discuss the pattern for the older group.

Results for young men and women are shown in the left portion of Table 3. For male junior high school graduates aged 25-39, the fall in employment in the low-wage regions is explained by higher wage growth (columns (1)-(3)). The coefficient of the Rank D dummy in equation (4a) is close to zero, while it is -0.008 (with a standard error of 0.005) in equation (2a). High employment growth in the Rank B region relative to Rank A region cannot be explained by wage growth, because the coefficient of Rank B dummy ranges from 0.011 to 0.013 for all specifications. When the $LogWage_{1990}$ is included, the estimate of β_2 in equation (2b) is positive (0.035), but the estimate of γ_2 in equation (4b) is close to zero.

For female junior and senior high school graduates aged 25-39, wage growth explains a large part of the low employment growth in the low-wage regions (columns (4)-(6) and (13)-(15)). The negative coefficients of Rank C and Rank D dummies become small in magnitude (in absolute value) in equation (4a) compared to those in equation (2a). The positive coefficients of the log wage in 1990 are less than 0.04 for equation (4b) while they are greater than 0.16 for equation (2b). Yet, the estimates of γ_1 and γ_2 are not quite close to zero, implying that regional differences in decline of employment for young women remains even after wage growth is accounted for.

The results for the older group are shown in the right portion of Table 3. For male junior high school graduates aged 40-59, the smaller decline in employment in the low-wage regions is partly explained by higher wage growth there (columns (7)-(9)). For male junior high school graduates, the estimates of γ_2 in equation (4a) are smaller in magnitude than the estimates of β_2 in equation (2a). For female junior high school graduates aged 40-59, the regional variations in employment growth are small in the first place (columns (10)-(12)). For female senior high school graduates, on the other hand, wage growth explains less of the regional differences in employment growth. The coefficients on the minimum wage ranks or the log wage in 1990 do not differ much between the regression equations of (2b) and (4b) (columns (16)-(18)).

Taken as a whole, the larger fall or lower growth in employment for young men and women in the low-wage regions than in the high-wage regions is explained by the higher wage growth in the former. This means that high wages in low-wage areas had an effect to reduce employment of young people. On the other 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.

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 Statistics Bureau, Ministry of Internal Affairs and Communications of Japan. Age-twist pattern is evident in the ESS data (Figures B1 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 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), ESS results show that regional differences are less likely to be explained by wage growth.

6 Possible interpretations

The notable findings from the above analysis are that regional wage growth is negatively related to regional employment growth for less-educated young men and

women, while the association is positive for the older group. In this section, we consider possible interpretations that explain these patterns, separately for wage growth and employment changes. We conclude that labor demand shifts that are favorable to the old in the low-wage regions best explain the results.

6.1 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 bind 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 effective wage floor).

The reason for why wages of older workers, the level of which are much higher than the minimum wages, grew faster in the low-wage areas than in the high-wage areas, 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. A full investigation of the causes of differing wage growth patterns is not the focus of the present paper; this paper is more concerned with the causes of employment changes taking the wage changes as given, to which we now turn.

6.2 Explaining employment changes

The age-twist patterns are unlikely to be interpreted as changes along the upward sloping labor supply curve. The pattern for the young is certainly inconsistent with such an interpretation, as wages did not grow for the group that experience increase in employment. The pattern for the old could be consistent with the move along the labor supply curve, but there are two problems with this interpretation. First, the relative increase in the employment-population ratio in the low-wage regions is not 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 old. Second, to interpret the changes to be on the supply curve, we must assume full employment. The

unemployment rate in the Rank D region was the highest of the four regions in 1990, and was next highest in 2000. Therefore, we assess that it is inappropriate to assume full employment in the Rank D region. Based on these two facts, we do not view the pattern for the old to be the move along a labor supply curve.

Can the age-twist patterns be understood as a move along a stable labor demand curve? With a stable, downward sloping labor demand curve, regions that experience a higher wage growth (low-wage regions) should experience lower employment growth. The patterns for the young are consistent with that interpretation, but the patterns for the old are not. That leads us to hypothesize that there were demand shifts that favored the old group in the low-wage regions.

