.3)	58. 0(16.7)	8.6(2.5)
1995*	180,664(62,874)	27,398(9,053)	4,107(1,237)	402.8(140.2)	61.1(20.2)	9.2(2.8)
Japan						
1982	382,466(85,348)	15,855(9,079)	3,969(1,190)	322.1(71.9)	13.4(7.6)	3.3(1.0)
1991	428,079(100,332)	26,815(16,054)	6,201(1,722)	345.1(80.9)	21.6(12.9)	5.0(1.4)
United States						
1970	839,730(134,390)	230,509(35,317)	32,107(13,000)	409.5(65.5)	112.4(17.2)	15.7(6.4)
1991	1,094,538(174,482)	337,168(47,972)	39,294(15,309)	433.2(69.0)	113.4(19.0)	15.6(6.1)

Note : the number in bracket denotes the number of degree awarded in the field of natural science and engineering quoted from, Jinhwa-Jung, Educational Expansion and Human Resource Development Policy Directions, mimeo, KIET, 1996. 4

* data for 1995 is added by the author

Source : Korea, Statistical Yearbook of Education, Ministry of Education, Various Years; Monthly Statistics of Korea, National Statistical Office, Various Years

Japan, Monbusho Survey of Education, Ministry of Education, Science and Culture, 1992

U.S. Department of Education, Digest of Education Statistics, 1993

V.S. Department of commerce, Statistical Abstract of the United States, 1992

exceeding specified graduation quotas be dropped out before graduation. This system not only encouraged high school graduates to continue studies instead of joining the workforce, but also encouraged middle school graduates to choose academic high schools over vocational high schools. Also, because it is easier to increase quotas in the fields of humanities and social sciences without significantly sacrificing education quality, the system initiated an unbalanced growth of students in these fields.

In the relative sense, education in science and engineering was hampered by this system. The number of degrees awarded in Korea per year per capita exceeds that of Japan, and is not far behind that of the United States. In fact, Korea awards more bachelor's degrees in science and engineering than the United States per capita. As is shown in Table 2, Korea produces enough highly educated workers

in science and engineering in terms of absolute quantity.

Due to the rapid expansion of university education during 1980's, qualified workers poured into the labor market. Highly educated workers, however, have not been fully utilized. As shown in Table 3, the unemployment rate of the highly educated has been greater than the total unemployment rate. The proportion of highly educated workers among the unemployed increased from 8% in 1980 to 25.8% in 1995. The disparity between the demand of economy and the supply of the education system is attributable to the following three factors. First, the sudden expansion and availability of higher education combined with a stagnant demand for highly educated workers resulted in over-educated unemployment. Second, the rapid expansion of higher education was not accompanied by increased education quality. For instance, the average student-faculty ratio of universities in 1994 was 33:1, a considerably high figure when compared to other OECD countries. As a result, the quality of higher education could not meet industrial standards. Third, since academic field specialty structures and composition differ from those of industrial practice, excess supply of the highly educated emerged for one field and excess demand for another. The education planning system in Korea had failed to explicitly accommodate changes in industrial demand. University enrollment quotas, which had been strictly controlled by the Ministry of Education, specified overall enrollment limits rather than enrollment limits specified according to academic fields. As noted earlier, the high costs of establishing or expanding academic facilities in the field of science and engineering discouraged universities to increase student enrollment in these fields even when industrial forecasts predicted shortages of manpower in science and engineering. In addition, competition among university professors to secure sufficient number of students in their respective fields resulted in increasing enrollment quotas in equal or unbalanced proportions, irrespective of industrial demand.

Figure 1 shows trends of manpower shortage rate for all occupational groups combined and shortage rate for professional and technical workers. As can be

confirmed by figure 1, the manpower shortage rate has been on the rise during the late 1980s as unemployment decreased. During 1990s, the unemployment rate of the highly educated reached its peak in 1993. Strangely, the shortage rate for the professional and technical workers reached its peak at the same year. If there in no severe quality mismatch between labor demand and supply of the highly educated, the unemployment rate of the highly educated and the shortage rate for professional and technical workers should move in opposite directions. This concurrent rise in the unemployment rate of educated and the shortage rate for professional and technical workers is another evidence that the quality of higher education has not met the industrial standards.

