KIEP Working Paper 07-06

Understanding Wage Inequality: Trade, Technology, and Location

Chul Chung and Bonggeun Kim

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Kyung Tae Lee
President

Korea Institute for International Economic Policy

300-4 Yomgok-Dong, Seocho-Gu, Seoul 137-747, Korea
Tel: 02) 3460-1114 / FAX: 02) 3460-1144,1199
URL: http//www.kiep.go.kr

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KOREA INSTITUTE FOR
INTERNATIONAL ECONOMIC POLICY (KIEP)
300-4 Yomgok-Dong, Seocho-Gu, Seoul 137-747, Korea
Tel: (822) 3460-1178 Fax: (822) 3460-1144
URL: http://www.kiep.go.kr

Kyung Tae Lee, *President*

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Executive Summary

This paper investigates the trend of the wage inequality and the metropolitan wage premium in the United States during the 1980s. Two distinct sets of literature documented that the wage inequality between skilled and unskilled workers and the metropolitan wage premium have risen significantly during the decade. When we combine these two sets of evidence and consider the interaction between skill and location, however, the increasing trends of the skill wage gap and the metropolitan wage premium almost disappear. Most of the dynamic changes are picked up by the interaction term, an extra metropolitan wage premium for skill, which rises significantly over the decade. As a partial explanation we find an increasing trend of the skill wage inequality across industries and occupations within metropolitan areas relative to non-metropolitan areas. This finding suggests that the skill-biased technology alone may not sufficiently explain the growing wage inequality and it can be interpreted as a metropolitan-specific phenomenon to an extent.

Keywords: Wage Inequality, Skill premium, Metropolitan areas, Globalization
JEL Classification: J31, R23, F16

국문요약

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Understanding Wage Inequality: Trade, Technology, and Location

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임금 및 소득의 불균형 내지 양극화 현상은 한국뿐 아니라 전세계적으로 중요한 경제 및 정치적 사안으로 부상하고 있으며 그 원인들로 국제무역의 증가와 숙련노동 편향적 기술진보(skill-biased technological progress) 등이 지목되고 있다. 1980년대 미국에서 숙련노동임금과 비숙련노동임금의 불평등도가 증가했다는 연구결과는 그 원인에 대해 학계에서 논쟁의 대상이 된 바 있으며 많은 관련연구를 양산하였다.

본 연구는 기존의 국제무역과 임금불평등 현상에 대한 연구들에서 간과하고 있는, 지역 간 임금격차의 증가추세에 착안하여 양극화 현상의 원인을 새롭게 규명하였다. 이를 위해 본 연구에서는 미국의 CPS 데이터와 센서스 데이터를 이용하여 기술숙련도, 지역, 그리고 기간에 따른 임금불평등도의 차이를 difference-in-difference-in-difference 방식에 의거 실증적으로 분석하였다. 실증분석의 주요 결과로, 숙련노동에 대한 임금의 추가적 할증(extra premium)이 도시지역에서만 존재하며 논쟁의 초점이었던 1980년대에 이 추가적 할증이 증가함을 보이고 있다. 이 연구결과에 의하면 기존에 양극화의 주요 원인으로 지목되어 온 무역의 증가, 기술진보의 편향성 이외에 지역 간 불균형이 양극화 현상의 새로운 설명변수로 유의하며 따라서 양극화해소를 위한 정책결정에 있어서도 지역 간 균형적 발전을 고려하는 것이 중요한 요소임을 지적하였다.

Chul Chung is a research fellow at the Korea Institute for International Economic Policy. He has been an Assistant Professor at Georgia Institute of Technology after his Ph.D. in Economics at the University of Michigan. His main research areas are international trade, industrial organization, and economic geography. His recent research interests include the mystery of missing trade and non-homothetic preferences, implications of the home market effect, effects of trade liberalization, wage inequality and trade, preference for cultural goods and welfare implications in the Korea films market. His recent publications are "Specialization, Fragmentation, and Factor Intensities: Evidence from Chilean Plant-level Data," *Journal of Developing Areas* (forthcoming) and "Technological Progress, Terms of Trade, and Monopolistic Competition," *International Economic Journal* (2007), "CPI Bias in Korea," *Journal of International Economic Studies* (2007).

Bonggeun Kim is an Associate Professor of Economics at Sungkyunkwan University. He has been an Assistant Professor at the University of Canterbury and Hanyang University after his Ph.D. in Economics at the University of Michigan. His main research agenda focuses on the spatial analysis of wage and housing prices, non-classical measurement errors, and a mechanism for public in-kind redistribution. His recent publications are "Implications of Mean-Reverting Measurement Error for Longitudinal Studies of Employment and Wages," *Review of Economics and Statistics* (2005), "The Role of Low Expectations in Health and Education Investment and Hazardous Consumption," *Canadian Journal of Economics* (2006), and "Paying vs. waiting in the pursuit of specific egalitarianism," *Oxford Economic Papers* (2007), "CPI Bias in Korea," *Journal of International Economic Studies* (2007).

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Understanding Wage Inequality: Trade, Technology, and Location*

Chul Chung** and Bonggeun Kim***

I. Introduction

Globalization has accelerated over the past two decades. One of the most active subjects of public debate is the relationship between

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** Research Fellow, Department of Trade and Investment Policy, KIEP, Seoul 137-747, Korea. E-mail: cchung@kiep.go.kr, Fax: 82-2-3460-1077.

*** Associate Professor, School of Economics, Sungkyunkwan University, 53 Myeongnyun-dong 3ga, Jongno-gu, Seoul 110-745, Korea. E-mail: bgkim07@skku.edu, Fax: 82-2-744-5717.

globalization and inequality. The debate on the distributional effect of globalization has brought about numerous studies at the world level, regional level, and country level. While acknowledging data limitations, cross-country studies on the whole conclude that income inequality has risen across most countries and regions over the past two decades. Meanwhile, studies at the country level conduct more in-depth analyses of individual countries and generate mixed results on the distributional effect of globalization.

In the 2007 World Economic Outlook (WEO), the World Bank documents that world trade has rapidly increased over the past two decades. At the same time, income inequality has risen in most countries except for the low-income countries. According to WEO, world trade has grown five times in real terms since 1980, and its share of world GDP has risen from 36 percent to 55 percent over this period. WEO also reports that inequality, measured by Gini coefficients, has risen in all but the low-income country aggregates over the past two decades, although there are significant regional and country differences. When changes in income shares are measured by quintile, the rising Gini coefficients are explained largely by the increasing share of the richer quintiles at the expense of middle quintiles, whereas the income share of the poorest quintile changes little. This suggests that income inequality has increased mainly in middle- and high-income countries, and less so in low-income countries.

The Stolper-Samuelson (1941) theorem is often employed in order to explain the correlation between increased globalization and the rising inequality. The theorem predicts that in a two-country two-factor framework, increased trade openness leads to a reduction in income inequality in a developing country where low-skilled labor is relatively abundant while the reverse is predicted for an advanced country where high-skilled labor is abundant. A particular challenge is to explain the discrepancy between the theorem and the observed pattern of inequality: the increase in skill premium observed in most developing countries. This challenge has led to extensions of the basic model using alternative analytical approaches such as a continuum of goods, intermediate imported goods used for skill-intensive goods production, and so on. However, we do not explore this particular challenge in this paper.

One natural question to ask is how relevant the Stolper-Samuelson theorem is with data and empirical analyses. That is, how much the increase in inequality can be attributed to increased globalization. In answering this question, WEO identifies technology as a key factor together with other channels, such as access to education, the sectoral share of employment, and financial development, through which globalization affects inequality. WEO concludes that contrary to popular concerns, trade globalization is not found to have a negative impact on income inequality in either developing or advanced countries. Meanwhile, financial openness through foreign direct investment (FDI) or technological change seems to have increased income inequality, and it reflects an increase in the returns to acquiring higher skills.

