YEAR	MEDIAN AGE OF THE VAP (1)	AGE OF A PERSON IN 2000 WHO WOULD HAVE THE SAME TIME HORIZON AS A PERSON AT THE MEDIAN AGE OF THE VAP (2)
	GERMANY	
2000	46.2	46.2
2010	48.8 (48.6-49.0)	46.8 (45.9-47.7)
2020	52.5 (52.0-53.1)	48.6 (46.9-50.5)
2025	54.2(53.2-55.2)	49.3 (47.1-51.7)
2030	54.9 (53.3-56.6)	49.0 (46.5-51.7)
2040	56.1 (53.9-58.5)	48.5 (44.9-52.0)
2050	57.7 (54.5-60.9)	48.2 (43.7-52.8)
	JAPAN	
2000	49.2	49.2
2010	51.8 (51.7-51.9)	49.9 (49.1-50.8)
2020	54.2 (53.8-54.6)	50.5 (48.9-52.2)
2025	55.5 (54.9-56.1)	51.0 (48.9-53.2)
2030	57.2 (56.5-57.9)	51.8 (49.3-54.3)
2040	60.5 (59.0-62.0)	53.5 (50.2-56.4)
2050	62.6 (60.1-65.1)	53.7 (49.9-57.6)

Table 3. Median Age of VAP and Age of a Person in 2000 Who Would Have the Same Time Horizon as a Person at the Median Age in the Specified Year, Germany, Japan, 10 Year Intervals 2000 to 2050

Source: Sanderson and Scherbov (2007). Figures are median values computed over 1,000 probabilistic forecasts. Figures in parentheses are 95 percent prediction intervals. We use the term "time horizon" to refer to expected remaining years of life.

Year	Germany	Japan
2000	20.1	21.7
2010	20.4	22.4
2020	22.6	28.4
2030	27.8	31.1
2040	31.7	36.0
2050	33.1	39.8

Table 4: Percentages of Total Populations Above Normal Pension Age, 2010 to 2050, and Percentage of the VAPs Above Normal Pension Age in 2000.

Source: Sanderson and Scherbov (2007).

Data are from the mean scenario in Sanderson and Scherbov (2005).

Figures for 2000 do not take Demeny voting into account.

Calculation treats the total population as if it were the the Demeny VAP. This is a close approximation, but it does produce a slight downward bias in the percentages, especially for Japan under Option 1. This is consistent with our interpretation of the Demeny voting results as showing the maximum possible effect of a voting age reform.

Regional patterns of employment changes in Japan: Evidence from the 1990s[*]

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Abstract

In this article, we study changes in employment of less-educated men and women in Japan in the 1990s using aggregate data. From 1990 to 2000, the low-wage regions experienced a higher wage growth than the high-wage regions did. The employment data show that decline in employment of less-educated young men and women was concentrated in the low-wage areas. For the older group, a fall in employment of men occurred in the highest-wage regions that include large metropolitan areas. We investigate whether the changes in employment can be explained by differential wage growth across regions. We find that higher wage growth in the low-wage regions is associated with large employment decline for those aged 25-39, but not for the older age group.

JEL classifications: J21, R11
Keywords: Regional wage growth, Age-twist, Minimum wage

1 Introduction

The labor force participation of men and women changed significantly in Japan from the early 1990s to the early 2000s, when the Japanese economy experienced deflation. Male participation has fallen, especially for the less-educated and for young men (Genda 2006; Abe 2008). Female participation has risen overall, but the participation rates for less-educated women did not rise as much as for other groups, or even declined (Abe 2008).

Regional wage growth has shown a unique pattern of changes during the same period. Wage growth was higher in the low-wage areas than in the high-wage areas. For example, the growth rate of mean hourly wages for male full-time employees from 1990 to 2000 was 18.2 percent in the three prefectures with the highest wages (Tokyo, Kanagawa, and Osaka) and 25.2 percent in the lowest wage prefectures (19 prefectures for which the minimum wage rank was D in 1990: Table A1 lists the names of these 19 prefectures).[1] As a result, regional wage differentials decreased from the early 1990s to the early 2000s.[2] The compression of regional wage differentials occurred for both mean full-time wages and mean part-time wages.