<Table 3> Unemployment statistics of Korea

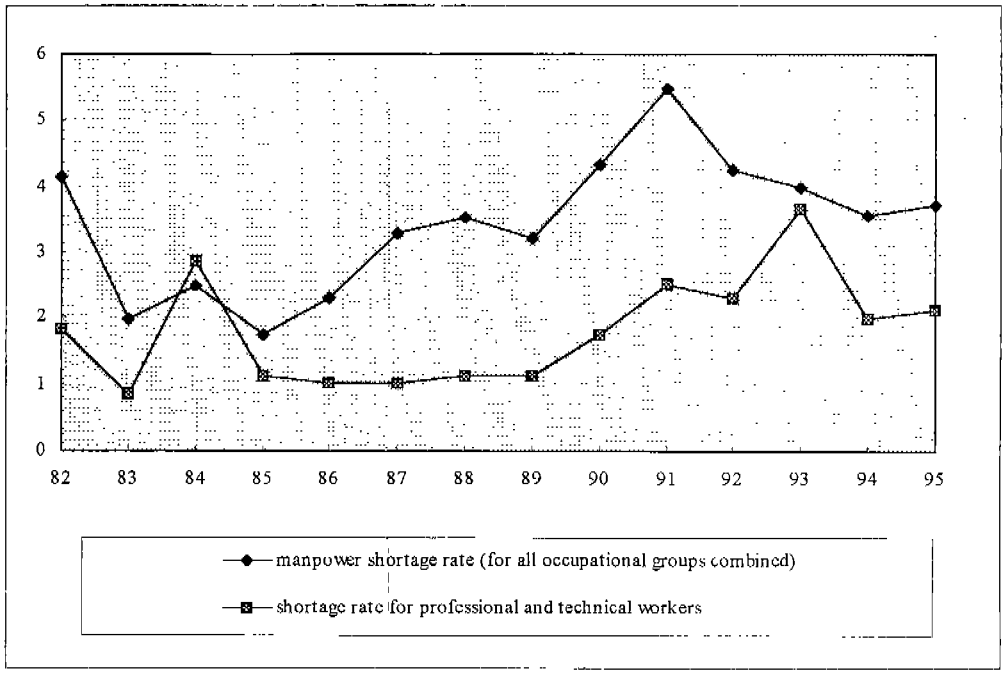
unit : Thousand

	unemployed(highly educated): A	unemployed (total) : B	A/B(%)	unemployment rate(highly educated): C	unemployment rate(total): D	C/D
1980	60	749	8.0	6.6	5.5	1.2
1981	63	661	9.5	6.6	4.7	1.4
1982	71	656	10.8	6.4	4.5	1.4
1983	77	613	12.6	6.5	4.2	1.5
1984	82	567	14.5	6.1	3.9	1.6
1985	109	619	17.6	7.1	4.1	1.7
1986	124	611	20.3	7.5	3.9	1.9
1987	111	519	21.4	6.1	3.2	1.9
1988	101	435	23.2	4.9	2.6	1.6
1989	116	460	25.2	5.1	2.6	2.0
1990	114	451	25.3	4.6	2.5	1.8
1991	101	436	23.2	3.8	2.3	1.7
1992	109	463	23.5	3.6	2.4	1.5
1993	141	551	25.6	4.2	2.9	1.4
1994	130	489	26.5	3.6	3.4	1.5
1995	108	419	25.8	2.7	2.0	1.4

*highly educated is defined as the junior college graduate or over

Source : National Statistical Office, Economically Active Population Survey, various years

The educational expansion not only leads to a rise in the unemployment rate of the highly educated but also to a drop in wage differentials by educational levels. Figure 2, shows the change in relative average wage of workers with