This paper takes a different approach to the issue of the rising wage inequality between skilled and unskilled workers. Instead of focusing on the direct relationship between globalization and the rising wage inequality, we take a closer look at the trend of the rising wage inequality between workers in metropolitan areas and those in non-metropolitan areas and their interaction. By combining these rising trends of wage premiums for skill and location together and examining consequences of their interaction, we attempt to see how they are related and what they imply for the link between the rising skill wage premium and globalization or technological progress.

Two distinct sets of literature have separately documented the growing wage inequality between skilled and unskilled workers during the 1980s and the large and consistent wage premium for urban workers compared to non-urban workers over time. Initiated by Katz and Murphy (1992), the rising wage premium for skill during the 1980s brought about an interesting debate between trade economists and labor economists regarding what might have caused the wage inequality to grow substantially during the otherwise relatively stable decade of the U.S. labor market with increased supply of skilled labor.[1],[2] This debate has generated a huge volume of research on the increased inequality in the context of trade and technology including Krugman (2000). Bound and Johnson (1992) arguably provided an eventual consensus that, while trade might have contributed to the growing skill wage premium, the primary cause of this change in relative wages is the skill-biased technical progress.[3]

This paper investigates the rising wage inequality in the United States during the 1980s and focuses on the geographic difference:

1) See Krugman (2000) and Leamer (2000) for trade economists' perspectives on this issue.
2) There exist different views on the US labor market during the decade, citing recessions in the early 1980s.
3) Some of the other explanations were also found to be valid to some extent, but not powerful enough to account for the large change in the relative wages.

metropolitan and non-metropolitan areas. As WEO points out, the advantage of country studies is that they focus on more detailed measures of inequality (that is, wage inequality) and at a finer level of disaggregation geographically or by sector. Given that globalization may affect inequality through different channels that are country-specific or time-specific, country studies can provide important insights that cannot be gained in cross-country work. Unlike most other studies in the wage inequality literature, we take a distinct approach in this paper by reflecting the heterogeneity of regions within a country.

As a hypothesis for our empirical investigations, we consider the skill-biased technical progress such as the more use of computers, which could be better used by skilled labor than unskilled; however, its productivity-enhancing effect is coming through the dense network (human rather than computer) or the more important managerial (or people) skill in metropolitan areas only as suggested by Bresnahan (1999). We employ a spatial model to see an effect of location-specific skill-biased technology on both skill and metropolitan wage premiums. For empirical investigations, we adopt difference (skilled vs. unskilled) in difference (1980 vs. 1990) in difference (metropolitan vs non-metropolitan areas) method.

The paper is organized as follows. Section Ⅱ reviews the existing literature of the metropolitan wage premium and the rising wage inequality between skilled and unskilled labor during the 1980s. Section Ⅲ presents a theoretical model. Section Ⅳ describes CPS data, empirical strategies, and results. In Section Ⅴ we provide sensitivity analysis using a more comprehensive set of Census data for the robustness check of our results in section Ⅳ. Finally, section Ⅵ concludes.

II. Literature Review

The rising wage inequality between skilled and unskilled workers during the 1980s was one of the most notable changes in the structure of wages in the U.S. labor market. This has brought about a very interesting yet serious debate between trade economists and labor economists regarding what might have caused the wage inequality to grow substantially during the otherwise relatively stable decade of the U.S. labor market. Early on, some studies in the literature of labor economics pointed to the United States' increased involvement in trade with less developed countries, citing the factor price equalization theorem of the traditional trade model: more specifically, imports from low wage countries were mentioned as an obvious source of the increased inequality.

Trade economists argued that the portion of trade in the U.S. economy was too small to rattle the U.S. labor market with such a strong and significant impact on the wage inequality. After generating a long list of research, this debate arguably found a consensus that, while trade of course can be a contributing factor as well, the primary cause of this change in the relative wages can be attributed to the skilled-labor-biased technical progress according to Bound and Johnson (1992). Levinsohn (2002) provides an excellent survey on the skill-biased technical progress as well as simple economic theories and interesting stories on trade, technical changes, and wage inequality.

In related works of country studies focusing on countries other than United States, the distributional effect of globalization on income inequality has been mostly confirmed. For example, Mexico experienced the earnings inequality between high- and low-skilled workers to widen after it undertook huge trade liberalization reforms between 1985 and 1994. Hanson (2007) finds that during the 1990s, individuals in regions more exposed to globalization enjoyed a 10 percent gain in labor income relative to individuals in regions less exposed to globalization, resulting in a reduction in poverty rates in high-exposure regions of 7 percent relative to low-exposure regions. In the case of China, the overall Gini coefficient rose from 0.28 in 1981 to 0.42 in 2004. According to Lin, Zhuang, and Yarcia (forthcoming), the observed increase in overall inequality can be mostly attributed to growing differences between rural and urban household incomes and uneven growth in incomes among urban households. A caution must be warranted, however, since there are various issues regarding data limitations and country-specific elements and institutional heterogeneity across countries.

The literature of public economics and urban economics represented by Roback (1982) and Glaeser and Maré (2001) implies that it would be natural to observe a wage premium in metropolitan areas compared to non-metropolitan areas because of the disparity in the cost of living. Roback identified amenity differences as a source of the wage and rent disparity among metropolitan areas in a general equilibrium model. Glaeser and Maré thoroughly documented that the city wage premium is large and it positively interacts with experience. They interpreted their empirical findings as an evidence for rapid skill acquisition by urban workers compared to non-urban workers.

Alternatively, Kim (2002) documents that the substantial portion of the metropolitan wage premium still remains even after controlling for the cost-of-living differences across areas. He shows that the metropolitan wage premium is related with unobservable quality differences of workers. Both Glaeser and Maré (2002) and Kim (2002) are common that the large metropolitan wage premium is related to skills either in acquired or in unobservable ability forms. Although a major explanation for changes in skill premium and the skill-related metropolitan premium interpretation might be closely related with each other, little is known about their relationship. Here we put these well-documented trends of skill and metropolitan wage inequality together to provide a better understanding of the wage inequality for skill in light of location.

On the whole, the existing literature suggests that we may expect to see metropolitan wage premium as well as skill premium. However, it is not obvious to explain why there should be an elevating wage gap in the form of the *extra* premium when the two wage premium sources are combined. The equilibrium explanation based on the disparity of cost-of-living or amenity differences in Glaeser and Maré (2001) and Roback (1982) can not account for the empirical pattern that the rising skill premium is location-specific. One possible reason is that the metropolitan premium would be related with unobservable quality differences of workers or different degree of specializations. This raises a need for developing a proper and alternative equilibrium model to explain the positive skill-biased metropolitan wage premium and its trend, which is such as dynamic ability sorting across areas.

Another possible explanation for the trend is the composition effect. It might be true during the 1980s that more skill-intensive industries and/or occupations have grown faster in metropolitan areas, and hence drawing more highly educated workers to the area than non-metropolitan area. The asymmetry in the demand for the skilled labor might have contributed to the *extra* premium for the skilled labor in metropolitan areas. We will look into this by using the U.S. Census data, which enables us to categorize individual workers by industry and by occupation with more than 350,000 observations for each year, which is more than ten times the number of observations from the CPS data.

The synergy effect may provide yet another explanation for the rising wage inequality. By making use of Roback's model and data for SMSAs, Rauch (1993) claims that geographic concentration of human capital precipitates productivity gains through positive externalities. He argues that the average level of human capital is a local public good, and cities with higher average level of human capital should therefore have higher wages and higher land rents based on the positive externality. Furthermore, Jovanovic and Rob (1989) provide useful theoretical insights on the "diffusion and growth of knowledge." Since individuals can increase their knowledge through formal and informal meetings with others, the human capital level of the pool they are involved must be crucial for these individuals' development of knowledge, which in turn should affect the speed of productivity growth in the region.

