WAGE INEQUALITY AND INTERNATIONAL TRADE*
— THE U. S., KOREA, AND DECREASING TARIFF —

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1. INTRODUCTION

Changes in the wage structure in the U. S. over the past 25 years or so have been a hot debate in recent years and are well documented in the empirical labor literature[1]. This paper documents wage inequality in the U. S. from 1967 to 1989 and relates change in wage inequality in the U. S. to international trade. In so doing, the paper will try to provide a rationale for the cause of wage inequality by setting up a model. This model shows what would happen to wage inequality when tariffs are lowered. Moreover, to check the validity of the model, the paper also shows what actually happened to wage inequality in Korea over the 1970s and 1980s.

2. WAGE INEQUALITY IN THE U. S.

2.1 Data

The main data we use are from the March Current Population Survey (CPS), also known as the Annual Demographic File, from 1967 to 1989(survey years 1968 to 1990)[2]. For purposes of analysis we selected a sample according to the following conditions : Workers are male, over 17 and less than 66 years old, non-agricultural, not self-employed or working without pay, participate in the labor force a minimum of 39 weeks and work at least 1 week, have at least a year of experience, and

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 1) For Example, Murphy and Welch (1987, 1988, 1989), Juhn, Murphy and Pierce (1989), Bound and Jonhson (1989), Krueger (1991), Katz and Kruger (1991), Borjas, Freeman and Katz (1991), Davis and Haltiwanger (1991), Katz and Murphy (1991), Mincer (1991), and Freeman (1991) are among them.
 2) For more information on the CPS, see Nahm (1993).

earn a minimum of $67.00 per week and a maximum of $3097 per week³ in 1982 dol-
lars. We imputed the weekly earnings for workers topcoded at the census maximum
as 1.45 times the topcoded value, as usual. For data years prior to 1975 the weeks
worked and the weeks looking for work are available only on a bracketed basis.
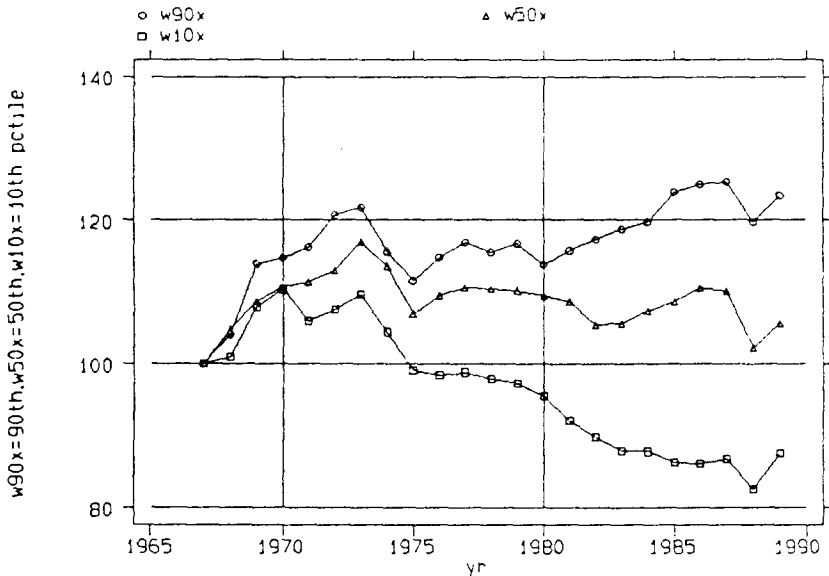Weeks for these years are imputed using cell means for the later years for male
workers.

Fiqure 1. Real Weekly Wages by Percentile : 1967=100

Using these criteria results in approximately 620,000 observation of wage data.
We divided annual wages and salaries by weeks worked to get weekly earnings and
then we deflated weekly earnings by the personal consumption expenditure defla-
tor from the national income and product accounts (1982=100) to obtain real week-
ly wages.