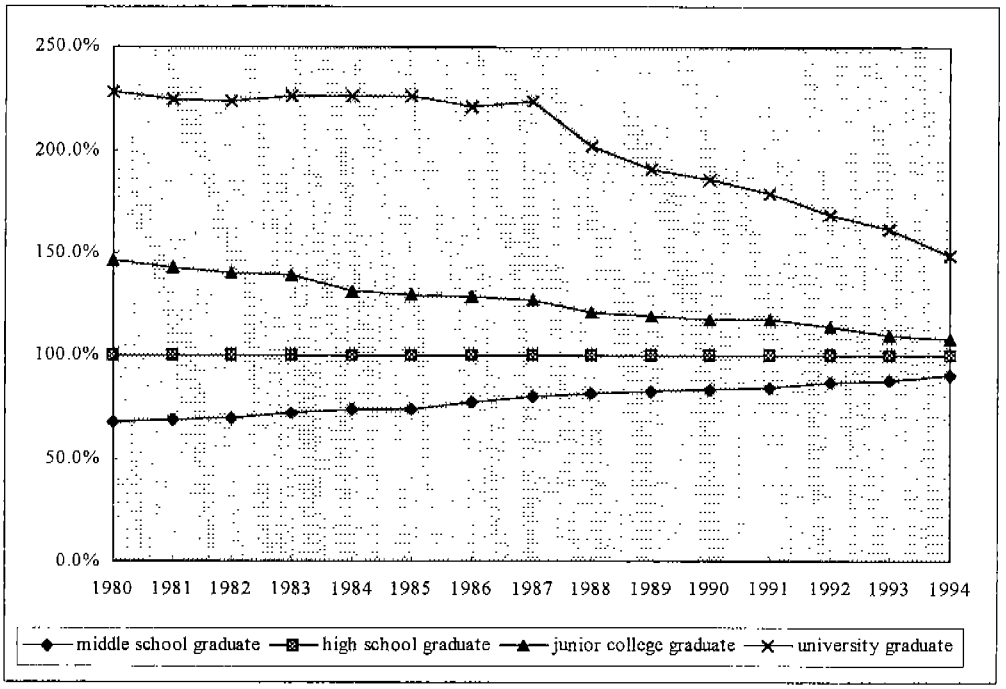


Source : Ministry of Labor, reports on employment forecast, various years

<Figure 1> Trends in manpower shortage rate

various educational levels compared to the average wage of high school graduates. Until the mid-1980s the average wage of college graduates was 2.3 times greater than that of high school graduates, and in 1994 the average wage of college graduates was only 1.5 times greater than that of high school graduates. The average wage of junior college graduates, which was 1.5 times greater than that of high school graduates in 1980, dropped to only 1.1 times greater than that of high school graduates in 1994.

Despite increasing unemployment rates of the highly educated and the narrowing wage differentials by educational levels, the demand for higher education is far from decreasing. Although Korean labor market has recently been characterized by a shortage of low-skilled uneducated workers and a surplus of white-collar workers, this does not seem to decrease the appetite of Korean youth



Source : Ministry of Labor, Wage Structure Survey, Various Years

<Figure 2> Change in relative average wage by educational levels (average wage of high school graduate =1)

for higher education. With the assumption of sticky wages and preferential hiring of the educated, it can be shown that the returns to education is not a simple decreasing function of the number of the educated. As the number of the educated are increased, the educated are bumped into the traditional jobs for the uneducated. When this happens, the expected wage of being educated will remain constant and that of being uneducated will decrease or remain constant when the number of the educated increases. Consequently the expected wage differential between an educated worker and an uneducated worker will remain constant or increase with respect to the number of the educated.[2] This widening expected wage differential

2) See Park, Se-il(1983), and Ko, Sangwon(1992)

between the educated and the uneducated with respect to the number of the educated under the assumption of sticky wages and preferential hiring of the educated can be a possible explanation for a persistent demand for education in Korea. Persistent demand for education in Korea can not simply be explained by better prospect for employment or wage premiums of the educated in the Korean labor market. Rather it can be explained more adequately by deeply-rooted respect for knowledge and elitism of college education which resulting from the strictly enforced college enrollment quota system. Most important positions in government, business, and even academics are monopolized by graduates of selective and prestigious universities. Graduates of prestigious universities are preferentially hired not because of the perceived education quality they have experienced, but because they are judged to be inherently smart to pass the very competitive exam and can get things done through informal connections with alumni friends in important positions.[3] High school graduates have to pass the extremely competitive entrance exam to enter universities. In fact, after-class private tutoring has been prevalent, incurring tremendous off-school education costs and creating serious sense of incompatibility between the rich and the poor. S&T education is substantially influenced by this system. High school education is tailored in such a way to facilitate the preparation for the entrance exam. Creative thinking and exploratory spirit, essential for S&T education, are discouraged. Public understanding of S&T among the younger is also hampered by this system.

2. Unbalanced distribution of S&T human resources among sectors

S&T human resources are not adequately distributed among various sectors. In

3) See Kim, Sookon, Jacwon Kim, and Chonsun Ihm(1990) for the same argument

particular, distributional imbalances in the following three categories are of major concern; distribution of high-caliber researchers among universities, GRIs (government supported research institutes), and industries, distribution of the highly educated workers between manufacturing and non-manufacturing sectors, and distribution of technical workers between large firms and SMEs(small and medium sized enterprises).

