hand, for those aged 40-59, wage growth explains less of the employment changes. We conclude that age twist is partly explained by differential wage growth across regions. Wage growth has more explanatory power for the fall in employment for the young in the low-wage regions, but it explains less of the regional differences for the older group.

Interestingly, the estimated coefficients in Table 2 for the junior high school graduates aged 40-59 are close to those obtained for less-skilled men by Juhn et al. (1991) using the U.S. data for years 1970-1989 and using a similar regression specification. Juhn et al.'s (1991) estimates range between 0.23 and 0.35 for wage percentiles between the 1st and 20th percentiles of wage distribution, while the estimates in Table 2 for junior high school graduate men aged 40-59 range between 0.12 to 0.45 (for the preferred specification, 0.18). While the wage coefficient is positive and significant for this group, residual regressions (Table 3) indicate that employment decline is still larger in the high-wage regions than in the low-wage regions.[26]

To check the robustness of our findings, we performed similar analyses using the aggregate employment data from the Employment Status Survey (ESS) in 1992 and 2002, assembled by the Statistics Bureau, Ministry of Internal Affairs and Communications of Japan. An age-twist pattern is evident in the ESS data (Figures B1

[26] This resembles the results for black men in Juhn (1992). She reports that wage decline explains most of the employment decline for white men, but about a half of the employment decline for black men.

and B2 in Appendix B). The regression results from the ESS data are summarized as follows (details are reported in the working paper version of this article). For the estimates of Equations (2a), (2b), and (3), results from the census data and the ESS data are similar. The major differences between the census results and the ESS results are as follows. First, since the ESS's sample size is much smaller than the census sample, the ESS estimates tend to be less precise than the census estimates. Second, the timing of the data differs by two years (the census data are from 1990 and 2000, whereas the ESS data are from 1992 and 2002). The business cycle factors differ somewhat because of this difference in timing. Third, for the estimates of Equations (4a) and (4b), the ESS results show that regional differences are less likely to be explained by wage growth.

7 Possible interpretations

Notable findings from the above analysis are that regional wage growth is negatively related to regional employment growth for less-educated men and women aged 25-39, while the association is positive for those aged 40-59. In this section, we consider possible interpretations to explain these patterns, separately for wage growth and employment changes.

7.1 Wage growth

One of the possible reasons for higher wage growth in the low-wage regions during the 1990s is the minimum wage. In Japan, the minimum wages is binding in the low-wage regions but they do not in the high-wage regions (Abe 2001; Abe and Tamada 2007; Abe and Tanaka 2007; Kawaguchi and Yamada 2007). Furthermore, the minimum wages grew at almost the same rate for all prefectures during the period studied here. It is possible that wages for young workers grew in the low-wage regions, keeping pace with the rising minimum wages; in the high-wage regions, on the other hand, the non-binding minimum wages did not have an impact to raise wages and thus, the wage growth was low (due to the lack of an effective wage floor).

The reason why wages of older workers, the level of which are much higher than the minimum wages, grew faster in the low-wage regions than in the high-wage regions, is a topic that warrants further investigation. For instance, minimum wage growth might have had spillover effects on wage growth of older workers. Alternatively, demand shifts that favored older workers might have contributed to wage growth in the low-wage regions. A full investigation of the causes of differing wage growth patterns is not the focus of the present article; we believe such an investigation is most appropriately done with microdata.

7.2 Explaining employment changes

While many papers that use U.S. data find positive labor supply elasticities from the specification similar to the one used in this article, the Japanese data of less-educated young men and women do not yield positive elasticity estimates. Are negative elasticity estimates for the young in Table 2 still consistent with a labor supply framework? Note that our dependent variable is the employment-population ratio and not working hours. The predicted sign of the elasticity estimates is positive, because income effect is zero at zero hours of work (Borjas 2008, p.42). Therefore, we assess that the pattern for the young cannot be understood as a labor supply response to changing wages. More generally, the results cast doubts on the assumption that the employment choices of this group during the 1990s can be understood as the outcome of optimizing behavior of labor supply. Rather, it is likely that individuals did not attain their optimal choice (i.e., not on the labor supply curve), and became involuntarily unemployed or discouraged from seeking employment.