2.2 Increasing Wage Inequality

Table 1 presents the average real weekly earnings of male workers. The average
worker earned $406(in 1982 dollar) a week in 1967. In 1973 his wage peaked at $470
and decreased to $435 in 1981, and increased again to $447 in 1989. Thus, an average

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3) To discard bad wages in the lower tail we chose a cutoff level which is equal to a half of the 1982 real minimum wage
based on a 40 hour week. To discard bad wages in the upper tail we chose a cutoff level which is equal to the topcode
amount $199,998 in 1988 that a full-time full-year worker can record in real earnings. Until 1987 it was $99,999 and in
1988 it changed to $199,998.

worker in 1989 gained only 10 percent relative to an average worker in 1967.

Also in table 1 are wages for the 90th, median and 10th percentile of the wage distribution. In order to see the wage behavior over time more clearly, we indexed real weekly earnings to 1967 value for each percentile. The indexed real weekly earnings are graphed in figure 1.

Now, look at the real wages by percentile in table 1 and figure 1 at the same time. The median worker earned $364 a week in 1967, while the 90th earned $615 and the 10th earned $203 a week. In the beginning, wages for workers at all levels increased. Since the early 1970s, however, wages behaved differently at each lebel. Median wages have been on the decreasing side within a 105-115 range since 1973, while wages for the 90th percentile have increased since 1975. Meanwile, wages of the 10th percentile decreased since 1971. More specifically, in 1989 the median worker earned $385 a week, while the 90th and the 10th earned $755 and $178 a week respectively. Thus, since 1970 workers at the 10th percentile have lost about 25 per-

Table 1. Real Weekly Wages : U. S. Economy

Year	Mean	90th	50th	10th
1967	406.14	614.69	363.69	203.31
1968	417.98	637.11	382.26	205.34
1969	440.84	704.64	396.14	219.38
1970	448.71	704.86	404.06	224.48
1971	449.07	712.07	407.51	214.48
1972	466.52	742.36	412.42	217.76
1973	470.45	749.44	427.14	222.11
1974	452.70	706.44	414.73	210.88
1975	435.84	682.17	389.81	201.40
1976	441.58	706.56	399.36	199.68
1977	444.71	720.79	403.64	201.42
1978	447.51	711.75	402.88	197.91
1979	444.45	713.16	402.03	196.73
1980	437.33	699.50	399.72	192.93
1981	434.91	711.50	396.41	186.41
1982	435.01	721.15	384.62	182.02
1983	434.14	730.81	384.25	177.34
1984	444.53	734.72	391.38	177.90
1985	452.32	758.20	396.33	174.04
1986	459.75	771.96	403.80	174.98
1987	456.02	771.80	401.98	176.87
1988	426.58	740.21	372.08	167.47
1989	446.94	755.02	384.91	177.65

Source : March CPS tapes

cent, while workers at the 90th percentile have gained about 10 percent. After all, over the last 23 years the workers at the top 10 percent have gained about 40 percent realtive to those who at the bottom 10 percent[4].

3. WAGE INEQUALITY AND INTERNATIONAL TRADE

As is shown above, the U. S. has experienced increased wage inequality among male workers since the late 1960s. However, we do not know what caused wage inequality to rise in the U. S. there is controversy about the driving force behind the phenomenon. Increased openness of the U. S. market to the rest of the world has been suggested as a leading hypothesis[5].

3.1 Existing studies

Starting with the question whether the data is consistent with exogenous supply and stable labor demand, Murphy and Welch (1987) show that there are movements in wages and quantities that are inconsistent with a stable demand explanation, and they search for a demand shifter. Finding that demand shifts were particularly important in the 1980s, they consider net imports of durable goods as a candidate for demand shifter, and they show that relative wages for skilled workers increase with a rise in durable imports, especially in the 1980s, using a sample of white males of all sectors.

Their paper has encouraged many authors to investigate the impact of foreign trade on the wage and employment changes. Murphy and Welch later (1988) set up an empirical model with a constant factor price assumption, that relates changes in the composition of the product demand to trade and to shifts in demand for the different labor groups. They show that demand for white male coollege graduates increased between 1979 and 1986 in response to trade deficits, indicationg that international trade might have played an important role in creating wage differentials in the 1980s.

Borjas, Freeman and Katz(1991) examine the contribution of less-skilled immigrants and the importance of imports in the U. S. economy to the trend of falling wages and employment rates of the less-skilled. They show that both trade and immigration augmented the nation's supply of less-skilled workers, particularly workers with less than a high school education. They attribute from 15 to 25 percent of the rise in the college/high school relative earnings from 1980 to 1985 to the increase in the trade deficit over the same period[6].