The pattern of unemployment is also consistent with the relatively favorable demand for older workers in the low-wage regions. Age-twist pattern is observed in the changes in unemployment. The unemployment rate rose for all age groups in all regions between 1990 and 2000, but the rise in unemployment of older men is larger in the Rank A region than in the Rank D region. The reason we observe age-twist in the employment-population ratio is that older men in the high-wage regions became more likely to be unemployed than those in the low-wage regions. Demand shifts that relatively favored older workers in the low-wage regions are consistent with smaller rise

in unemployment of the old in the low-wage regions.

7 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. It is also 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 young men and women in the low-wage regions but the decline was smaller in the high-wage regions; for the older 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 confirmed by aggregate data of the ESS.

We examine whether the age-twist pattern is explained by the differential wage

growth across regions. It is found that higher wage growth is related to a loss of employment for the younger group, but not for the older 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 older group. The different patterns for the young and the old can be best explained by the demand shifts that relatively favored the old workers in the low-wage regions.

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 the Employment Status Surveys (ESS)

We performed similar analyses reported in Sections 4 and 5 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 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 in the census figures

(Figure B2).[21] The regression results of the ESS data are broadly similar to 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

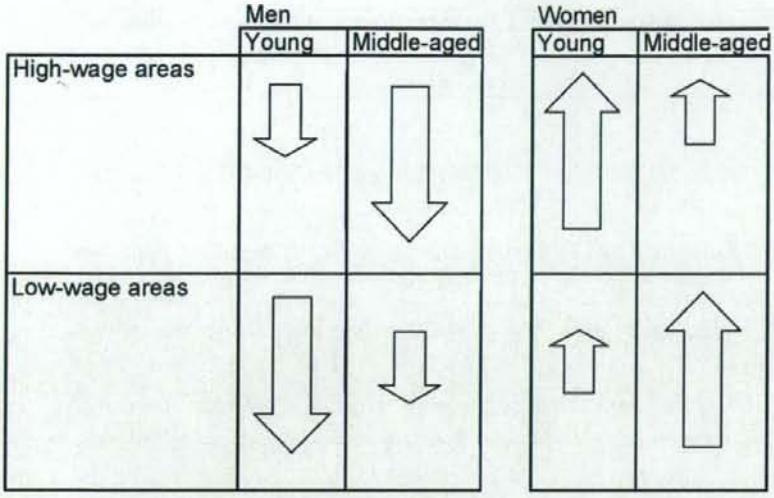
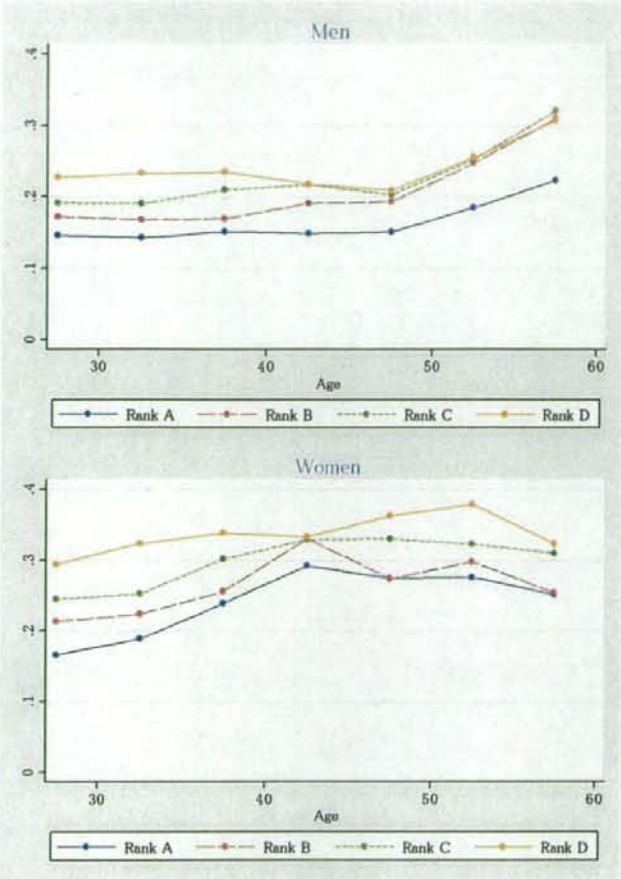
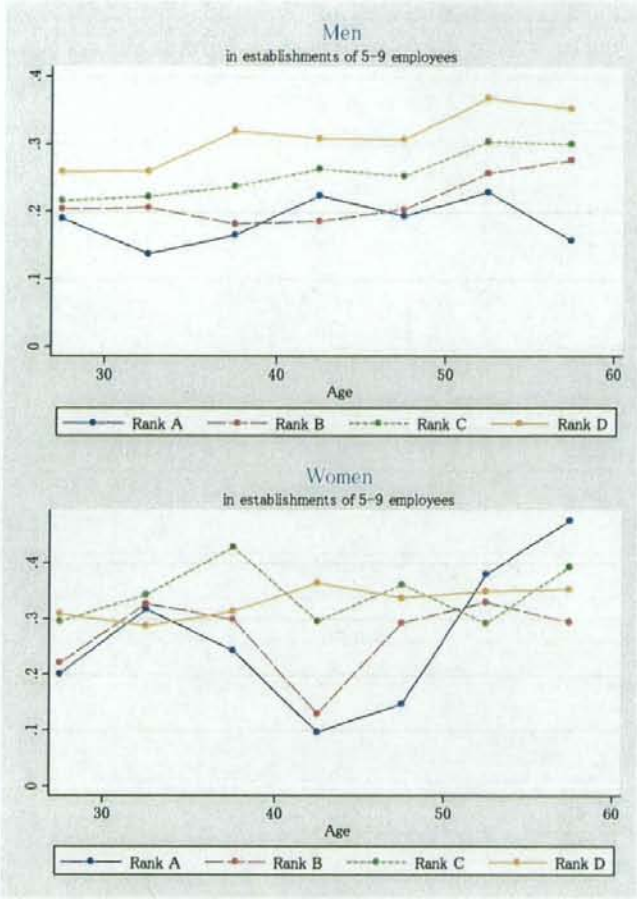