III. A Spatial Equilibrium Model

1. Labor Supply across Areas

Let us consider a model with two goods: traded good and non-traded good, two areas: metropolitan area and non-metropolitan area. An individual worker in area j maximizes

$$X_1^{\theta} X_2^{1-\theta} \text{ subject to } w_j = X_1 + P_j X_2, \tag{1}$$

where X_1 is the individual's consumption of traded good, which is a numeraire, X_2 is the individual's consumption of non-traded good, w_j is a wage rate in area j (j = m for metropolitan area and j = n for non-metropolitan area), and P_j is the price of non-traded good in area j. By solving the maximization problem of (1), we obtain the indirect utility function as

$$V(w_j, P_j) = \theta^{\theta}(1-\theta)^{1-\theta} w_j P_j^{\theta-1}. \tag{2}$$

A worker will be indifferent between two areas if the following condition is satisfied:

$$V_i(w_m, P_m) = V_i(w_n, P_n). \tag{3}$$

By applying log transformation, we can express this condition as

$$\ln V_i(w_m, P_m) = \ln V_i(w_n, P_n). \tag{4}$$

By substituting (2) into (4), we obtain the equilibrium condition across areas

$$\ln w_{im} - \ln w_{in} = (1-\theta)(\ln P_{im} - \ln P_{in}). \tag{5}$$

The left hand side of equation (5) is the log wage difference $(\ln w_{im} - \ln w_{in} = \Delta \ln w_i)$ across areas and the right hand side is a fraction of the log price difference of non-traded good.

2. Labor Demand across Areas

Assume that both areas produce X_1 according to constant returns to scale (CRS): $X_1 = T_j F(K_j, L_j)$, where Tj is the total factor productivity, K_j and L_j are capital and (aggregate) labor used in production in area j. Firms in the two areas have the same profit function for the traded good, X_1 and hence firms in area j maximize

$$T_j F(K_j, L_j) - w_j L_j - r_j K_j, \tag{6}$$

where r_j is the rental price of capital in area j. L_j, the aggregate labor in area j, is composed of two types of workers based on skill levels: skilled and unskilled. A worker's type is determined solely by efficiency units, $h_i \epsilon \{h_s, h_u\}$, where h_s and h_u denote efficiency units of a skilled worker and an unskilled worker, respectively. We assume that a proportion π_s of the population is defined as skilled workers. Then the aggregate labor can be defined as follows:

$$L_j = h_{sj} N_{sj} + h_{uj} N_{uj}, \tag{7}$$

where N_s and N_u represent the number of skilled and unskilled workers.[4)]

We use Cobb-Douglas production function: $F(K_j, L_j) = K_j^{\alpha} L_j^{1-\alpha}$. From the profit maximization problem of (6) with free entry and zero profit assumptions, we obtain the following isoprofit condition of firms of the two areas with free entry and zero profit assumptions

$$[1/(1-\alpha)]\ln[T_m/T_n] = \ln[w_m/w_n] + [\alpha/(1-\alpha)]\ln[r_m/r_n]. \quad (8)$$

Firms in the metropolitan area can stay in business because of the higher total factor productivity even though they pay higher rental price and wages.

With competitive labor markets, wages are set to equal to the value of marginal product, and thus we have the following equation

$$\ln w_{sj} - \ln w_{uj} = \ln h_{sj} - \ln h_{uj}. \quad (9)$$

In the case of metropolitan-skill-biased technical progress, we expect only h_{sm} to increase. From equation (9) for *j*=*m*, *n*, we can obtain the following comparative statics:

$$\frac{d(\ln w_s - \ln w_u)}{d \ln h_{sm}} > 0, \quad \frac{d(\ln w_{sm} - \ln w_{um})}{d \ln h_{sm}} > 0, \frac{d(\ln w_{sn} - \ln w_{un})}{d \ln h_{sm}} = 0 . \quad (10)$$

4) For simplicity, we assume no interactions between changes in skill-biased technical progress (Δh_{sj}) and changes in unskilled productivity, but it could be extended to have some potential complementarities between skilled and unskilled workers.

That is, there will be a growing skill wage premium due to metropolitan-specific changes in skill wage premium and the metropolitan areas will be a more polarized place between the skilled and the unskilled. We will examine the difference-in-difference-in-difference results in light of the above statics.

IV. CPS Data and Empirical Results

1. Data

The data used here for cross-sectional estimation are from Current Population Survey (CPS March 1981 and 1991). In order to control for other wage determinants, we restrict our samples to male heads of household with the age range of 18 to 65. In addition, our samples are restricted to those earning positive income, having worked more than 5 weeks in the previous year, and with more than 35 hours per week worked. We use the natural log of average hourly earnings, computed by annual labor earnings divided by annual hours worked. For control variables, we use age and dummy variables for time, skill, location, regions, and race. Skill and metropolitan dummy variables are created for workers who are college educated (education > 12 years) and those who live in metropolitan areas, respectively. Table 1 presents the descriptive statistics for log hourly wage, skill

Table 1. Descriptive Statistics, Current Population Survey (1981, 1991)

	1981, N=25158		1991, N=25022	
	Mean	S.D.	Mean	S.D.
Lhwage	2.4922	.5258	2.4976	.5952
Metro	.6696	.4703	.7580	.4282
Skill	.4076	.4703	.4879	.4998

Notes: Lhwage: Log real hourly wage rate of male head of household, Metro: Metropolitan dummy equals to one if individual lives in the metropolitan area, Skill: Skill dummy equals to zero if individual's years of completed education is less than or equal to 12.

and metropolitan status variables.

2. Difference-in-Difference-in-Difference Results

The rising wage inequality between skilled (college educated) and unskilled (no college) workers during the 1980s is evident in our sample, which is in line with many other studies in the literature. The wage inequality for skill jumped from 30 percent (=exp(0.2625)-1) in 1981 to about 45 percent in 1991 as in row 3 of Table 2.

What is interesting is that this rising skill premium is not observed everywhere. Rather, it happened to be location specific, particularly in metropolitan areas only. The last column of Table 2 shows a 13.5 percent skill premium increase in metropolitan areas (row 9) contrary to a minimal 2.9 percent in non-metropolitan areas (row 6). When we add another dimension, the metropolitan status, the last row of Table

Table 2. Log wage difference (skill level) in difference (metropolitan status) in difference (time period) results, CPS 1981 and 1991

		1981	1991	Change (1991-1981)
Skill wage premium	Unskilled	2.3852	2.3155	-.0697
	Skilled	2.6477	2.6887	.0410
	Change (Skill Premium)	.2625	.3732	.1107
Skill wage premium in non-metropolitan areas	Unskilled	2.2966	2.2104	-.0862
	Skilled	2.2533	2.4758	-.0575
	Change (Skill Premium) (1)	.2367	.2654	.0287
Skill wage premium in metropolitan areas	Unskilled	2.4380	2.3593	-.0787
	Skilled	2.6896	2.7378	.0482
	Change (Skill Premium) (2)	.2516	.3785	.1269
D-D-D	(2)-(1)	.0149	.1131	.0982

2 shows that the metro/non-metro skill wage premium rose from non-significant 1.5 percent in 1981, which can be interpreted as a compensating differential for the high urban cost of living, to puzzling 12.0 percent in 1991. That is, changes in skill premium happened only in metropolitan areas and resulted in a substantial metro/non-metro skill wage premium.