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4) The increase in inequality can be decomposed into that due to observable characteristics and unbservables. About two thirds of the increase are due to unobservables such as international trade. Even after change in distribution and price of observables were controlled for, the inequality increased in the U. S. See Nahm(1993).

5) Another important hypothesis suggested dy many authors is biased technological change, such as the growing use of computer, which favors skilled workers.

6) In contrast, they found that immigration had only a small effect on the college/high school wage differential.

Bound and Johnson (1989), Davis and Haltiwanger (1991), Mincer (1991), and Katz and Murphy (1991) also mention, but with less emphasis, the international trade effect on wage inequality[7].

However, the above studies do not provide a rationale why increased wage inequality should be associated with international trade. Murphy and Welch (1987) say only that "Since foreign competition has been intense in areas such as autos, steel and the other primary industries where high school graduates and the less educated workers have traditionally done well, incredased foreign competition is likely to reducse relative wages for these groups". Murphy and Welch (1988) also fail to show the effect of imports on the wages due to the constatn factor price assumption. Borjas, et al. (1991) also have not developed a complete analysis of how trade-induced changes in relative labor skill endowments play themselves out across sectors or how they interact with changes in productivity across sectors. Moreover, they do not show why and how the wages of the skilled workers have gone up.

In the next section using our data we will examine if international trade really matters. That is, we will see if there is any difference in the wage inequality between international trade sector and non-international trade sector. Then, we will give a rationale for the international trade hypothesis as the cause of the wage inequality. We will discuss why increasing openness of the U. S. market would result in higher wage inequality in the U. S. by adopting a simple international trade model.

3.2 Does International Trade Really Matter?

In this section we divide the economy into the international trade sector [TRADE] and the non-international trade sector [NTRADE]. International trade sector consists of goods sector and service sector. In the goods sector are manufacturing, mining, and agriculture, fishery, and forestry. In the sevice sector are transportation, advertisement, etc.[8] Non-international trade sector sector consists of government sector and non-trade private sector[9].

On the average, workers in the trade sector earn more than those in the non-trade sector. An average worker in the trade sector earned $416 a week in 1967, while a worker in the non-trade secotr earned only $396 a week. In the trade sector, by 1973 his wage increased to $478, but then it decreased and never gained to the level in 1973 until 1984. In 1986 the average wage became the highest at $503. A little

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7) The first three works put more emphasis on technological change effects on wage inequality, while the last authors give more weight to the increases in the relative supplies of more educated workers.

8) In the service sector are transportation, communications, advertisement, commercial research, development and testing labs, business management and consulting services, computer and data processing sevice, hotels and motels, theaters and motion picutres, legal services, engineering, architectural and surveying services, accounting, auditing and bookking services, and finance, insurance, and real estate. For the service sector internationally involved, see Anthony DiLullo and Obie Whichard (1990).

9) In the non-trade private sector are construction and the rest of the service industries, which include, for example, wholesale trade, retail trade, personal services, repair services, etc.

different story goes to the non-trade sector. In the non-trade sector 1973 saw the highest real wage of $464. Since then the average real wage never gained to that level, but rather was on the down side.

Now, look at wages for the 90th, 50th, and 10th percentile. We indexed real week-ly wages to 1967 values for each percentile as in figure 2. Also in figure 2 are the log wage differentials between the 90th and 10th percentiles for each sector. Panel A and C are for the trade sector. Until 1973 wages for all workers increased and since
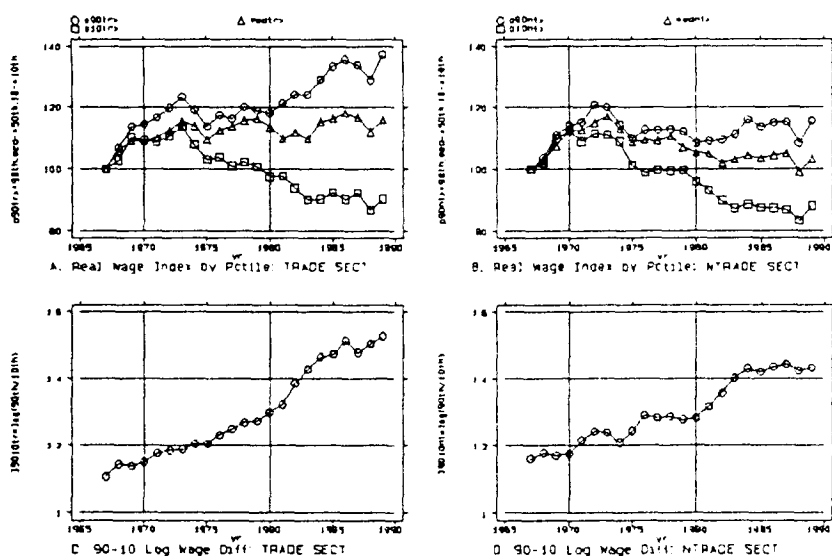