The allocation of researchers among sectors of performance

<Table 4> shows allocation of researchers and R&D expenditures among universities, GRIs and industries. As is shown in the table, the distribution of highly-qualified R&D personnel among universities, GRIs, and industries is not in concert with the allocation of R&D expenditure. As table 4 shows, universities retain 77.9 per cent of Ph.D. - holding researchers, but R&D expenditure of universities accounts for only 7.7% of the total. This imbalance is caused by sluggish R&D activities of Korean universities. These imbalances imply that the research potential is under-utilized and basic research is stagnated.

<Table 4> The allocation of researchers and R&D expenditures among sectors of performance, 1994

	Universities	GRIs	Industries	Total
Researchers	42,700(36.4%)	15,465(13.1%)	59,281(54.7%)	117,446(100%)
Researchers holding Ph.D. Degree	26,475 (77.9%)	4,725 (13.9%)	2,798 (8.2%)	33,998(100%)
R&D Expenditure (in 100 million won)	6,089 (7.7%)	15,406 (19.5%)	57,452 (72.8%)	78,947(100%)
Government financed R&D expenditure (in 100 million Won)	1,710 (13.6%)	9,829 (78%)	1,063 (8.4%)	12,602(100%)
R&D expenditure per researcher (in 1,000 Won)	14,259	99,619	96,916	67,220(100%)

Source : *Report on the Survey of Research and Development in Science and Technology*, MOST, 1995

To address this problem, the government has endeavored to promote basic science. Governmental support for basic science is mainly supervised by MOST(Ministry of Science and Technology) and MOE(Ministry of Education). KOSEF(Korea Science and Engineering Foundation) under MOST and the Korea Academic Promotion Foundation under MOE are the managerial bodies.

Encouragement of excellence in research centers is the major tool for promoting basic science in universities. The Engineering Research Center /Scientific Research Center(ERC/SRC) Program was initiated to improve capability for self-supported technology development by organizing scientific human resources in specific research areas at universities, by energizing basic research, and by fostering superior talents. The SRCs focus on new theory in basic science and in-depth research on phenomena, while the ERCs emphasize developing highly advanced technology for developing industries. To apply for ERC or SRC status, more than twenty professors from at least five universities must participate. ERCs and SRCs are selected with a view to their research capability and to balance development of the regional universities. To insure the continuation of research activities, they receive government aid for a period of nine years, provided that periodic evaluation, conducted every three years, show good progress. Currently, there are 17 SRCs and 21 ERCs and the number is expected to grow significantly over the next few years. ERCs and SRCs are designated in connection with regional industries, so that they can meet local demands. Another mechanism to expedite basic research is providing expensive high-tech R&D equipment and facilities. The Korea Basic Science Center assumes this task by maintaining equipment that can be shared by universities and related organization[4)]

Distribution of highly educated across industries

Employment of highly educated human resource is concentrated in the

4) Reviews of National Science and Technology Policy, *Republic of Korea, Background Report*, p58-59, OECD, 1996

non-manufacturing sector. In 1995, the lions share of highly educated workers was employed by the non-manufacturing sector, whereas only 19.3% belongs to the manufacturing sector(See table 5). Hypothetically, the underlying reason is three-fold. First, skills and knowledge of the highly educated might be insufficient to meet the demand of the manufacturing sector. Second, as pointed out previously, the academic field specialty structure and composition of education system may not correspond to the industrial demand of manufacturing sector. Third, seemingly dominant factor, job conditions of manufacturing sector may be inferior to that of service sector. At any rate, the unbalanced distribution erodes the industrial competitiveness of the manufacturing sector

<Table 5> The educational composition of employment within and across the industries