The pattern for the 40-59 age group could be consistent with the move along the labor supply curve, and in fact, the estimated elasticities are close to the U.S. results. Yet, there are two caveats with this interpretation. First, the relative increase in the

employment-population ratio in the low-wage regions is not fully explained by wage changes for the older group (Table 3, Columns (8), (9), (11), (12), (17), and (18)); much of the relative employment growth in the low-wage regions remains after controlling for wage changes. Thus, factors other than wage are likely to have played a role for the relatively higher employment growth for the 40-59 age group in the low-wage regions. Second, to interpret the changes to be on the supply curve, we must assume involuntary unemployment does not exist. The unemployment rate in the Rank D region (the region that experienced high wage growth) was the highest of the four regions in 1990, and was the second highest in 2000. Therefore, it might be inappropriate to assume full employment in the Rank D region.

What accounts for the negative relationship between wage growth and employment growth for the 25-39 age group? One possibility is that the minimum wage had an effect to reduce employment for this group in the low-wage regions. Minimum wage is much more likely to be a binding constraint in the low-wage regions than in the high wage regions. If the wage growth in the low-wage regions is induced by the minimum wage rather than demand conditions, then the negative coefficients on the wage growth variable for the 25-39 age group is consistent with the interpretation that minimum wages had an impact to reduce employment for the young.

8 Conclusion

In this article, we investigate the regional patterns of wage growth and changes in employment in Japan through the 1990s. The low-wage regions experienced higher growth in average wages, leading to compression of regional wage differentials over this period. The compression of regional wage differentials occurred for both men and women of all age groups. This pattern is observed for several different wage measures (full-time wages for all firm sizes, full-time wages for very small firms, and part-time wages). Using aggregate data of the Census in 1990 and 2000, we find that changes in the employment-population ratios for less-educated men and women differed for different age groups, which we call the "age twist." A large decline in employment is evident for men and women in the 25-39 age group in the low-wage regions but the decline was smaller in the high-wage regions; for the 40-59 age group, there was a larger decline in employment in the high-wage regions than in the low-wage regions. This pattern is confirmed by both raw tabulations and regression analysis, and is also confirmed by aggregate data of the ESS.

We examine whether the age-twist pattern is explained by the differential wage growth across regions. We find that higher wage growth is related to a loss of

employment for the 25-39 age group, but not for the 40-59 age group. A large part of regional differences in employment for the younger group is explained by the differential wage growth across regions, but wage growth explains less of the employment changes for the older group.

The age-twist pattern indicates that the employment decline for men during the 1990s was not uniform across region and age groups. Previous studies point out that employment for the young was lost (Genda 2003), and employment for the less-educated was lost (Genda 2006, Abe 2008) during this period. This article shows that the employment loss during the 1990s had complex regional differences: the loss of employment for those aged 25-39 was larger in the low-wage regions than in the high-wage regions; for those aged 40-59, the employment decline was larger in the high-wage regions. The overall weak performance of the Japanese economy in the 1990s resulted in a somewhat complicated consequences in terms of employment.

It is of interest to compare our results with those obtained in previous studies using U.S. data. Juhn (1992) emphasizes the role of declining wages for the employment decline of the less-educated in the U. S. during the 1980s. She concludes that wage declines for the less-educated in the 1980s account for almost all decline in labor market participation for white men, and about half of the participation decline for

black men. Unlike the evidence reported by Juhn (1992), this article shows that it is hard to interpret the employment decline of the less-educated as a labor supply response to falling wages in Japan in the 1990s. In particular, employment loss for the young occurred in regions where wage growth was higher.

Appendix A: Classification of prefectures to the minimum wage ranks

The minimum wage rank classification is shown in Table A1.

Appendix B: Summary of the results using Employment Status Surveys (ESS)

We performed similar analyses reported in Sections 5 and 6 of this article using the Employment Status Survey (ESS) in 1992 and 2002, the alternative aggregate data. The employment-population ratios and their changes from the ESS data are shown in Figures B1 and B2.

The regional pattern of the employment-population ratios from the ESS data (Figure B1) is very similar to that of the census data (Figure 4). However, since sampling errors of ESS figures are larger than those of the census figures, the changes of employment-population ratios in the ESS are more variable than those in the census figures (Figure B2).[27] The regression results of the ESS data are broadly similar to

[27] In 2002, the ESS was conducted for adults in 440,000 households, the size of the original sample being 1.05 million persons aged 15 and over. This is far smaller than the census sample. Furthermore,

those of the census data (details are reported in the working paper version of this article).