Figure 2. Wage Index by Pctile and Log Wage Diff by Sect

then wages have behaved differently by each percentile. Wages for the 90th de-creased until 1975 and then increased until 1989 more or less. The median wages have been fluctuating within 110-120 range. The 10th percentile wages have de-clined since 1973. Thus, 23 years later, workers at the top 10 percent gained about 50 percent relative to those in the bottom 10 percent in terms of real wage. In terms of log wage, the 90-10 inequality increased by about 38 percent (1.52/1.1) in 23 years.

Quite different stories go to the non-trade sector in panel B and D. Until 1972 the 90th percentile in the non-trade sector increased and then it decreased until 1980. Since 1980 it has been on the increasing side within the 110 and 120 range. In this sector wages for the median as well as for the 10th percentile decreased since the early 1970s. Thus, after 23 years, workers at the top 10 percent gained about 16 per-cent and workers at the bottom 10 percent lost about 12 percent relative to those in 1967. As a result, workers at the top 10 percent gained about 28 percent relative to

those in the bottom 10 percent over the period in terms of real wage. In terms of log wage, the 90–10 differential increased by about 24 percent (1.43/1.15) in 23 years.

Wage inequality in both sectors increased since 1967. However, there is a substantial difference in the amount of changes in inequality between these sectors. As is clear from the figure, the international trade sector experienced a more rapid increase in the inequality. As a result, beginning with lower inequality in 1967, the trade sector ended up being more unequal by 1980, and thereafter, than the non-trade sector. This finding tells us that international trade really matters. In what follows, we provide a rationale why international trade increases wage inequality in the U. S.

3.3 Decreasing Tariff Effect on Wage Inequality

Assume a perfectly competitive economy for the U. S. Technology exhibits constant returns to scale and is described by $(a_{ij})_{2\times2}$, where a_{ij} denotes the guantity of factor i required to produce a unit of commodity j. Then, the unit cost of producing each product is equal to the price of the product which is given to this country. That is,

(1) $a_{lc}w+a_{sc}r=P_c$
(2) $a_{lf}w+a_{sf}r=P_f,$

where w and r are wages for labor(L) and skill(S), and P_c and P_f are prices for clothing(C) and financial services(F), respectively.

Suppose the U. S. is relatively skill abundant and imports clothing(C) and imposes an ad valorem tariff on the imports at the rate of t. Then in the U. S. domestic price of C becomes $q_c=(1+t)p_c$ and the unit cost equations above would become

(3) $a_{lc}w+a_{sc}r=(1+t)p_c$
(4) $a_{lf}w+a_{sf}r+p_f.$

Then, we have the following lemma about the effect of tariff on the factor rewards.
Lemma A : dw/dt>0 and dr/dt<0 if $a_{lc}/a_{sc}>a_{lf}/a_{sf}.$
Proof : Totally differentiating (3) and (4), we have

(5) $wda_{lc}+rda_{sc}+a_{lc}dw+a_{sc}dr=(1+t)dp_c+p_cdt$
(6) $wda_{lf}+rda_{sf}+a_{lf}dw+a_{sf}dr=dp_f$

However, the envelope theorem says that

(7) $wda_{lc}+rda_{sc}=0$
(8) $wda_{lf}+rda_{sf}=0$

Thus, we have

(9) $a_{lc} dw + a_{sc} dr = (1+t)dp_c + p_c dt$
(10) $a_{lf} dw + a_{sf} dr = dp_f$

We now solve for dw/dt and dr/dt, with $dp_c = dp_f = 0$ from a small country assumption. From (10) we have

(11) $dr = -(a_{lf}/a_{sf})dw.$
Plug (11) into (9) to get
(12) $dw = [p_c/(a_{lc} - a_{sc}*a_{lf}/a_{sf})]dt.$

Then, we have

(13) $dw/dt = p_c/(a_{lc} - a_{sc}*a_{lf}/a_{sf})$
(14) $dr/dt = p_c/(a_{sc} - a_{lc}*a_{sf}/a_{lf}).$ QED.