unit : thousand, %

	1985			1990			1995		
	highly educated	total	%	highly educated	total	%	highly educated	total	%
Agriculture, forestry & Fishery	42 (2.7)	3,722 (24.9)	1.1	41 (1.7)	3,292 (18.3)	1.2	52 (1.4)	2,541 (12.5)	2.0
Mining	6 (0.4)	154 (1)	3.9	4 (0.2)	81 (0.4)	4.9	1 (0.03)	27 (0.1)	3.7
manufacturing	336 (22)	3,500 (23.4)	9.6	517 (21.0)	4,847 (26.9)	10.7	736 (19.3)	4,773 (23.4)	15.4
electricity, gas & water	12 (0.8)	41 (0.3)	29.3	20 (0.8)	70 (0.4)	28.6	22 (0.6)	69 (0.3)	31.9
construction	85 (5.6)	908 (6.1)	9.4	144 (5.8)	1,339 (7.4)	10.6	287 (7.5)	1,896 (9.3)	15.1
wholesale/ retail trade, hotels, restaurants	277 (18.1)	3,370 (24.6)	8.2	462 (18.8)	3,290 (21.7)	11.8	775 (20.3)	5,358 (26.3)	14.5
transport, storage & communication	66 (4.3)	698 (4.7)	9.5	101 (4.1)	922 (5.1)	11.0	160 (4.2)	1,068 (5.2)	15.0
finance, insurance & real estate	121 (7.9)	561 (3.8)	21.6	224 (9.1)	936 (5.2)	23.9	512 (13.4)	1,635 (8.0)	31.3
community, social & personal services	58.6 (38.3)	1,980 (13.3)	29.6	949 (38.5)	2,649 (14.6)	36.1	1,277 (33.4)	3,010 (14.8)	42.4
total	1,529	14,395	10.2	2,463	18,036	13.7	3,822	20,377	18.8

Source : National Statistical Office, Economically Active Population Survey, various years

The distribution of S&T human resources by firm size

S&T manpower is not adequately distributed between large conglomerate and SMEs. Table 6 exhibits the shortage rate of technical manpower during 1985-1993. The rate has more than doubled between 1989 and 1991, with a slight downturn afterwards. In case of SMEs, however, the rate has almost tripled from 1985 to 1993. The increasing gap between large firms and SMEs is mainly due to the sharp increase in wage differential, as shown in table 7. This imbalance causes low productivity and innovativeness of SMEs in turn, deteriorating the overall competitiveness of the Korean Economy.

<Table 6> Shortage rate of technical manpower within industries

unit : %

	1985	1987	1989	1991	1993	1995
Industry average	1.6	1.9	1.8	3.9	3.4	2.3
shortage rate of SMEs	1.8	2.3	2.8	5.6	5.1	3.1

note : technical manpower here is defined to indicate following occupations according to ISCO-68 for the year 1985, 1987, 1989. 02/03: Architects, Engineers & related technicians; for the year 1991, 1993 and 1995 technical manpower here is defined to indicate following occupations according to ISCO-88

21 : Physical, math and engineering science professionals; 22. Life Science and health professionals

31 : Physical and engineering science associate professionals, 32: Life science and health associate professionals

Source : Ministry of Labor, reports on employment forecast, various years

<Table 7> Relative average wage level of SMEs in manufacturing comparing to large firms in the manufacturing sector

unit : %

	1980	1985	1987	1989	1991	1993	1994
relative wage level of SMEs(average wage level of large firms =100)	80.2	75.0	72.2	66.3	67.2	65.9	64.7

Source : national statistical office, report on mining and manufacturing survey, various years

3. Expected changes in the supply in the future and S&T human resources policy directions

Expected changes in the labor supply

Four major changes are expected in the supply side of the labor market during the next 10-15 years. This includes a sudden decrease in the number of high school graduates between year 2000 and 2003, an increasing labor force participation of women, an increasing proportion of aged workers and an increasing trend of internalization of Korean labor market. Expected changes are elaborated below.

(a) a sudden decrease in the number of high school graduates

Table 8 shows the expected number of high school graduates and their advancements to higher educational levels. Due to the decline of the absolute labor force size of age-cohort corresponding to high school age category in the future, presuming that application rate of high school graduates to higher education level remains high, there will be a major decline of high school graduate who would enter the labor market. As the second baby-boom generation graduates high school, the number of high school graduates is expected to increase from 650,000 in 1995 to 740,000 in 2000. The number of high school graduates will start to decrease in 2000 and will be down to 560,000 in three years. This cumulative decrease is equivalent to 24 per cent of annual high school graduates. Starting from the year 2003, the number of high school graduate is expected to remain at the level of 560,000 until the year 2010.

The expected change in the number of high school graduates in the next 15 years requires the following policies. First, in order to encourage high school graduates entering the labor market instead of advancing into higher educational institutions, vocational educational systems must be developed. Second, incentives are required for the firms to introduce automated production processes and to change personnel management strategies toward attracting blue-collar workers

<Table 8> Expected decline in high school graduates entering labor market

	1995	1997	2000	2003
Population of aged 18	767,795	785,719	838,029	663,143
expected number of high school graduates	651,000	660,000	742,000	564,000
expected newly entrants to labor markets among high school graduates	219,932	190,219	189,695	112,800

Source : Lee Ju-ho, Manpower Forecasts and Higher Education Reforms, The Korea Development Review, Vol. 16, No. 4, Winter 1994

and reducing their turnover rates. Third, policies supporting the utilization of foreign workers need to be expanded in the future. The issues of international mobility of workers will be analyzed again in section (d).