Based on these observations, we pose the following question in this article: Are

[1] This calculation is based on the data from the Basic Survey of Wage Structure (Ministry of Health, Labour and Welfare of Japan).
[2] This fact is also pointed out in Abe and Tanaka (2007).

there regional differences in the recent decrease in participation by less-educated men and women? The analysis reveals that such differences do exist. Then we pose the second question: Can such regional differences be understood as responses to differential wage growth across regions? To answer these questions, we use aggregate data of participation and wages.[3]

We find changes in the regional employment differ for the young and the middle-aged groups, which we call the "age twist." Age twist is illustrated in Figure 1. On average, the employment-population ratio fell for men and rose for women, but the pattern of changes differ across regions and age groups. There was a larger fall (or lower growth) in employment for young men and women living in the low-wage than in the high-wage regions; for the older group there was a larger decline in employment in the high-wage than in the low-wage regions.

We then relate these changes in employment to the changes in average wages classified by sex, age, and region.[4] We conclude that the age-twist pattern is best explained by demand shifts that favored older workers in the low-wage regions.

The article is organized as follows. In Section 2, the data used in the analysis

[3] It is desirable to use microdata because aggregate data have several limitations. However, the microdata currently available for research purposes do not allow analysis at the prefecture-level, because the prefecture code is unavailable in such data sets.
[4] Although several studies have looked at the regional differences in unemployment in Japan in the 1990s (e.g., Ohta 2005; Yugami 2005), we are not aware of any research that examines the role of differential wage growth across regions on labor force measures.

are explained. Section 3 provides results for regional wage growth patterns. In Section 4, employment patterns across regions from 1990 to 2000 are presented as raw tabulations. Regression results are reported in Section 5. Section 6 discusses possible interpretations for the results. Section 7 concludes.

2 Data

2.1 Employment data

The employment data used in this article are from the published version of Census in 1990 and 2000 (Statistics Bureau, Ministry of Internal Affairs and Communications of Japan). We use data classified by education (junior high school graduates, senior high school graduates, junior college graduates, and university graduates or above) and age groups (5-year intervals) for 47 prefectures, separately for men and women. In order to minimize the possible impact of school enrollment at young ages and retirement at old ages on participation, we focus on the population aged 25-59 years.

2.2 Average wage data

For wages, we use aggregate data of the Basic Survey of Wage Structure

(BSWS, Ministry of Health, Labour and Welfare of Japan). This data set contains mean earnings and working hours for full-time employees for each prefecture by age groups defined by 5-year intervals; the data are not available separately by the level of education. Full-time wages are defined as monthly salary (shoteinai kyuyo) divided by monthly hours.[5] This is an hours-weighted measure of hourly wages.[6]

Mean hourly wages for male and female part-time employees are available for each prefecture, aggregated over all age and all education groups. We use wages for female part-time employees to form an instrumental variable in the regression analysis reported in Section 5. The mean part-time wages published in the BSWS are the mean of hourly wages and are not weighted by hours worked. The sampling error of part-time wages is rather large for prefectures with a small population. The wages of full-time employees are less likely to suffer from large sampling errors.

3 Patterns of wage growth across regions from 1990 to 2000

In this section, we report hourly wage changes from 1990 to 2000 for each prefecture to gauge the pattern of wage growth by region. In some of the following

[5] Here, the earnings figure in the numerator does not include bonuses.

[6] Since the mean hourly wages of individual full-time workers are not reported in the published BSWS data, hourly wages are calculated by dividing mean earnings by mean hours in each cell. The resulting measure is an hours-weighted measure of hourly wages: see Abe and Tanaka (2007) for an explanation. On the other hand, for part-time workers, average hourly wages that are not weighted by hours worked are reported in the published version of the BSWS.

analysis, 47 prefectures are classified as the high- and the low-wage regions based on the four minimum wage ranks (A to D) in 1990.[7] The classification in 1990 is referred to as the "minimum wage rank" in the rest of the article. The Rank A region is the set of highest-wage prefectures, while the Rank D corresponds to the lowest-wage prefectures. To examine the growth in wage rates by sex and region, we calculate the growth rate of hourly wages as

$$\Delta LogWage_a = ln(hw_{a,2000}) - ln(hw_{a,1990}), \qquad (1)$$

where $hw_{a,t}$ is the hourly wage for age group a in year t.[8] These growth rates are calculated for each pair of prefecture, age group, and sex. Figure 2 plots wage growth for full-time employees defined by equation (1) against age for the four regions classified by the minimum wage rank, separately for men and women.[9]

The most notable feature of wage growth during this period is that it was much lower in the high-wage areas than in the low-wage areas. Wage growth rates in the regions were in the order Rank A≤Rank B≤Rank C≤Rank D. It is striking that this

[7] The minimum wage ranks are the classification of prefectures used for the minimum wage setting in Japan: see Kawaguchi and Yamada (2007) for a detailed explanation of minimum wage setting and the minimum wage ranks. The prefectures classification into minimum wage rank is shown in Table A1.