Lemma A says that increase in tariff would increase wage of labor and decrease wage of skill if C industry has a higther labor/skill ration than F industry. Note the lemma also implies that for a skill abundant country, as long as import competing industry has a higher labor/skill ratio, the decrease in tariffs on importables results in decreasing wage for labor and increasing wage for skill. In other words, for a skill abundant country like the U. S, as long as import competing industry has a higher labor/skill ratio, the opening up the country for a free international trade would result in increasing wage ratio of skill to labor. This explains why we see increasing wage inequality in the U. S. since the late 1960s when the U. S. started to net-trade.

Now, let's look at another country with a different composition of factor endowment, say, Korea, which imports F. With the same model instead of (3) and (4) we have

(3') $a_{lc}w + a_{sc}r = p_c$
(4') $a_{lf}w + a_{sf}r = (1+t)p_f$
Then, a corollary follows.

Corollary A : dw/dt < 0 and dr/dt > 0 if $a_{lc}/a_{sc} > a_{lf}/a_{sf}$.
Proof : Follow the steps in Lemma A. QED.

What this corollary says is that quite opposite to the case of the U. S. As long as F industry has a lower labor/skill ratio, the opening up Korea for a free international trade (or, decreasing tariffs on importables) results in the increasing wage for labor and the decreasing wage for skill, which is to say decreasing wage inequality in Korea. Thus, the model not only explains increasing wage inequality in the U. S., but also predicts decreasing inequality in countries like Korea. The next section

shows how wage inequality changed in Korea.

4. WAGE INEQUALITY IN KOREA

4.1 Data

I refer to the data set Occupational Wage Survey (OWS) reported annually by the Ministry of Labor, Korea. Data available to me are from 1972 to 1988 in every other year and 1989, a total of 10 years of micro data with about 30,000 observations a year randomly selected from the OWS tapes. Wages are based on the monthly payment. There are regular payments and overtime payments[10]. Throughout the essay I define monthly payment as the sum of regular payment and overtime payment and focus on the real hourly wages and log real hourly wages. I deflated monthly payment by the consumer price index (1985=100) and defined the real hourly wage as the deflated monthly payment divided by hours worked a month, where hours worked are the sum of regular work hours and overtime work hours.

Sample selection criterion for this paper is as follows. Male workers from 16 years old to 65 years old working between 80 and 450 hours a month should earn real hourly wage of at least 50 won in 1985 won. This criterion gives rise to the data of total 189, 036 wage observations of working men.

4.2 Decreasing Wage Inequality

Given the data set described in the last section, this section presents how the average real wage and wage inequality changed over the last two decades in Korea.

Table 2 presents real hourly wage for the mean. The average male worker earned 712 won an hour in 1972. In 1984 his wage became 1488 won, more than double the wage in 1972. By 1989 he earned 2127 won, about 3 times the wage in 1972. Average real hourly wages have steadily increased since 1972 and in 1989 the wages are triple what they were in 1972. This increase in average real wage in Korea is an amazing phenomenon, especially compared to U. S. real weekly wages which decreased from 1973 to 1983 and then gained a little bit since 1983.

Then, a question one might ask is if all workers gained equally. The following part of this section examines how the wage gains ae spread across workers.

Table 2 also presents real hourly wages for the 90th, 50th and 10th percentile. A worker in the 90th percentile of wage distribution earned 1289 won in 1972. With an average increase of 10 percent a year, his wage increased a little less than 3 times by 1989. A median worker earned 582 won in 1972 and 1847 won in 1989. That is, with an average increase of 12.8 percent a year, his wage increased more than 3 times. A

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10) Th...

worker in the 10th percentile earned 246 won in 1972 and 1057 won in 1989. That is, with an average increase of 19.4 percent a year, his wage increased more than 4 times in 17 years. The wage of the least skilled worker, proxied by the 10th percentile in the wage distribution, increased very rapidly relative to the wages of the more skilled. Thus, wage inequality declined in Korea over the observed period.