<Table 9> Past and Predicted ratio of female to male in labor force by age group

	15-19	20-24	25-59	60 and over	total
1990	1.59	1.66	0.57	0.81	0.68
2010	1.38	2.19	0.67	0.65	0.72

Source : Park, Foonku and Chonghoon Rhee, Long term manpower forecast, KDI, 1993

<Table 10> Ratio of female students in University enrollment

Unit : %

country(year)	Natural Science		Engineering	
	Men	Women	Men	Women
Korea(1990)	69.0	31.0	95.0	5.0
Japan(1991)	81.0	19.0	93.8	6.2
U.K.(1989)	64.9	35.1	87.9	12.1
Germany(1989)	70.3	29.7	87.7	12.3
U.S.A.(1989)	69.6	30.4	84.8	15.2

Source : *Human Resources for Science & Technology: the Asian region,* NSF, 1993

(b) increasing labor force participation of women

Generally speaking, female S&T human resources has been under-utilized.

Although women account for a large portion of the highly educated, their employment rate is low. It is predicted that the proportion of the female labor force will be increased in the future as the participation rate of the women increases(see table 9). The average wage of female workers was only 58.4% of that of male workers in 1994, although this is a remarkable hike when compared to 42.2% in 1975. This wage differential exists not because female workers are paid less in the same job but because they are mostly hired in low-paying jobs.

As shown in Table 10, female students account for only 5% of the enrollment in engineering, which is quite low compared to major OECD countries. In natural science, however, female students account for 31% of the total enrollment, which is relatively high. Thus, full utilization of female natural scientist and active inducement of female students to engineering is one of the major tasks Korea must confront.

<Table 11> Forecast of composition of labor force by age-group

unit : %

	15-19	20-24	25-59	60 and over	total
1990	3.4	10.8	78.8	7.0	100
1995	1.9	10.1	80.0	8.0	100
2000	1.6	8.4	80.8	9.3	100
2005	1.1	7.5	80.9	10.5	100
2010	1.0	6.0	81.2	11.8	100

Source : Foonku Park & Chonghoon Rhee, Long term manpower forecast, KDI, 1993

(c) an increasing proportion of aged workers

Creation of jobs for experienced aged human resources is another concern. According to the forecast of labor force composition by age-group, the proportion of the aged(60 and older) displays an increasing trend. However, it is also predicted that the proportion of the prime-age group(25-59) will increase as well,

making the aged difficult to find jobs. Because the accumulation of scientific and technological knowledge is indispensable in a competitive society, the utilization of experienced human resources is important. In that regard, creation of jobs for the aged requires attention.

(d) increasing trend of internalization of Korean labor market

With labor shortage and rising wages, Korea has attracted foreign workers as the other countries have.[5] In August 1994, 4,481 foreign workers had been legally hired in professional jobs while 22,129 had been legally hired in unskilled jobs. An estimated 80,000 to 100,000 illegal foreign workers had been illegally employed in unskilled jobs. The foreign employment has played a important role in reducing labor shortage rate, especially in unskilled jobs. The expected decline of labor market entrants with lower educational background calls for policies supporting efficient utilization of foreign labor force. On the other hand, heavy reliance on foreign workers would slow down the pace of automation and impede overall structural adjustment.[6] Korea must find balance between cost and benefits of hiring foreign workers.

Since the 1960s, attracting and deploying Korean scientists and engineers who were educated and living abroad have been a strategic issue. In particular, U.S. higher education institutions have been a significant source for doctoral education of Korean students. As shown in Table 12, about one-half of natural science and engineering Ph.D. holders were educated in U.S. universities.[7]

---

5) Pacific Economic Cooperation Council, Human resource Development Outlook 1994-1995, Times Academic Press, 1994

6) Pacific Economic Cooperation Council, Human resource Development Outlook 1994-1995, Times Academic Press, 1994

7) The data for Korean students studying other countries are not available, but in relation to S&T, the number of students is presumed to be insignificant.