Figure 2: Full-time Wage Growth, by sex, 1990 and 2000



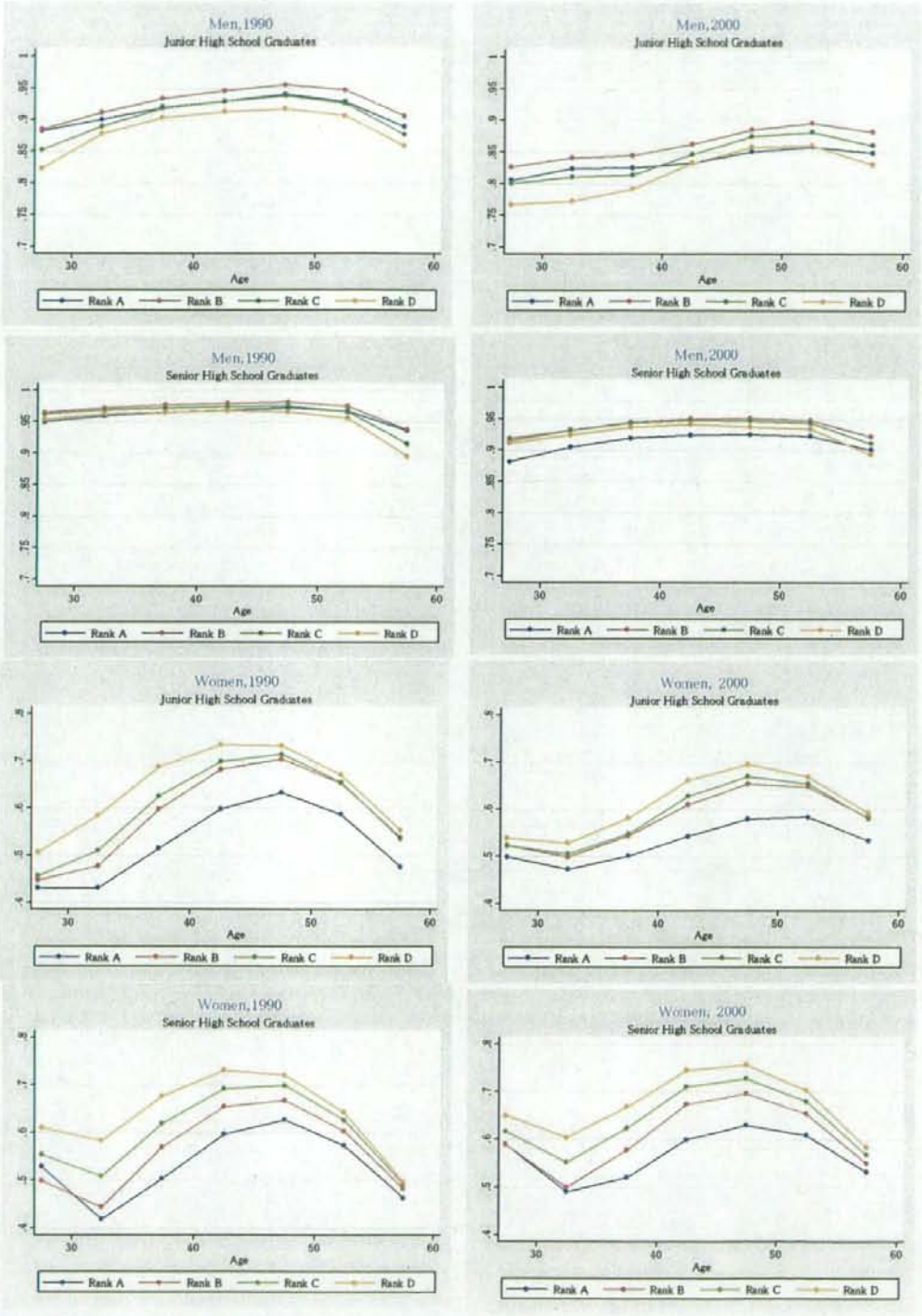
Source: Authors' calculation from the BSWS (1990, 2000).