We attempt to capture this increased metropolitan-specific skill wage premium more precisely in a linear regression context. In so doing, we can directly test the statistical significance of the difference-in-difference-in-difference result presented in the previous section by estimating the following regression equation with other individual characteristic variables as additional control variables. We estimate the pooled wage specification with some interaction variables as follows:

$$\ln w_{it} = \alpha + \beta' X_{it} + \delta_1 t + \delta_2 S_{it} + \delta_3 M_{it} + \delta_4 t \times S_{it} + \delta_5 t \times M_{it} + \delta_6 M_{it} \times S_{it} + \delta_7 t \times S_{it} \times M_{it} + \varepsilon_{it}, \quad (11)$$

where $\ln w_{it}$ is the log hourly wage rate of individual i in year t, $\mathbf{X}_{it}$ is a vector of individual characteristics including age and dummies for race and region, S_{it} is a skill dummy variable equal to one if the individual attended a college, M_{it} is a metropolitan dummy variable equal to one if the individual lives in metropolitan area, t is a time dummy variable equal to one if the year is 1991, and ϵ_{it} is a pure random error term.

We compare regression estimates with the difference-in-difference-in-difference results in the previous section. δ_2 and $\delta_2 + \delta_4$ represent the skill wage premiums for 1981 and 1991 respectively when we

Table 3. Regression adjusted diff-in-diff-in-diff. results, CPS 1981 and 1991

	(1)	(2)	(3)	(4)
	Basic Model	(1) + Interaction	(2) + Premium Trend	(3) + Interaction Trend
Intercept	.4713 (.0301)***	.4925 (.0302)***	.5116 (.0303)***	.5175 (.0304)***
NE	.1202 (.0064)***	.1218 (.0063)***	.1195 (.0063)***	.1206 (.0063)***
NC	.0922 (.0060)***	.0931 (.0060)***	.0943 (.0060)***	.0949 (.0060)***
West	.0788 (.0062)***	.0808 (.0062)***	.0809 (.0062)***	.0826 (.0062)***
Race	.1549 (.0076)***	.1551 (.0076)***	.1559 (.0076)***	.1559 (.0076)***
Age	.0716 (.0014)***	.0715 (.0014)***	.0714 (.0014)***	.0714 (.0014)***
Age^2	-.0007 (.0000)***	-.0007 (.0000)***	-.0007 (.0000)***	-.0007 (.0000)***
Metro	.1561 (.0051)***	.1231 (.0064)***	.1237 (.0068)***	.1123 (.0085)***
Skill (College)	.2816 (.005)***	.2195 (.0088)***	.2395 (.0065)***	.2181 (.0117)***
Time	-.0587 (.0045)***	-.0592 (.0045)***	-.1469 (.0091)***	-.1185 (.0106)***
Metro*Skill	—	.0848 (.0103)***	—	.0307 (.0141)**
Time*Metro	—	—	.0719 (.0101)***	.0330 (.0101)***
Time*Skill	—	—	.0818 (.0091)***	.0092 (.0177)
Time*Metro*Skill	—	—	—	.0914 (.0207)***
N	50180	50180	50180	50180
Adj-R^2	0.1923	0.1934	0.1947	0.1958

Notes: ***,**, * refer to significance at the 1%,5% and 10% levels. NE, NC, and WEST: Regional dummies equal to one if individual lives in north-east, north-central, and west region. Race is equal to one if race is white.

omit skill and location interaction variables: $M_{it} \times S_{it}$ and $t \times S_{it} \times M_{it}$. The difference ($\delta_4$) of two skill premiums represents the change in the skill premium during the 1980s. Similarly, location parameters (δ_3 and $\delta_3 + \delta_5$) represent the metropolitan wage premiums for 1981 and 1991 respectively, and the difference (δ_5) of two location premiums indicates the change in the metropolitan premium during the 1980s. Likewise, the difference-in-difference-in-difference result for the skill and location interaction variable, which represents the change in the metropolitan-specific skill wage premium, is δ_7. We will test the significance of this δ_7 estimate. Together with this test, we can confirm the results of the previous section by verifying from the non-significance of δ_4 that non-metropolitan-specific skill wage premium does not increase significantly.

Table 3 presents the results for equation (11). This table shows several interesting results. The column (1) shows clearly the presence of the wage premium ($\hat{\delta}_3$) for "Metro" at about 17 percent (=exp (0.1561)-1) and for "Skill" ($\hat{\delta}_2$) about 33 percent (=exp(0.2816)-1). What is interesting is when we include interaction terms. In column (2) of Table 3, we can see a significant degree of skill-biased metropolitan wage premium ($\hat{\delta}_6$) from the coefficient of the interaction term of "Metro" and "Skill" and it picks up significant portion of each wage premium for skilled labor and metropolitan areas. The column (3) shows the growing skill wage premium ($\hat{\delta}_4 = .0818$) and the growing metropolitan wage premium ($\hat{\delta}_3 = .0719$) as well. However, when we include the interaction term for all three dummy variables – "Time", "Metro" and "Skill" in column (4), it (δ_7) picks up most of the wage dynamics over the decade and the interaction term (δ_4) for "Time" and "Skill" becomes insignificant. This is an important finding because it suggests that the rising skill premium was not happening commonly across areas. That is, the rising skill premium during the 1980s was not a location-free phenomenon, but a *metropolitan-specific phenomenon*.[5)]

This disproportionate change in the metropolitan wage premium between skilled workers and unskilled workers undermines the hypothesis that an increase in the location wage inequality between metropolitan and non-metropolitan areas is a simple representation of an increase in the cost of living such as rent in metropolitan areas. Besides, the usual or location-free skill-biased technical change explanation can not be applied to this location-specific phenomenon of the growing skill wage gap. Thus, we need some other explanations for the increase in the location-specific skill wage gap during the 1980s. One of them can be the disproportionate, metro-specific spillover effect; the large positive interaction between the skill and metropolitan dummy variables may indicate large positive externalities between skill and metropolitan areas, which is in line with what Jovanovic and Rob (1989) pointed out as positive externalities through diffusion of knowledge. Another possibility is that there might be skill and metropolitan biased technological progress during the 1980s as discussed in the model.

5) As Table 2 shows that there were labor movements across areas during the decade, there might be a composition effect. By not controlling for the composition effect, there can be an attenuation bias in this result. This suggests that the metro-specific wage premium for skill can be underestimated, but not overestimated, which is only strengthening our result.

V. Robustness Check

For the robustness of our empirical results, we conduct sensitivity analyses. First, we use a more comprehensive data (Census data) to replicate difference-in-difference-in-difference results. Second, we extend our sample points from two (1981 and 1991) to five (every five years from 1976) periods to verify whether our results are a special case that can be applied to the 1980s only.

1. Census Data and Results

For the more comprehensive data, we use the 1980 and 1990 Census 1 percent Integrated Public Use Microdata Series (IPUMS)-USA. The sample size is 716481 for 1980 and 1990 data. The sample descriptive statistics are comparable to the CPS samples. In this sample, we also find an upward trend of the metropolitan wage premium and growing wage inequality between skilled and unskilled labor during the 1980s.

Variables are defined analogous to the analysis using CPS data and they are described in Table A-1 in Appendix.[6] Overall simple statistics for 1980 and 1990 census data are in Table A-2. Both 1980 and 1990 census data are divided into metropolitan and non-metropolitan areas and into college and no college groups so that we can easily see differences across groups. Their simple statistics

6) We put tables of this section in Appendex since their purposes are primarily for describing and analyzing the Census data, which are employed for the robustness check of our main results.

(compared by area and by skill level) are reported in Table A-3 through Table A-6 for 1980 and 1990 separately.

The Census data confirm upward trends of the metropolitan wage premium and the rising wage inequality between skilled (college educated) and unskilled (no college) workers during the 1980s. These statistics are reported in Table A-3 through Table A-6. The mean hourly wage in 1980 was $7.70 in non-metropolitan areas with metropolitan wage about 22.7 percent higher, at $9.45. The hourly wages in both areas rose but at the disproportionate rate: in 1990, the mean hourly wage in the non-metropolitan areas increased to $12.15 about 58 percent higher than 1980 and metropolitan wage to $16.80 about a 78 percent increase from 1980. The wage inequality between metro and non-metro also increased from 22.7 percent in 1980 to 38.3 percent in 1990. Table A-5 and Table A-6 show that the wage inequality for skill jumped from about 30 percent in 1980 to about 50 percent in 1990.