To show decreasing wage inequality more clearly, figure 3 graphs indexed real hourly wages. It graphs the 10th percentile, median, and 90th percentile of the real

Table 2. Real Hourly wages by Percentile
(in 1985 won)

Year	90th	50th	10th	Mean
1972	1288.89	582.32	246.15	712.48
1974	1541.80	695.53	305.24	861.16
1976	2107.14	813.69	375.46	1084.67
1978	2096.40	858.37	398.84	1110.47
1980	2118.38	977.85	492.20	1200.99
1982	2256.23	1080.98	532.31	1294.29
1984	2571.26	1257.33	649.18	1488.03
1986	2833.17	1387.29	738.06	1654.92
1988	3145.77	1611.82	911.43	1888.18
1989	3479.98	1846.65	1057.13	2127.24
Avg % ch	10.0%	12.8%	19.4%	11.7%

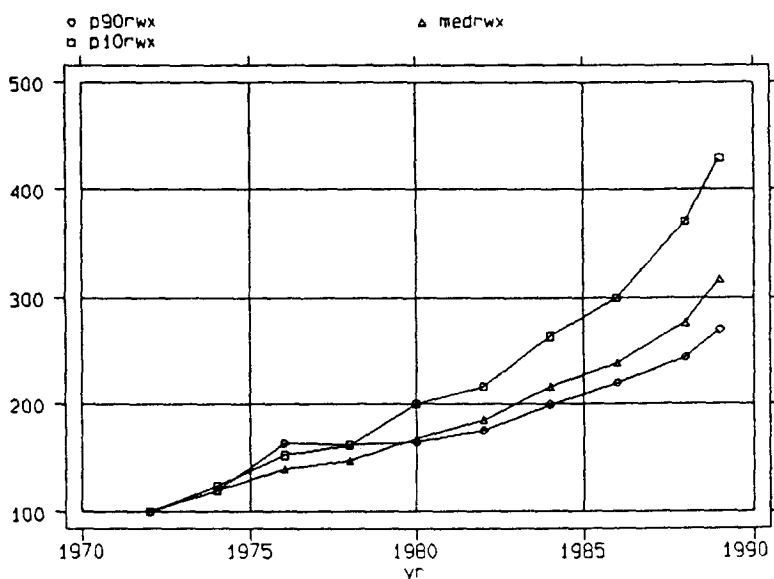Source : Author's calculation from the OWS tapes

Figure 3. Real Hourly Wages by Percentile : Korea, 1972=100

hourly wage distribution of men from 1972 to 1989. Wages for the three groups are indexed to 1972 values for each group[11].

5. CONCLUSION

In this paper we started with empirical findings of growing wage inequality in the U. S. Our question was why the U. S. experienced increasing inequality associated with internationl trade. To answer this, we first saw international trade really matters in inequality by showing differences in inequality between international trade sector and non-trade sector. Then we set up a model that predicts growing wage inequality in the U. S. with decreasing tariffs. Moreover, the symmetry of the model gives rise to a prediction of decreasing wage inequality for a country with different factor endowment. Thus, we were able to double check the validity of the model with the relevant data.

As the model predicts, OWS data showed Korea experienced decreasing wage inequality over the 1970s and 1980s. Thus, we have seen that the data are consistent with the prediction of increasing wage inequality in the U. S. and of decreasing wage inequality in Korea. This supports the model, which tends to give a good rationale for the increasing U. S. wage inequality.

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11) Associated with these phenomena is an improvement in human capital. When the decreased wage inequality is decomposed into changes in observable dimensions of skill (i. e., education, age and tenure) and a decrease associated with unobservable components of skill, the contribution of the first is roughly the same as that of the second. Thus, even though the observed improvement of human capital has quite and effect on the changes in wage inequality in Korea, there are still factors that cannot be identified at this stage (for example, international trade). See Nahm (1994).

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