Figure 3: Full-time Wage Growth in establishments of 5-9 employees, by sex, 1990-2000



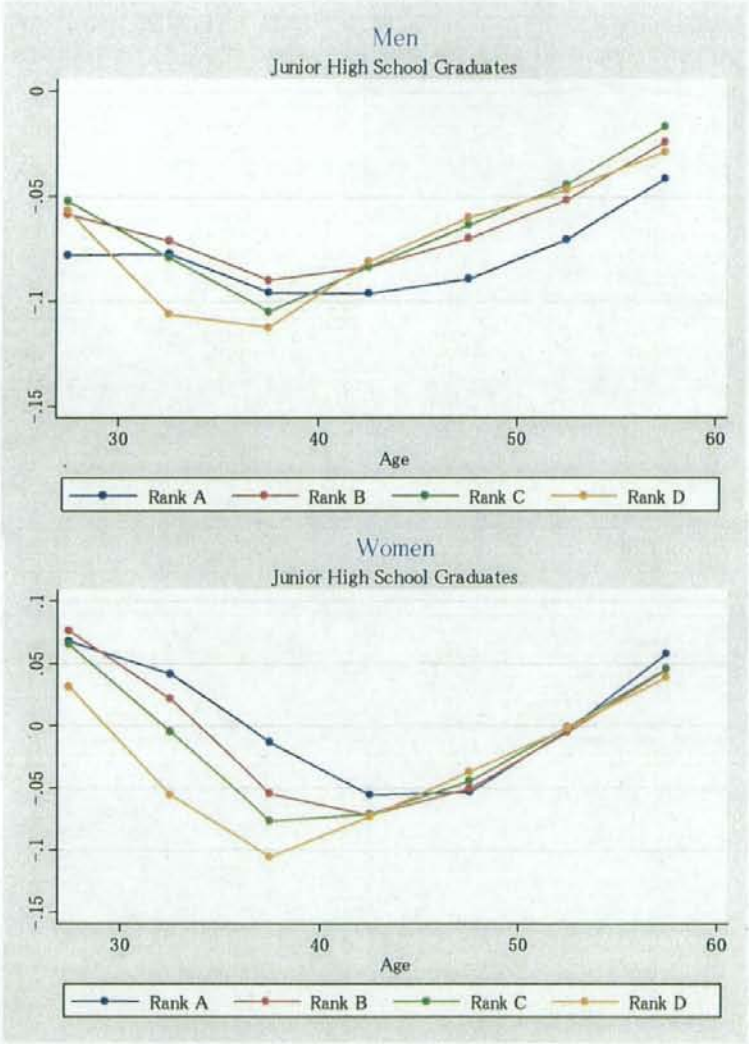
Source: Authors' calculation from the BSWS (1990, 2000).