Tables A-7 through A-9 illustrate industry and occupation wage breakdown for the 1980 and 1990 census data. Table A-9 shows that a larger number of workers are found in almost all industries and occupations in the metropolitan areas than non-metropolitan areas, with obvious exceptions of agriculture, forestry, fisheries, and mining. The majority of workers in metropolitan areas are found to be working in manufacturing and professional related services industries and the dominating occupations in metropolitan areas are managerial and professional specialty occupations and technical, sales and administrative support. In non-metropolitan areas, the majority of workers are found in occupations of precision production, craft, and repair occupations or as operators, fabricators and laborers and in industries of manufacturing, construction and other professional related services.

We can observe from Table A-8 that enormous skill upgrading occurred in almost all categories during the period. Table A-9 shows that the distribution of industries and occupations between metro and non-metro remained pretty stable over the period. We find little fluctuation in employment across categories during the 1980s. On the other hand, it is evident in Table A-9 that the growth rates of wages have been relatively low for industries and occupations that are prevailing in non-metropolitan areas such as fishing, agriculture, mining and construction compared to other industries and occupations during the period. This trend might have attributed to the increasing wage inequality between metropolitan and non-metropolitan workers. As also suggested by Levy and Murnane (1992), increases in returns to skill and technology would constitute higher wages for relatively higher technological industries/occupations, which might have contributed to this trend.

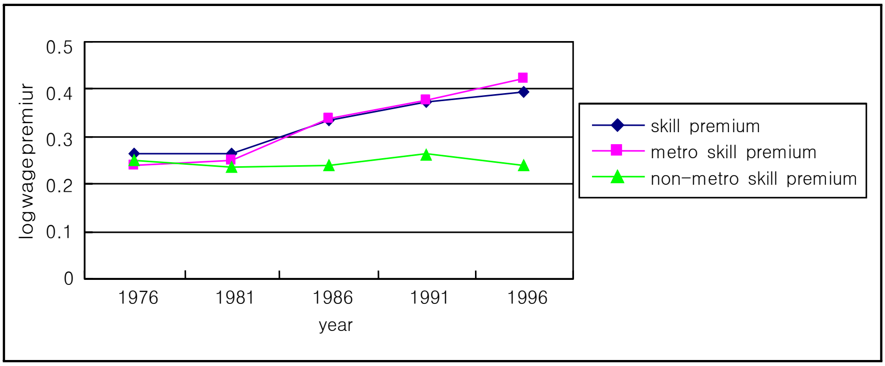
Tables A-10 through A-12 show the distribution of education, race, and region for metropolitan and non-metropolitan areas. In Table A-10, our sample confirms the rising trend of obtaining more education among population. Little or no racial distribution change across areas can be found in Table A-11, which reports a higher percentage of minorities living in metro rather than non-metro. Our sample also seems to be in line with the trend identified by Glaeser and Shapiro (2001): workers are moving towards areas of warmer and dryer climates. There is about a seven percent increase in the number of people living in South and West during the 1980s, although this might be simply due to the sampling bias.

We use Census data to check robustness of our main results reported in the previous section. With the same specification as the column (3) of Table 3, the estimated changes in the skill wage premium and the metropolitan wage premium are .072 and .078, respectively, which are analogous to the CPS results in Table 3. When we include the interaction term for all three dummy variables (time, skill and metropolitan status) as in column (4) of Table 3, the change in metropolitan skill wage premium of about 8 percent (exp(.075)-1)) picks up most of the wage dynamics over the decade and the estimated change in skill premium in non-metropolitan area is only 2 percent.7)

2. A Time Series Graph

We present in Figure 1 the patterns of changing wage premiums for skilled labor across areas with five time points for every five

Figure 1. Trends of Skill Premia



7) These results are available upon request.

years since 1976 in order to see if our findings are only a special case for the specific two time points, 1981 and 1991. Figure 1 confirms our findings and interpretations described in the above. The skill wage premium grows rapidly during the 1980s and its pattern is mainly attributed to the rapid increase in skill wage premium in metropolitan areas. The skill wage premium in non-metropolitan areas has stayed at about 25 percent since 1976. This graph again confirms that the metropolitan areas have become more polarized than non-metropolitan areas in terms of the wage inequality between skilled and unskilled labor.

VI. Conclusion and Discussion

By analyzing CPS data, we found about 9 percent increase in the location wage inequality between metropolitan areas and non-metropolitan areas and about 15 percent increase in the skill wage inequality during the 1980s. We employed the difference-in-difference-in-difference method to find that the rising wage premium for skill during the decade can be almost entirely attributed to the positive interaction between skill and metropolitan areas. We confirmed our results with sensitivity analyses using Census data and illustrating trends graphically with extended periods of CPS data.

In addition to the story of location-specific skill-biased technological progress, we can consider other possible explanations for the established trend in this study. One of them is the disproportionate spillover effect discussed in previous sections. Another is the composition effect. It might be true during the 1980s that more skill-intensive industries and/or occupations have grown faster in metropolitan areas, and hence drawing more highly educated workers to the area than non-metropolitan areas. The asymmetry in the demand for the skilled labor might also have contributed to the extra premium for the skilled labor in metropolitan areas.

We have not sought in this paper for the empirical distinction among some possible explanations for the particular empirical pattern of the wage inequality. As stated particularly in Introduction, it is not this paper's objective to give an answer with regard to whether the rising skill wage inequality can be attributed to globalization or freer trade. Nevertheless, our results shed light on the debate regarding which channel is responsible for the rising wage inequality.

The results of this paper suggest some policy implications. First, the rising wage inequality between skilled and unskilled workers is not a location-free issue. From our results, we can expect more severe widening of the wage inequality in urban areas than rural areas and hence policymakers should pay more attention to regional differences in the degree of urbanization when designing policies for the social safety net across regions and across groups of workers with different skill levels. Second, it is important to know what is driving the asymmetric consequences for the wage inequality across areas. If the composition effect is found to be a crucial determinant for the asymmetry, more resources and governmental (both at the federal and regional level) efforts should be devoted to developing appropriate industrial policies and job training programs for the work force. In any event, for better understanding of the wage inequality, it would be an interesting future research topic to distinguish among those possible explanations, which will generate more meaningful policy implications.

References

Blau, Francine and Lawrence Kahn. 1992. "The Gender Earnings Gap: Learning from International Comparisons." *American Economic Review Papers and Proceedings,* 82(2), pp. 533-538.

Bound, John and George Johnson. 1992. "Changes in the Structure of Wages in the 1980's: An Evaluation of Alternative Explanations." *American Economic Review,* 82(3), pp. 371-392.

Bresnahan, Timothy. 1999. "Computerisation and Wage Dispersion: An Analytical Reinterpretation." *Economic Journal,* 109(456), F390-F415.

Glaeser, Edward L. and David C Maré. 2001. "Cities and Skills." *Journal of Labor Economics,* 19(2), pp. 316-342.

Hanson, Gordon H. 2007. "Globalization, Labor Income, and Poverty in Mexico." Ann Harrison ed. *Globalization and Poverty,* pp. 417–456. Chicago: University of Chicago Press.

International Monetary Fund. 2007. *World Economic Outlook.* (Oct.)

Jovanovic, Boyan and Rafael Rob. 1989. "The Growth and Diffusion of Knowledge." *Review of Economic Studies*, 56(4), pp. 569-582.

Katz, Lawrence and Kevin Murphy. 1992. "Changes in Relative Wages, 1963-1987: Supply and Demand Factors." *Quarterly Journal of Economics,* 107(1), pp. 35-78.