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Figure 1: Age twist in employment changes

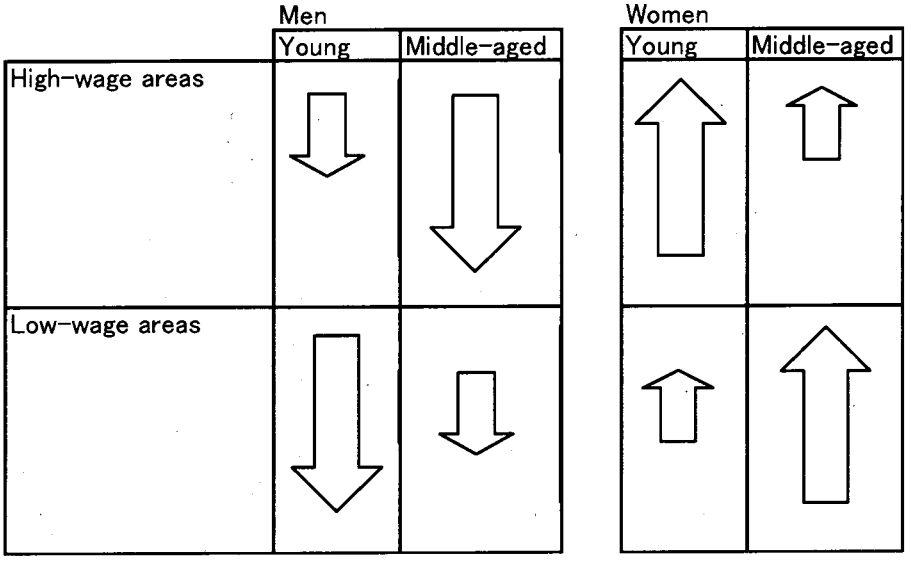
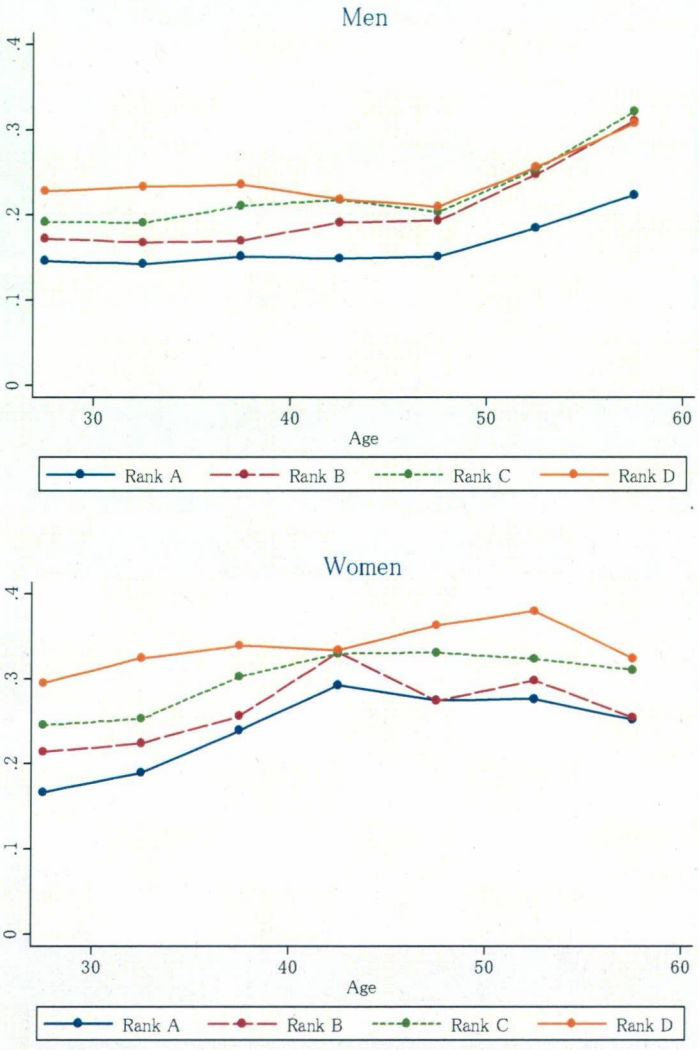
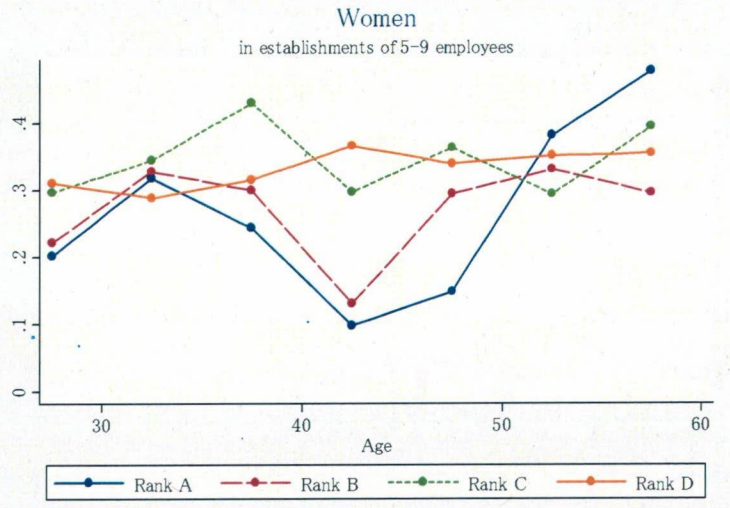