<Table 12> Doctoral degrees in natural science and engineering awarded domestically and in the U.S. in 1992

Unit : number

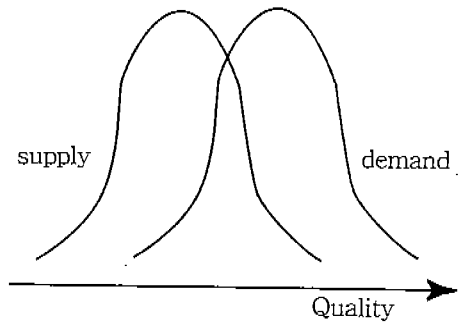
Within-country		U.S. Universities	
Natural Science	Engineering	Natural Science	Engineering
432	798	413	435

Source : Statistical Yearbook of Education, Ministry of Education, Republic of Korea, 1992
KAIST, enrollment statistics, unpublished data
Science & Engineering Indicators, NSF, 1996

Until recently, Korean scientists and engineers working abroad have been repatriated with financial support. A total of 2,178 scientists and engineers (including foreigners) in advanced countries were invited by research institutes, colleges, and industries to come to Korea on a permanent or temporary basis during the period between 1968-1994.

The trend of getting advanced degrees in advanced countries is expected to continue in the future. The future policy of attracting scientists and engineers from foreign countries will not be restricted to Korean students studying abroad but extended to persons with right qualifications regardless of nationality.

Diagrammatic model of labor demand and supply taking into account heterogeneity of workers

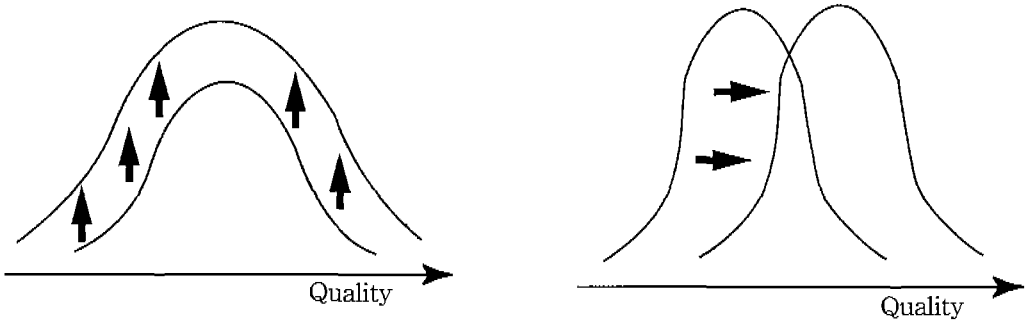


<Figure 2> Diagrammatic model of labor demand and supply

In the textbook model , labor demand and supply are determined by the real wage rate. A higher real wage increases workers incentive to work and decreases firms incentive to hire workers. Consequently we have upward sloping labor supply schedule and downward sloping labor demand schedule. In the intersection of labor demand and labor supply schedules, we can find the equilibrium level of employment and real wage rate. According to this model, every worker is paid same level of real wage. In fact, there exists considerable wage dispersion among workers and this model fail to recognize the heterogeneity among workers. A productive worker is willing to work only if level of compensation is comparable to his productivity and firms are willing to pay higher wage to the productive workers. In the labor market, hence, right question to ask is what is the demand for workers with certain characteristics? and not what is the aggregate demand for labor? Labor market can be classified into various sectors among which mobility is restricted. The equilibrium in each classified labor market has more relevance to the policy makers than equilibrium of the labor market as a whole. There are many ways to classify the labor market. First, the labor market can be classified from the demand side. It can be classified by industries, firm-sizes and so forth. On the other hand, the labor market can be classified from the supply side. Workers characteristics such as educational level, major field of study, sex, age can be bases for classification.

From now on, we focus our attention to highly educated S&T human resources and classify labor market for highly educated S&T human resources according to major field of study of workers. The demand for worker in a particular major field of study is dependent upon economic growth rate, industrial structure, and occupational structure within industry. Quality of a worker should be measured by his productivity. Productivity of the worker is only observed from the demand side of labor market and it can be hypothetically corresponded to workers characteristics from the supply side of labor market. In figure 2, hypothetical demand and supply of labor for a particular major field of study is given. In this

figure, both demand and supply are assumed to indicate stock rather than flow for analytical conveniences. For hypothetical case of figure 2, there exists excess supply for lower quality of workers and excess demand for higher quality of workers. To correct this situation, we should adjust either labor demand or labor supply. Labor demand is derived from firms optimization process and has a greater danger of hurting efficiency when intervention policy is adopted. Labor supply is closely related to education and training system and more policy-relevant. There might be some disagreement about supply side of labor market having more room for policy intervention, but I will treat supply adjusting policy as an only viable option.