Kim, Bonggeum. 2002. "The Wage Gap between Metropolitan and Non-metropolitan Areas." Mimeo. University of Michigan. (June)

Krugman, Paul. 2000. "Technology, Trade, and Factor Prices." *Journal of International Economics,* 50(1), pp. 51-71.

Leamer, Edward. 2000. "What's the Use of Factor Contents?" *Journal of International Economics,* 50(1), pp. 17-49.

Levinsohn, James. 2002. "A Primer on Skill-Biased Technical Change in an Open Economy: Ideas and Evidence." Mimeo. University of Michigan. (June)

Levy, Frank and Richard Murnane. 1992. "U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations." *Journal of Economic Literature*, Vol. 30, pp. 1333-1381.

Lin, T., J. Zhuang, and D. Yarcia. "China's Inequality: Evidence from Group Income Data, 1985–2004." ERD Working Paper Series. Manila: Asian Development Bank, Economics and Research Department. (forthcoming)

Rauch, James. 1993. "Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities." *Journal of Urban Economics,* 34, pp. 3-33. (November)

Roback, Jennifer. 1982. "Wages, Rents, and the Quality of Life." *Journal of Political Economy,* 90(6), pp. 1257–1278.

Stolper, Wolfgang F., and Paul A. Samuelson. 1941. "Protection and Real Wages." *Review of Economic Studies*, Vol. 9, pp. 58–73. (November)

Appendix

Table A-1. Description of Variables (Census)

1980 and 1990 Census Data	
Variable	Description
region	Census region and division coding
metro	Metropolitan Central City Status
age	Age in years
raceg	Race of Head of Household
educrec	Highest year of education complete, intervalled
higraded	Highest grade or year of education completed
schltype	Type of school attending
empstatd	Labor force status (10=working)
occ	Occupational code from census
ind	Industry code from census
wkswork1	Number of weeks worked the previous year
hrswork1	Number of hours worked the previous week
uhrswork	Usual number of hours worked in a work week
incwage	Total annual salary
edu	Years of Education
uhrwage	Usual hourly wage (Annual wages/Annual hours worked)
exp	Years of experience = (Age-Eduation-6)
dummetro	Metropolitan dummy variable (=1) if individual lives in a metropolitan area
college	College dummy variable (=1) if individual attended college at all
incolmet	Interaction variable between College and Metro dummy variables (=1) if individual attended college and works in a metropolitan area
lnwage	The natural log of uhrwage
exp2	experience squared to account for the diminishing value of experience

Table A-2. Simple Statistics 1980/1990 (Census)

	1980 (N=352272)				1990 (N=364209)			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
region	28.68316	15.5177	11	97	28.29255	13.34336	11	92
metro	2.447541	0.9778708	1	4	2.608944	1.13468	1	4
relateg	1	0	1	1	1	0	1	1
age	39.83622	11.79266	18	65	40.58343	10.7165	18	65
sex	1	0	1	1	1	0	1	1
raceg	1.165506	0.6801073	1	7	1.186091	0.7477938	1	7
educrec	7.034675	1.818244	1	9	7.487791	1.540508	1	9
higraded	158.3415	32.75536	10	230	11.14636	2.751468	1	17
schltype	0.1089896	0.5671607	0	6	1.066385	0.292024	1	3
empstatd	10.0368	0.2687697	10	12	10.02545	0.2241811	10	12
occ	3.411653	2.017372	1	6	3.248621	1.988474	1	6
ind	6.360735	3.341447	1	13	6.580941	3.428476	1	13
wkswork1	49.57449	6.547323	5	52	49.64651	6.709545	5	52
hrswork1	43.35942	11.4853	0	99	45.05248	11.88228	0	99
uhrswork	43.99544	7.817666	35	99	45.30041	9.014037	35	99
incwage	19562.99	11270.71	445	75000	34644.22	27309.51	500	197927
edu	12.74349	3.13899	1	16.995	13.45242	2.84385	1	16.995
uhrwage	9.050414	5.160649	2.00125	263.1842	15.56098	12.44245	2	979.375
exp	21.09273	12.69219	0	58	21.13101	11.23844	0	58
dummetro	0.7715146	0.4198575	0	1	0.7418296	0.4376288	0	1
college	0.4243426	0.4942435	0	1	0.5579818	0.4966274	0	1
incolmet	0.3522846	0.4776827	0	1	0.4499038	0.4974847	0	1
lnwage	2.076463	0.4979009	0.693772	5.572854	2.552164	0.6040786	0.6931472	6.886915
exp2	605.9945	614.6503	0	3364	572.8216	544.6995	0	3364

Table A-3. Simple Statistics Metro/Non-Metro 1980 (Census)

	1980 Metro (N=271783)				1980 Non-Metro (N=80489)			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
region	29.031	16.821	11	97	27.508	9.833	11	97
metro	2.876	0.660	2	4	1.000	0.000	1	1
relateg	1.000	0.000	1	1	1.000	0.000	1	1
age	40.046	11.766	18	65	39.126	11.853	18	65
sex	1.000	0.000	1	1	1.000	0.000	1	1
raceg	1.187	0.730	1	7	1.095	0.467	1	7
educrec	7.142	1.784	1	9	6.671	1.883	1	9
higraded	160.360	32.857	10	230	151.526	31.469	10	230
schltype	0.122	0.606	0	6	0.064	0.408	0	6
empstatd	10.036	0.267	10	12	10.038	0.274	10	12
occ	3.280	2.010	1	6	3.855	1.977	1	6
ind	6.516	3.311	1	13	5.835	3.390	1	13
wkswork1	49.675	6.408	5	52	49.234	6.988	5	52
hrswork1	43.207	11.194	0	99	43.874	12.405	0	99
uhrswork	43.776	7.565	35	99	44.737	8.573	35	99
incwage	20412.100	11659.680	445	75000	16695.860	9287.513	495	75000
edu	12.940	3.123	1	16.995	12.081	3.102	1	16.995
uhrwage	9.448	5.312	2.00125	263.1842	7.708	4.353	2.00125	224.425
exp	21.107	12.640	0	58	21.045	12.866	0	58
dummetro	1.000	0.000	1	1	0.000	0.000	0	0
college	0.457	0.498	0	1	0.315	0.465	0	1
incolmet	0.457	0.498	0	1	0.000	0.000	0	0
lnwage	2.122	0.494	0.693772	5.572854	1.924	0.480	0.693772	5.413542
exp2	605.273	609.995	0	3364	608.431	630.115	0	3364

Table A-4. Simple Statistics Metro/Non-Metro 1990 (Census)

	1990 Metro (N=264107)				1990 Non-Metro (N=94028)			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
region	27.220	11.008	11	42	27.191	9.093	11	92
metro	3.154	0.720	2	4	1.000	0.000	1	1
relateg	1.000	0.000	1	1	1.000	0.000	1	1
age	40.674	10.686	18	65	40.325	10.808	18	65
sex	1.000	0.000	1	1	1.000	0.000	1	1
raceg	1.222	0.831	1	7	1.092	0.446	1	7
educrec	7.613	1.519	1	9	7.141	1.557	1	9
educ99	11.394	2.774	1	17	10.464	2.583	1	17
schltype	1.075	0.311	1	3	1.044	0.232	1	3
empstatd	10.025	0.222	10	12	10.028	0.233	10	12
occ	3.037	1.957	1	6	3.824	1.958	1	6
ind	6.806	3.385	1	13	5.967	3.479	1	13
wkswork1	49.783	6.512	5	52	49.248	7.244	5	52
hrswork1	44.984	11.580	0	99	45.261	12.730	0	99
uhrswork	45.187	8.821	35	99	45.655	9.572	35	99
incwage	37540.950	29425.650	500	197927	26710.260	18575.670	500	197869
edu	13.707	2.866	1	16.995	12.752	2.676	1	16.995
uhrwage	16.803	13.299	2	979.38	12.155	9.042	2	615.7
exp	20.967	11.199	0	58	21.573	11.346	0	58
dummetro	1.000	0.000	1	1	0.000	0.000	0	0
college	0.609	0.488	0	1	0.419	0.493	0	1
intcolmet	0.609	0.488	0	1	0.000	0.000	0	0
exp2	565.030	538.915	0	3364	594.132	560.347	0	3364
lnwage	2.629	0.604	0.6931	6.8869	2.338	0.553	0.69315	6.42276