Figure 2: Full-time Wage Growth, by sex, 1990 and 2000
Wage Growth=log(Wage$_{2000}$)-log(Wage$_{1990}$)



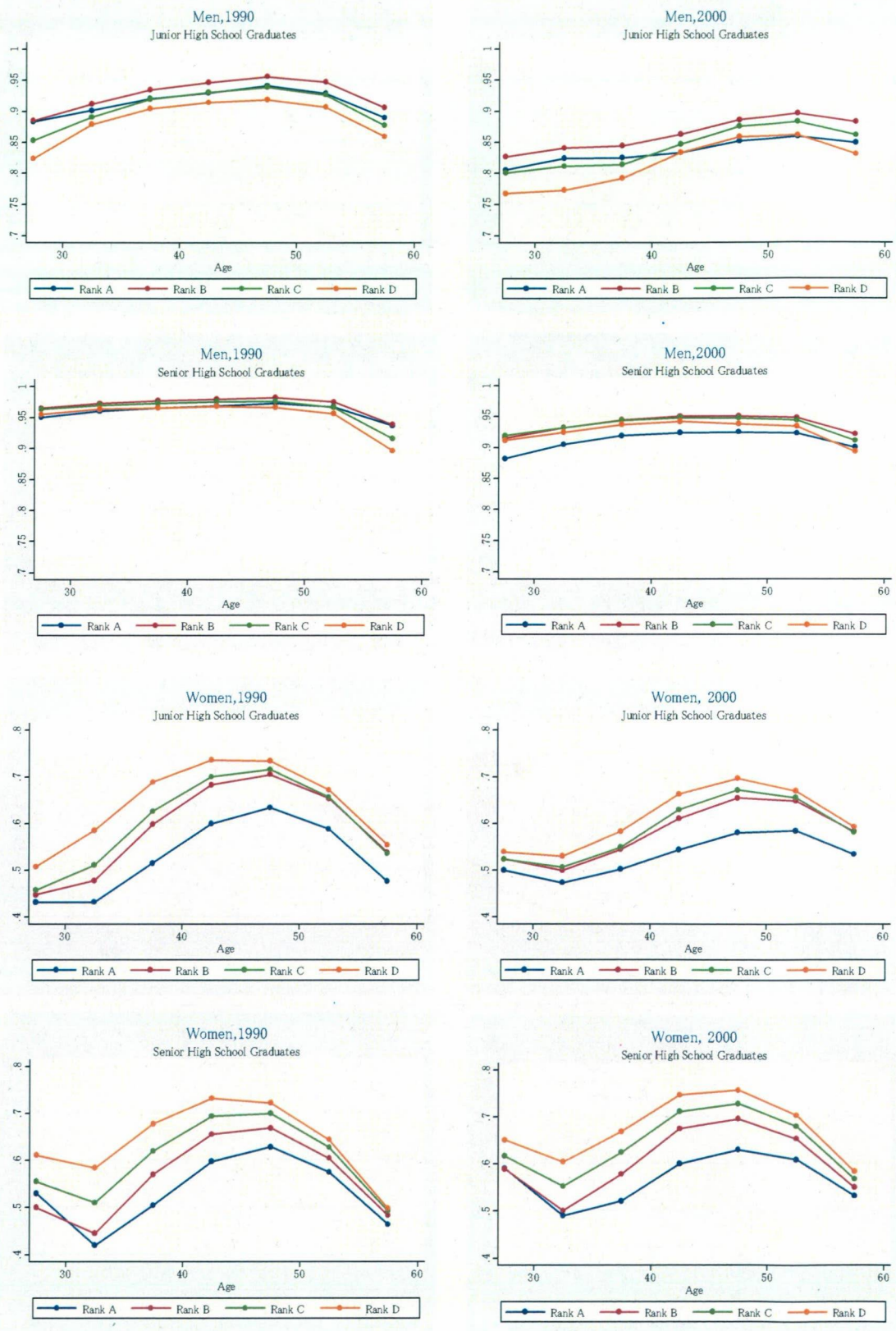
Source: Authors' calculation from the BSWS (1990, 2000).