<Figure 3> Policy options of adjusting supply of labor

Diagramatically, there are three ways to adjust the supply to correct the situation; a)shift supply curve vertically, b)shift supply curve horizontally, c)shift supply curve both vertically and horizontally. Shifting supply curve upward can be called as a quantity increasing policy, since it increases supply of workers in a particular major field of study for every quality level. Shifting supply curve to the right can be called as a quality improving policy, since it will only upgrade quality of the workers in a particular major field of study without increasing the stock of workers. These two cases are drawn in figure 2. To increase enrollment in higher education, to reduce the case of brain drain are examples of quantity increasing policy. To improve student-faculty ratio, to have more efficient on-the-job

training program are important examples of quality improving policy. In most of the cases, government should optimally mix both a quantity increasing(or decreasing) policy and a quality improving (or downgrading) policy to correct the situation in the labor market. Major challenge to the policy maker is to find a more appropriate way to measure quality of a worker from characteristics of a worker. We should make educational system and national certification system efficient enough to signal appropriate quality measures of entrants to the labor market.

Educational reform

The government announced drastic reform in the education system on May 31, 1995. The main goal of the reform is to give more autonomy to schools to facilitate competition among suppliers of education. The reform intends to raise the responsiveness of educational system to changing demand patterns of industry. Under the reform plan, every school is allowed to set tuition fees and the number of enrollment by itself, which is tightly regulated at present. Regulation of the establishment of universities and colleges will be relaxed so that anyone including the Chaebol can establish one. High schools are required to submit complete record of academic and non-academic performance of the students so that universities may use it in screening applicants for education. Cross recognition of credit among universities will be introduced. Most importantly the government expenditure on education will be increased to 5 percent of GNP. The educational reform will make the Korean educational system more responsive to the market . However, full autonomy and diversity of the educational system does not guarantee the reduction of huge spending outside of formal educational system which is estimated to be two times larger than total government spending on education.

The main task of the Korean educational system is to improve the quality of education. In terms of a simple diagrammatic model of labor demand and supply previously sketched, Korea has been focused on a quantity increasing policy rather than a quality improving policy. Korea needs to find an optimal mix of a quantity

increasing policy and a quality improving policy in the labor market classified by major fields of study. Korea should improve the quality of formal education not only to make educational system more responsive to changing demand patterns but also to cut down the huge spending outside the formal educational system.

REFERENCES

1. Cho, Soon, "The dynamics of Korean Economic Development", *Institute for International economics,* 1994
2. Kim, Sookon, Jaewon Kim, and Chonsun Ihm, *Human resource Policy and Economic development: Republic of Korea, in Human Resource Development -Selected country studies,* Asia Development Bank, 1990
3. Ko, Sangwon, *The Consequences of educational expansion in less developed countries, unpublished doctoral dissertation,* Cornell University, 1992. 8
4. Ko, Sangwon & Jinkyu Jang, *S&T human resources forecast and manpower policy directions,* STEPI, 1995(in Korean)
5. Jung, Jinhwa, *Educational Expansion and Human Resource Development Policy Directions, mimeo,* KIET, 1996. 4(in Korean)
6. Lee Ju-ho, "Manpower Forecasts and Higher Education Reforms", *The Korea Development Review,* Vol. 16, No. 4, Winter 1994(in Korean)
7. Lee, Won -Young, *Building Koreas Scientific and Technological Infrastructure, mimeo,* STEPI, 1995
8. Ministry of Education, *Education in Korea 1993-1994,* 1995
9. MOST/STEPI, *Review of National Science and Technology Policy - Republic of Korea- Background Report,* 1995
10. NSF, *Human Resources for Science & Technology : The Asian Region,* 1993
11. OECD, *Reviews of National Science and Technology Policy - Republic of Korea-,* 1996
12. Pacific Economic Cooperation Council, *Human resource Development Outlook 1994-1995,* Times Academic Press, 1994
13. Park, Funkoo and Chonghoon Rhee, *Long term manpower forecast, in Issues in Economic Development of Korea,* KDI, 1993 12(in Korean)
14. Park, Se-il, "Labor market Consequences of educational expansion", *The*

Korea Development Review, Vol. 5, No. 1, 1983(in Korean)

15. Park, Se-il, "Labor Issues in Koreas future", *World Development,* Vol. 16, No. 1, 1988
16. Presidential Commission on the 21st Century, *Korea in the 21st Century,* Seoul Press, 1994