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



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

Figure 5: The Changes in The Employment-population Ratios, by sex and education
The Changes in EPR=EPR(2000) - EPR(1990)



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

Table 1: Age twist regression results
Dependent variable =EPR2000-EPR1990

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 40-45 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) and the BSWS 1990

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* (0.039)	-0.132 (0.071)	-0.129* (0.060)	-0.099* (0.042)	0.117** (0.025)	0.451** (0.164)	0.291** (0.053)	0.176** (0.035)
	R-squared	0.45	-	-	-	0.67	-	-	-
	Women	-0.393** (0.060)	-0.613** (0.143)	-0.609** (0.102)	-0.499** (0.072)	-0.042 (0.022)	-0.192 (0.204)	-0.017 (0.054)	-0.072* (0.030)
	R-squared	0.67	-	-	-	0.80	-	-	-
Senior High	Men	0.148** (0.023)	0.178** (0.036)	0.209** (0.033)	0.164** (0.025)	0.151** (0.016)	0.388** (0.086)	0.313** (0.033)	0.212** (0.026)
	R-squared	0.52	-	-	-	0.51	-	-	-
	Women	-0.150** (0.041)	-0.211* (0.095)	-0.299** (0.065)	-0.181** (0.048)	0.033 (0.022)	0.329* (0.140)	0.229** (0.062)	0.049 (0.030)
	R-squared	0.53	-	-	-	0.63	-	-	-
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 40-45 for columns (5)-(8).
All regressions are weighted by the weight explained in the text.
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)

Table 3: continued

Explanatory Variable: $LogWage_{1990}$

Numbers in parentheses indicate columns in Table 2	Junior High											
	Age 25-39						Age 40-59					
	Men			Women			Men			Women		
	Without Wage (Tab. 1 B. Col.(2))	WLS (1) residuals	IV(4) residuals	Without Wage (Tab. 1 B. Col.(5))	WLS (1) residuals	IV(4) residuals	Without Wage (Tab. 1 B. Col.(3))	WLS (5) residuals	IV(8) residuals	Without Wage (Tab. 1 B. Col.(6))	WLS (5) residuals	IV(8) residuals
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log(Wage1990)	0.035**	-0.006	-0.004	0.166**	0.037**	0.030*	-0.050**	-0.023**	-0.013**	0.007	-0.001	-0.007
	(0.013)	(0.005)	(0.005)	(0.020)	(0.013)	(0.013)	(0.007)	(0.004)	(0.004)	(0.008)	(0.008)	(0.008)

Numbers in parentheses indicate columns in Table 1	Senior High					
	Age 25-39			Age 40-59		
	Women			Women		
	Without Wage (Tab. 1 B. Col.(11))	WLS (1) residuals	IV(4) residuals	Without Wage (Tab. 1 B. Col.(12))	WLS (1) residuals	IV(4) residuals
	(13)	(14)	(15)	(16)	(17)	(18)
log(Wage1990)	0.180**	0.037**	0.031*	0.007	-0.029**	-0.027**
	(0.020)	(0.013)	(0.013)	(0.007)	(0.007)	(0.007)

Note: The sample sizes are 141 for columns (1)- (6), (13)-(15) and 188 for columns (7)-(12), (16)-(18)
All regressions include a constant.
All regressions use the weight explained in the text.
Robust standard errors in parentheses.
* significant at 5%; ** significant at 1%.

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