Figure 3: Full-time Wage Growth in establishments of 5-9 employees, by sex, 1990-2000
Wage Growth=log($Wage_{2000}$)-log($Wage_{1990}$)



Source: Authors' calculation from the BSWS (1990, 2000).

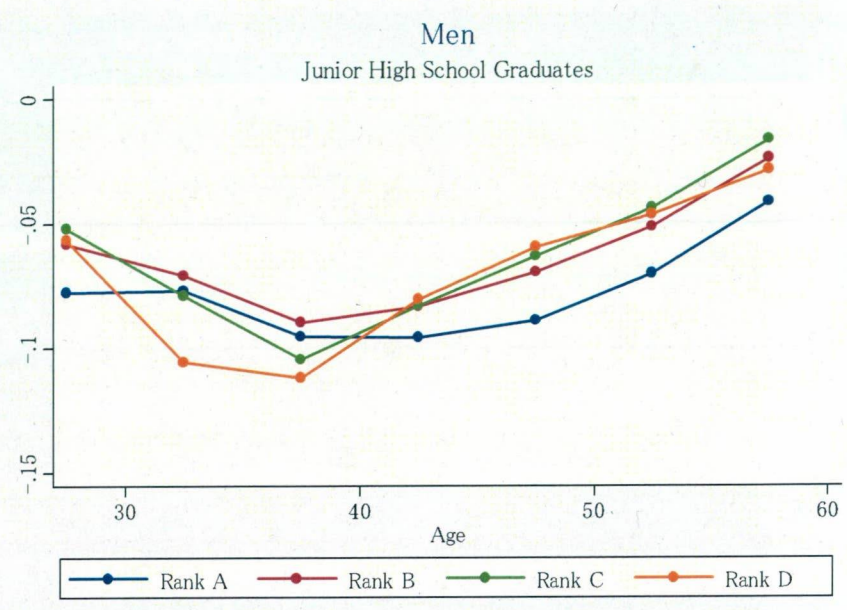
Figure 4:The Employment-population Ratios, by sex, education, and year:Census

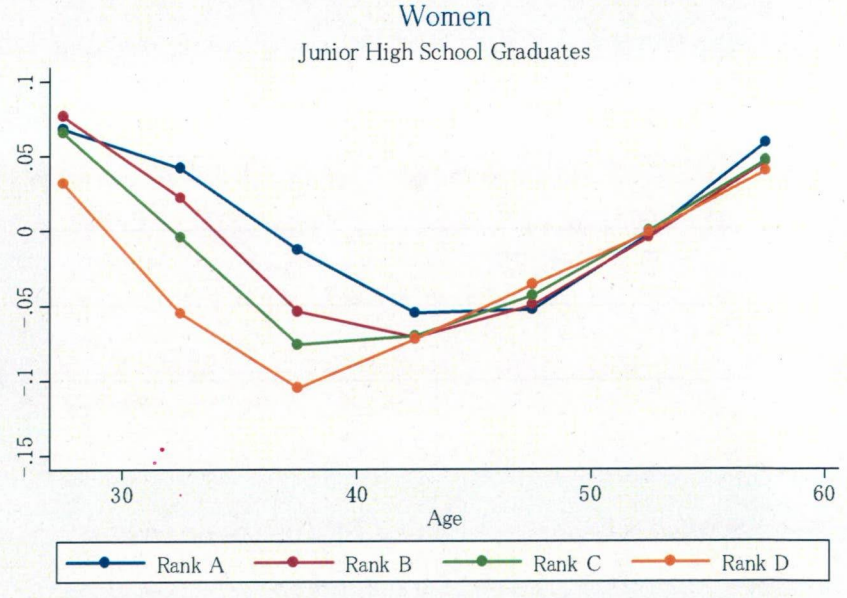


Source: Authors' calculation from Census (1990, 2000) .