Table A-5. Simple Statistics College/No College 1980 (Census)

	1980 No College (N=202788)				1980 College (N=149484)			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
year	98	0	98	98	98	0	98	98
region	28.40555	15.79183	11	97	29.05976	15.12981	11	97
metro	2.375382	1.01912	1	4	2.54543	0.9098589	1	4
relateg	1	0	1	1	1	0	1	1
age	40.91646	12.37662	18	65	38.37078	10.77915	20	65
sex	1	0	1	1	1	0	1	1
raceg	1.157894	0.613138	1	7	1.175832	0.761482	1	7
educrec	5.913673	1.612327	1	7	8.555411	0.4969218	8	9
higraded	137.0846	22.35741	10	152	187.1783	20.14392	160	230
schltype	0.031274	0.2845003	0	6	0.2144176	0.7930559	0	6
empstatd	10.04629	0.3007433	10	12	10.02391	0.2173626	10	12
occ	4.286363	1.780631	1	6	2.225034	1.686284	1	6
ind	5.544071	2.874686	1	13	7.468612	3.601284	1	13
wkswork1	49.36682	6.795785	5	52	49.8562	6.183237	5	52
hrswork1	42.5677	11.60936	0	99	44.43345	11.22595	0	99
uhrswork	43.60185	7.511074	35	99	44.52937	8.185144	35	99
incwage	17041.78	8653.45	445	75000	22983.23	13321.03	505	75000
edu	10.65529	2.233148	1	12	15.57632	1.585678	13.804	16.995
uhrwage	8.024674	4.221604	2.00125	224.425	10.44192	5.934719	2.001282	263.1842
exp	24.26118	13.06704	0	58	16.79446	10.76565	0.0049992	45.196
dummetro	0.728263	0.4448561	0	1	0.8301892	0.3754678	0	1
college	0	0	0	0	1	0	1	1
incolmet	0	0	0	0	0.8301892	0.3754678	0	1
lnwage	1.974917	0.4625805	0.693772	5.413542	2.214218	0.5108459	0.693788	5.572854
exp2	759.3516	674.4881	0	3364	397.9523	444.9319	0.000025	2042.678

Table A-6. Simple Statistics College/No College 1990 (Census)

	1990 No College (N=160987)				1990 College (N=203222)			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
year	99	0	99	99	99	0	99	99
region	27.8815	13.50777	11	92	28.61817	13.20262	11	92
metro	2.451465	1.200098	1	4	2.733695	1.063628	1	4
relateg	1	0	1	1	1	0	1	1
age	40.99894	11.55344	18	65	40.25427	9.991692	20	65
sex	1	0	1	1	1	0	1	1
raceg	1.158187	0.6189602	1	7	1.208196	0.8352135	1	7
educrec	6.215365	1.466873	1	7	8.495773	0.4999834	8	9
educ99	8.856721	1.928774	1	10	12.96015	1.782693	11	17
schltype	1.023486	0.168858	1	3	1.100368	0.3572582	1	3
empstatd	10.03433	0.2597569	10	12	10.01842	0.1910685	10	12
occ	4.346568	1.727664	1	6	2.378857	1.735043	1	6
ind	5.535211	2.916448	1	13	7.409341	3.574292	1	13
wkswork1	49.1855	7.373402	5	52	50.01171	6.108225	5	52
hrswork1	43.92055	12.12037	0	99	45.94916	11.6122	0	99
uhrswork	44.58695	8.895687	35	99	45.86559	9.066957	35	99
incwage	26092.73	16516.49	500	197869	41418.48	31885.75	500	197927
edu	11.01156	2.099047	1	12	15.38601	1.595447	13.804	16.995
uhrwage	12.16627	8.748393	2	979.375	18.25018	14.15859	2	977.675
exp	23.98739	12.06485	0	58	18.86826	9.973175	0.0049992	45.196
dummetro	0.6604384	0.4735619	0	1	0.8063054	0.3951933	0	1
college	0	0	0	0	1	0	1	1
intcolmet	0	0	0	0	0.8063054	0.3951933	0	1
exp2	720.9543	631.6061	0	3364	455.4748	429.6079	0.000025	2042.678
lnwage	2.350988	0.535997	0.6931472	6.886915	2.711531	0.607405	0.6931472	6.885177

Table A-7. Industry and Occupation Wage Breakdown

	1980 Census (N=352272)					1990 Census (N=364209)					% Increase
Occupation	Obs	Avg. Wage	Std. Err.	Min	Max	Obs	Avg. Wage	Std. Err.	Min	Max	Average Wage
Managerial and Professional Specialty Occupations	96288	$11.30	6.304	$ 2.00	$263.18	105553	$21.07	16.493	$2.00	$979.38	86.5%
Technical, Sales and Administrative Support Occupations	66556	$9.05	5.228	$ 2.00	$224.43	75492	$15.84	12.288	$2.00	$598.41	75.0%
Service Occupations	24224	$6.63	3.459	$ 2.00	$62.50	26862	$11.15	7.401	$2.00	$210.00	68.2%
Farming, Forestry and Fishing Occupations	6075	$5.89	4.438	$ 2.00	$73.52	8485	$8.82	8.370	$2.00	$175.00	49.9%
Precision Production, Craft and Repair Occupations	79316	$8.71	4.139	$ 2.00	$187.50	74788	$13.67	7.732	$2.00	$310.00	57.0%
Operators, Fabricators and Laborers	79813	$7.66	3.739	$ 2.00	$183.35	73029	$11.65	7.614	$2.00	$615.70	52.1%
Industry											
Agriculture, Forestry and Fisheries	6363	$6.26	$4.85	$2.00	$73.52	9262	$9.80	$13.76	$2.00	$979.38	56.5%
Mining	7012	$9.76	$5.47	$2.00	$224.43	5432	$15.82	$11.01	$2.00	$243.55	62.1%
Construction	30722	$8.95	$5.18	$2.00	$175.02	35654	$14.30	$10.81	$2.00	$615.70	59.8%
Manufacturing	111574	$9.20	$4.79	$2.00	$263.18	97131	$15.51	$10.80	$2.00	$600.98	68.6%
Transporation, Communications and Other Public Utilities	40134	$9.50	$4.43	$2.00	$140.03	39364	$15.64	$9.77	$2.00	$351.11	64.6%
Wholesale Trade	21156	$9.09	$5.54	$2.00	$95.73	22457	$15.82	$12.73	$2.00	$500.00	74.0%
Retail Trade	35058	$7.51	$4.62	$2.00	$103.72	39214	$12.38	$10.33	$2.00	$417.77	64.9%
Finance, Insurance and Real Estate	16453	$10.71	$6.87	$2.00	$102.87	18612	$21.48	$19.42	$2.00	$598.41	100.6%
Business and Repair Services	14111	$8.72	$5.38	$2.00	$75.02	16415	$14.41	$11.79	$2.00	$247.17	65.2%
Personal Services	3695	$6.64	$4.45	$2.00	$50.02	4530	$11.33	$9.33	$2.00	$107.00	70.5%
Entertainment and Recreation Services	2281	$8.25	$6.70	$2.03	$125.01	3687	$14.39	$14.85	$2.00	$232.76	74.5%
Professional and Related Services	40085	$9.54	$5.97	$2.00	$125.02	49185	$18.62	$16.07	$2.00	$977.68	95.2%
Public Administration	23628	$9.18	$4.29	$2.00	$120.01	23266	$15.54	$8.62	$2.02	$270.00	69.2%