[8] We do not deflate wages by regional price level. Prefecture-level Consumer Price Index (CPI) data are available for the capital city of each prefecture. We performed the analysis presented below using the data deflated by regional CPI, and find that the results are very similar to the ones obtained using the wage data without the regional-CPI adjustment.

[9] For aggregating the wage growth at prefecture-level into the four regions, the weight used in the regression analysis in Section 5 is used.

pattern holds true for almost all age groups for both sexes, although the profiles of different regions almost coincide for several age groups (e.g., male employees aged 45-59). Full-time wage growth was higher for females than for males during this period, but regional differences in wage growth are quite similar.[10] A similar regional pattern is observed for the hourly wage of part-time employees of all ages (not shown).

Unfortunately, wage measures are not available by level of education in the published version of the BSWS. It is possible that the educational composition of the workforce changed during the analysis period, which may have affected the wage growth pattern shown in Figure 2. To partly address this concern, we calculate the wage growth rates for very small firms (firms with 5 to 9 employees) and plot them against age in Figure 3.[11] The less-educated are more likely to work in very small firms than others, and thus wage growth in such firms is likely to reflect the wage growth pattern of the less-educated, which is the main focus of the subsequent analysis. While sampling errors of wage data for very small firms are larger than sampling errors for wage data for all firm sizes, and the variations by age in Figures 2 and 3 are different, the basic pattern of differential regional wage growth seems to hold here as well: wage

[10] In fact, female full-time wages grew more than the minimum wage, while male full-time wages did not grow as fast as the minimum wage for most regions; the minimum wage growth during this period was almost uniform for all prefectures.

[11] For the aggregation here, we use the weight created from the total hours supplied by the workers in firms with 5-9 employees in the two years.

growth is higher in the low-wage regions than in the high-wage regions.[12]

It must be kept in mind that sampling errors of the mean wage measures here are rather large, and sampling errors in the growth rate of the wages are even larger. To account for measurement error in the wage growth variable, we use region dummy variables (the minimum wage rank dummies or the prefecture dummies) as instruments in the regression analysis reported in Section 5. The differential wage growth across regions means that the region dummies are correlated with wage growth.

4 Patterns of employment across regions from 1990 to 2000

For analysis of regional patterns in employment, we begin with a simple tabulation of the employment-population ratios, separately by sex, education, age group, and region. Figure 4 shows the level of employment-population ratios from the census data, by minimum wage rank, sex, education, and year (1990 and 2000).

[12] It is possible that regional wage growth observed in Figure 2 is partly due to worker migration across regions. For example, if the proportion of university graduates among workers in the low-wage regions increased relative to that in the high-wage regions, high wage growth in the low-wage regions from 1990 to 2000 can be explained by changes in the educational composition of workers. To check such possibilities, we look at changes in the educational composition of workers in the four minimum wage ranks using the census data. The proportion of university graduates among male workers aged less than 40 has increased slightly more in the low-wage regions compared to the high-wage regions. For older men, however, the proportion of university graduates increased more in the high-wage regions. For women aged 25-59, the proportion of university graduates generally increased more in the high-wage regions than in the low-wage regions. The higher concentration of more educated workers in the high-wage regions tends to increase wage differentials across regions, rather than compressing them. According to these facts, it is unlikely that migration is the major cause of differential wage growth across regions reported here.

The employment-population ratio for men increases with age until the late 40s and then starts to decline. Male participation is highest in the Rank B region and lowest in the Rank D region for almost all age groups; participation by men is somewhat low in the highest wage regions (Rank A). This pattern is particularly apparent for older men in 2000.

For women, the employment-population ratios increase in the 30s and the 40s, and then starts to decline. The increase in the 30s corresponds to the move toward the second peak in the M-shaped labor force participation profiles for women in Japan.[13] It is also notable that regional differences in participation are large for women. Female participation is highest in the low-wage regions (Rank D) and lowest in the high-wage region (Rank A). This pattern is consistent with the findings of Abe et al. (2007).