Figure 5: The Changes in The Employment-population Ratios, by sex and education :Census

The Changes in $EPR=EPR_{2000}-EPR_{1990}$





Source: Authors' calculation from Census (1990, 2000).

Table 1: Age twist regression results
Dependent variable $=EPR_{2000}-EPR_{1990}$

A. Explanatory variables: Minimum Wage Rank dummies

	Junior High						Senior High					
	All ages	Age 25-39	Age 40-59	All ages	Age 25-39	Age 40-59	All ages	Age 25-39	Age 40-59	All ages	Age 25-39	Age 40-59
	Men			Women			Men			Women		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Rank B	0.015**	0.011*	0.017**	-0.011	-0.015*	-0.009*	0.017**	0.016**	0.017**	0.005	-0.001	0.009*
	(0.003)	(0.005)	(0.003)	(0.006)	(0.007)	(0.004)	(0.002)	(0.003)	(0.002)	(0.006)	(0.007)	(0.004)
Rank C	0.019**	0.005	0.023**	-0.010	-0.034**	-0.003	0.021**	0.020**	0.022**	0.002	-0.014*	0.013**
	(0.003)	(0.005)	(0.004)	(0.006)	(0.010)	(0.006)	(0.002)	(0.002)	(0.002)	(0.006)	(0.007)	(0.005)
Rank D	0.014**	-0.008	0.021**	-0.019**	-0.071**	-0.007	0.022**	0.020**	0.023**	-0.003	-0.034**	0.020**
	(0.003)	(0.005)	(0.003)	(0.006)	(0.010)	(0.005)	(0.002)	(0.002)	(0.002)	(0.006)	(0.007)	(0.004)
R-squared	0.70	0.51	0.73	0.56	0.70	0.80	0.65	0.66	0.72	0.38	0.60	0.68

B. Explanatory Variable: $\log(Wage_{1990})$

	Junior High						Senior High					
	All ages	Age 25-39	Age 40-59	All ages	Age 25-39	Age 40-59	All ages	Age 25-39	Age 40-59	All ages	Age 25-39	Age 40-59
	Men			Women			Men			Women		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log(Wage1990)	-0.041**	0.035**	-0.050**	0.021*	0.166**	0.007	-0.014*	-0.052**	-0.054**	-0.005	0.080**	-0.035**
	(0.006)	(0.013)	(0.007)	(0.009)	(0.020)	(0.008)	(0.005)	(0.007)	(0.005)	(0.010)	(0.014)	(0.007)
R-squared	0.71	0.46	0.72	0.55	0.73	0.80	0.34	0.55	0.69	0.37	0.60	0.68

Note: The sample sizes are 329 for columns (1), (4), (7), (10), 141 for columns (2), (5), (8), (11) and 188 for columns (3), (6), (9),(12).
All regressions include age dummies and a constant.
Base groups are age 25-29 for columns (2), (5), (8), (11) , and age 40-44 for columns (1), (3), (4), (6), (7),(9), (10), (12).
All regressions are estimated by WLS using the weight explained in the text.
Robust standard errors in parentheses.
* significant at 5%; ** significant at 1%.

Source: Authors' calculation from Census (1990, 2000).

Table 2: Employment changes and wage growth
Dependent variable =EPR_{2000}-EPR_{1990}
Coefficient on ΔLogwage (α)