Table A-8. Industry and Occupation College Experience Breakdown

	1980 Census		1990 Census	
Occupation	No College OBS	College OBS	No College OBS	College OBS
Managerial and Professional Specialty Occupations	20,335	75,953	13,506	92,047
Technical, Sales and Administrative Support Occupations	31,071	35,485	23,673	51,819
Service Occupations	16,995	7,229	14,691	12,171
Farming, Forestry and Fishing Occupations	4,718	1,357	6,052	2,433
Precision Production, Craft and Repair Occupations	61,125	18,191	47,782	27,006
Operators, Fabricators and Laborers	68,544	11,269	55,283	17,746
Industry				
Agriculture, Forestry and Fisheries	4,594	1,769	6,009	3,253
Mining	5,005	2,007	3,351	2,081
Construction	22,854	7,868	22,157	13,497
Manufacturing	74,185	37,389	51,402	45,729
Transporation, Communications and Other Public Utilities	26,915	13,219	19,822	19,542
Wholesale Trade	12,284	8,872	9,924	12,533
Retail Trade	21,670	13,388	19,416	19,798
Finance, Insurance and Real Estate	5,097	11,356	3,364	15,248
Business and Repair Services	7,514	6,597	7,411	9,004
Personal Services	2,343	1,352	2,154	2,376
Entertainment and Recreation Services	1,207	1,074	1,461	2,226
Professional and Related Services	9,273	30,812	8,189	40,996
Public Administration	9,847	13,781	6,327	16,939

Table A-9. Industry and Occupation Distribution for Metro/Non-Metro

	1990 Census				1980 Census			
	Non-Metro		Metro		Non-Metro		Metro	
Industry	OBS	% of Total	OBS	% of Total	OBS	% of Total	OBS	% of Total
Agriculture, Forestry and Fisheries	5,245	5.6%	4,017	1.5%	3,431	4.3%	2,932	1.08%
Mining	3,330	3.5%	2,102	0.8%	4,169	5.2%	2,843	1.05%
Construction	10,288	10.9%	25,366	9.4%	8,328	10.3%	22,394	8.24%
Manufacturing	28,175	30.0%	68,956	25.5%	25,849	32.1%	85,725	31.54%
Transporation, Communications and Other Public Utilities	9,857	10.5%	29,507	10.9%	8,694	10.8%	31,440	11.57%
Wholesale Trade	4,609	4.9%	17,848	6.6%	4,039	5.0%	17,117	6.30%
Retail Trade	9,349	9.9%	29,865	11.1%	7,566	9.4%	27,492	10.12%
Finance, Insurance and Real Estate	2,438	2.6%	16,174	6.0%	2,286	2.8%	14,167	5.21%
Business and Repair Services	2,705	2.9%	13,710	5.1%	1,963	2.4%	12,148	4.47%
Personal Services	972	1.0%	3,558	1.3%	710	0.9%	2,985	1.10%
Entertainment and Recreation Services	627	0.7%	3,060	1.1%	349	0.4%	1,932	0.71%
Professional and Related Services	10,859	11.5%	38,326	14.2%	8,383	10.4%	31,702	11.66%
Public Administration	5,574	5.9%	17,692	6.5%	4,722	5.9%	18,906	6.96%
Total	94,028		270,181		80,489		271,783	
Occupation								
Managerial and Professional Specialty Occupations	18,908	20.1%	86,645	32.1%	16,886	21.0%	79,402	29.22%
Technical, Sales and Administrative Support Occupations	14,489	15.4%	61,003	22.6%	11,526	14.3%	55,030	20.25%
Service Occupations	6,643	7.1%	20,219	7.5%	4,998	6.2%	19,226	7.07%
Farming, Forestry and Fishing Occupations	4,726	5.0%	3,759	1.4%	3,218	4.0%	2,857	1.05%
Precision Production, Craft and Repair Occupations	22,773	24.2%	52,015	19.3%	20,721	25.7%	58,595	21.56%
Operators, Fabricators and Laborers	26,489	28.2%	46,540	17.2%	23,140	28.7%	56,673	20.85%
Total	94,028		270,181		80,489		271,783	

Table A-10. Education Distribution for Metro/Non-Metro

Education	1990 Census				1980 Census			
	Non-Metro		Metro		Non-Metro		Metro	
	OBS	% of Total	OBS	% of Total	OBS	% of Total	OBS	% of Total
None or preschool	306	0.3%	1,486	0.6%	226	0.3%	829	0.31%
Grade 1, 2, 3, or 4	595	0.6%	1,659	0.6%	1,224	1.5%	2,833	1.04%
Grade 5, 6, 7, or 8	4,671	5.0%	8,294	3.1%	8,669	10.8%	18,554	6.83%
Grade 9	2,629	2.8%	4,734	1.8%	3,589	4.5%	8,932	3.29%
Grade 10	3,682	3.9%	6,615	2.4%	4,028	5.0%	11,767	4.33%
Grade 11	3,373	3.6%	6,378	2.4%	3,896	4.8%	11,738	4.32%
Grade 12	39,409	41.9%	77,156	28.6%	33,473	41.6%	93,030	34.23%
to 3 years of college	23,372	24.9%	79,098	29.3%	12,398	15.4%	54,061	19.89%
4+ years of college	15,991	17.0%	84,761	31.4%	12,986	16.1%	70,039	25.77%
Total	94028		270,181		80489		271,783	

Table A-11. Race Distribution for Metro/Non-Metro

Race	1990 Census				1980 Census			
	Non-Metro		Metro		Non-Metro		Metro	
	OBS	% of Total	OBS	% of Total	OBS	% of Total	OBS	% of Total
White	88,261	93.9%	241,640	89.4%	75,394	93.7%	243,234	89.5%
Black/Negro	4,226	4.5%	18,651	6.9%	3,950	4.9%	21,544	7.9%
American Indian	1,019	1.1%	1,156	0.4%	661	0.8%	1,030	0.4%
Chinese	60	0.1%	2,211	0.8%	38	0.0%	1,301	0.5%
Japanese	126	0.1%	1,231	0.5%	119	0.1%	1,067	0.4%
Asian or Pacific	313	0.3%	5,147	1.9%	210	0.3%	2,728	1.0%
Other race, etc.	23	0.0%	145	0.1%	117	0.1%	879	0.3%
Total	94,028		270,181		80,489		271,783	

Table A-12. Region Distribution for Metro/Non-Metro

Region	1990 Census				1980 Census			
	Non-Metro		Metro		Non-Metro		Metro	
	OBS	% of Total	OBS	% of Total	OBS	% of Total	OBS	% of Total
New England Division	3,874	4.1%	13,992	5.2%	4,092	5.1%	13,188	4.85%
Middle Atlantic Division	8,023	8.5%	47,973	17.8%	6,694	8.3%	49,175	18.09%
East North Central Div.	18,583	19.8%	44,111	16.3%	13,904	17.3%	52,468	19.31%
West North Central Div.	13,194	14.0%	12,282	4.5%	10,682	13.3%	13,640	5.02%
South Atlantic Division	16,174	17.2%	44,506	16.5%	14,975	18.6%	38,635	14.22%
East South Central Div.	9,546	10.2%	10,688	4.0%	9,161	11.4%	11,065	4.07%
West South Central Div.	11,086	11.8%	27,683	10.2%	9,489	11.8%	27,466	10.11%
Mountain Division	7,694	8.2%	13,073	4.8%	6,399	8.0%	11,640	4.28%
Pacific Division	5,789	6.2%	49,799	18.4%	4,821	6.0%	44,897	16.52%
cross state lines-1% sam	65	0.1%	6,074	2.2%	272	0.3%	9,609	3.54%
Total	94,028		270,181		80,489		271,783	

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