Figure 5 graphs changes of the employment-population ratios (defined as the difference in the employment-population ratios between 1990 and 2000) for junior high school graduates in a similar manner as in Figure 4. Reflecting secular declines in participation by men and secular increases in participation by women, changes of male participation in Figure 5 are mostly negative and those for female participation tend to be positive, although there are significant variations across age groups and regions.

[13] The profiles for junior high school graduate women in Figure 4 are not M-shaped partly because they are plotted for over age 25. When we plot them from age 15, they are close to M-shape.

The most notable changes in participation of male junior high school graduates between 1990 and 2000 in Figure 5 is the "age twist," which refers to the fact that the employment-population ratios fell more (or grew less) for those aged 25-39 living in the low-wage regions than for those living in the high-wage regions, while for those aged 40-59, the decline was larger (or the growth was smaller) in the high-wage regions than in the low-wage regions (Figure 1). While decline in participation by less-educated men occurred for both the young and the middle-aged (Genda 2006; Abe 2007), regional patterns of the decline differed sharply depending on age.

For female junior high school graduates, the regional differences in the increase in participation are quite large for younger ages. The regions where young women experienced increases in participation are the ones where female participation was low (Rank A and Rank B); these regions contain the large metropolitan areas. The regional differentials in women's participation shrank remarkably at young ages: in the panels of the third row of Figure 4, the profiles of employment-population ratio for the four regions are located in closer positions in 2000 than in 1990. For female junior high school graduates aged 40-59, there are small regional differences in the increase in participation. Thus, the "age twist" is less apparent for female than for male junior high school graduates.

The changes in the employment-population ratios of other educational groups are summarized as follows (graphs not shown). For male university graduates, regional differences in employment changes are much smaller than those for less-educated men. For male senior high school graduates and university graduates, differences across age groups are minimal. The employment-population ratios fell more or less uniformly for the younger and older groups. For female senior high school graduates, age twist is observed. For female university graduates, employment fell more for young women living in the low-wage regions than in the high-wage regions, but employment changes for older women show only small regional differences. Statistical significance of the age-twist patterns is confirmed by a regression analysis below.

5 Regression Results[14]

We now turn to regression analysis of the regional patterns in changes in employment, using prefecture-level cell-mean data. The unit of observation for the cell-mean data is the cell defined by sex, education, age group (5-year interval) and prefecture. In the following, we confine our attention to male and female junior and senior high school graduates. First, we report the results for the age-twist pattern, and

[14] Here and in the rest of the paper, we use the words "insignificant" and "significant" to denote a statistical test at the 5% level.

then examine the extent to which the age-twist pattern is related to the differential regional wage growth reported in Section 3.

5.1 Age twist

We begin by estimating the age-twist pattern using the following regression equations:

$$\Delta EPR_j = \beta_1 \cdot (Minimum\ wage\ rank\ Dummies) + X\eta + u\,, \qquad (2a)$$

$$\Delta EPR_j = \beta_2 \cdot LogWage_{1990,j} + X\eta + u\,, \qquad (2b)$$

where ΔEPR_j is the change in the employment-population ratio between 1990 and 2000 in the cell j (the cell defined by a pair of age group and prefecture), $LogWage_{1990,j}$ is the log of hourly wage in year 1990 for full-time employees in cell j, and X are age dummies. The base group for the minimum wage rank dummies in equation (2a) is the Rank A region (the highest wage region). We estimate equation (2a) and (2b) separately for each sex and level of education. We further estimate (2a) and (2b) separately for ages 25-39 and for ages 40-59, for each sex-education pair. Regression equations are weighted by $\{(pop_{j,1990})^{-1} + (pop_{j,2000})^{-1}\}^{-1}$, where pop_{jt} is the population of cell j in year t.[15]

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[15] To motivate this weight, note that the variance of EPR_{jt} is $EPR_{jt}(1 - EPR_{jt}) / pop_{jt}$. If we

The age twist hypothesis suggests that β_1's for the low-wage areas (i.e., Rank C or Rank D) take small values for young ages, and large values for older ages. It also suggests that estimates for β_2 is positive for the young but negative for the middle-aged. The estimates for equation (2a) are shown Panel A of Table 1, and those for equation (2b) are shown in Panel B of Table 1. The results show that the age-twist hypothesis clearly holds for male junior high school graduates and female senior high school graduates. It holds weakly for female junior high school graduates: for this group, while the decline in employment for young women is significant in the low-wage regions, changes for older women exhibit small regional differences. Age twist is not observed for male senior high school graduates, for whom differences across age groups are minimal.