		Age 25-39				Age 40-59			
		WLS	IV			WLS	IV		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Junior High	Men	-0.099*	-0.132	-0.129*	-0.099*	0.117**	0.451**	0.291**	0.176**
		(0.039)	(0.071)	(0.060)	(0.042)	(0.025)	(0.164)	(0.053)	(0.035)
	R-squared	0.45	–	–	–	0.67	–	–	–
	Elasticities	-0.110	-0.146	-0.143	-0.109	0.128	0.491	0.317	0.192
	Mean	0.901				0.918			
	Women	-0.393**	-0.613**	-0.609**	-0.499**	-0.042	-0.192	-0.017	-0.072*
		(0.060)	(0.143)	(0.102)	(0.072)	(0.022)	(0.204)	(0.054)	(0.030)
	R-squared	0.67	–	–	–	0.80	–	–	–
	Elasticities	-0.694	-1.083	-1.076	-0.881	-0.067	-0.303	-0.027	-0.113
	Mean	0.566				0.633			
Senior High	Men	0.148**	0.178**	0.209**	0.164**	0.151**	0.388**	0.313**	0.212**
		(0.023)	(0.036)	(0.033)	(0.025)	(0.016)	(0.086)	(0.033)	(0.026)
	R-squared	0.52	–	–	–	0.51	–	–	–
	Elasticities	0.153	0.184	0.216	0.170	0.156	0.403	0.324	0.220
	Mean	0.966				0.963			
	Women	-0.150**	-0.211*	-0.299**	-0.181**	0.033	0.329*	0.229**	0.049
		(0.041)	(0.095)	(0.065)	(0.048)	(0.022)	(0.140)	(0.062)	(0.030)
	R-squared	0.53	–	–	–	0.63	–	–	–
	Elasticities	-0.274	-0.385	-0.545	-0.329	0.053	0.529	0.368	0.078
	Mean	0.549				0.622			
Instruments		-	part-wage growth	Minimum wage rank dummies	Prefecture dummies	-	part-wage growth	Minimum wage rank dummies	Prefecture dummies

Note: The sample sizes are 141 for columns (1)-(4) and 188 for columns (5)-(8).
All regressions include age dummies and a constant.
Base groups are age 25-29 for columns (1)-(4), and age 40-44 for columns (5)-(8).
All regressions are weighted by the weight explained in the text.
Elasticities are computed at the mean.
Robust standard errors in parentheses.
* significant at 5%; ** significant at 1%.

Source: Authors' calculation from Census (1990, 2000) and the BSWS (1990, 2000).

Table 3: Residual regressions
Dependent variable= Residuals of Table 2
Explanatory variables: Minimum Wage Rank dummies

Numbers in parentheses indicate columns in Table 2	Junior High											
	Age 25-39						Age 40-59					
	Men			Women			Men			Women		
	Without Wage (Tab. 1 A, Col.(2))	WLS (1) residuals	IV(4) residuals	Without Wage (Tab. 1 A, Col.(5))	WLS (1) residuals	IV(4) residuals	Without Wage (Tab. 1 A, Col.(3))	WLS (5) residuals	IV(8) residuals	Without Wage (Tab. 1 A, Col.(6))	WLS (5) residuals	IV(8) residuals
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Rank B	0.011*	0.013**	0.013**	-0.015*	-0.003	0.000	0.017**	0.009**	0.006	-0.009*	-0.008*	-0.008*
	(0.005)	(0.005)	(0.005)	(0.007)	(0.010)	(0.011)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Rank C	0.005	0.010*	0.010*	-0.034**	-0.007	-0.000	0.023**	0.014**	0.010*	-0.003	-0.001	-0.000
	(0.005)	(0.005)	(0.005)	(0.010)	(0.012)	(0.013)	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.005)
Rank D	-0.008	0.000	0.000	-0.071**	-0.025*	-0.013	0.021**	0.012**	0.008*	-0.007	-0.004	-0.001
	(0.005)	(0.005)	(0.005)	(0.010)	(0.012)	(0.012)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.004)

Numbers in parentheses indicate columns in Table 2	Senior High					
	Age 25-39			Age 40-59		
	Women			Women		
	Without Wage (Tab. 1 A. Col.(11))	WLS (1) residuals	IV(4) residuals	Without Wage (Tab. 1 A, Col.(12))	WLS (1) residuals	IV(4) residuals
	(13)	(14)	(15)	(16)	(17)	(18)
Rank B	-0.001	0.004	0.005	0.009*	0.008*	0.008*
	(0.007)	(0.008)	(0.008)	(0.004)	(0.004)	(0.004)
Rank C	-0.014*	-0.004	-0.002	0.013**	0.011*	0.011*
	(0.007)	(0.008)	(0.008)	(0.005)	(0.005)	(0.005)
Rank D	-0.034**	-0.016*	-0.012	0.020**	0.018**	0.016**
	(0.007)	(0.007)	(0.008)	(0.004)	(0.004)	(0.004)