5.2 Age-twist and wage growth

Next, we assess whether the age-twist pattern confirmed above is explained by regional wage growth. The basic specification we estimate is as follows:

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ignore the heteroscedasticity due to the term $EPR_{jt}(1-EPR_{jt})$ in the numerator, the variance of EPR_{jt} is proportional to the inverse of pop_{jt}. Then, the variance of $\Delta EPR_j (= EPR_{2000} - EPR_{1990})$ is $(pop_{j,1990})^{-1} + (pop_{j,2000})^{-1}$, the inverse of which is the weight used here. The standard errors are corrected for heteroscedasticity. For the regressions reported in Section 5.2, we experimented with a feasible generalized least-squares (GLS) procedure that takes into account the heteroscedasticity due to $EPR_{jt}(1-EPR_{jt})$.

$$\Delta EPR_{j,s} = \alpha \Delta LogWage_j + X\phi + u, \qquad (3)$$

where $\Delta EPR_{j,s}$ is the change in the employment-population ratio between 1990 and 2000 for cell *j* and education level *s*, $\Delta LogWage_j$ is the wage growth measure defined by the log-difference in wages between 1990 and 2000 for cell *j*, and X is a set of age dummies. Equation (3) is estimated separately for men and women, for education, and for two age groups (ages 25-39 and 40-59).[16] Separate estimation for the two age groups is motivated by our focus on the age-twist pattern. To account for measurement error in $\Delta LogWage_j$, we estimate equation (3) by three different sets of instrumental variables: (1) part-time wage rates in the region, (2) three dummy variables for the minimum wage rank in 1990, or (3) 46 prefecture dummy variables (excluding the base group).[17] As for the age-twist regressions, the regressions are weighted by

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[16] We consider that the first-differenced specification of equation (3) is preferable to the level specification in which the dependent variable is the employment-population ratio in levels and wages are measured in levels for the following reason. Since we wish to focus on the impact of differential wage growth across regions from 1990 to 2000, it is important to "difference out" the permanent factors in wage and participation levels in the regression analysis. The easiest way to do this is to take first difference. This is particularly relevant for women, for whom the regional differences in participation are large (Figure 2). This formulation is close to that used by Devereux (2004) in estimating labor supply elasticities from the U.S. census data.

[17] A possible concern for using this IV procedure is the problem of weak instruments. Among the IV regressions, we consider the one that uses 46 prefecture dummies as the preferred specification. For this specification, the R^2 coefficient from the first stage regression is about 0.87 and the F-statistic is above 12 for the four samples for men (junior high school graduates aged 25-39 and 40-59, and senior high school graduates of the same two age groups). For female junior and senior high school graduates aged 25-39, the R^2 coefficient is about 0.83 and the F-statistic is around 9. For female junior and senior high school graduates aged 40-59, the instruments have smaller explanatory power and the R^2 coefficient is about 0.5 and the F-statistic is around 3. Therefore, instruments have reasonable explanatory power for men and young women, while there is a possible concern for weak instruments for older women.

$\{(pop_{j,1990})^{-1} + (pop_{j,2000})^{-1}\}^{-1}$.[18] Results are reported in Table 2. The IV estimates using the 46 prefecture dummies as instruments yield results that are close to the weighted least squares estimates.

Estimates for α are negative for the younger group except for male senior high school graduates, while they are positive for the older group, except for female junior high school graduates. Positive α means that higher wage growth is correlated with higher participation (or, a smaller decline in participation), while negative α means that higher wage growth is negatively correlated with participation.[19] Clearly, the relationship between wages and employment differs across age groups. For the younger group, wage growth has a negative effect on employment, while for the older group, wage growth promotes employment. It should be kept in mind that the wage data are

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[18] We also experimented with a feasible GLS procedure to take into account the heteroscedasticity due to $EPR_{jt}(1-EPR_{jt})$ (see footnote 14). To apply a feasible GLS, it is necessary to obtain a consistent estimate of EPR_{jt}. We run a cross-sectional regression for each year for which the dependent variable is EPR_{jt} and the explanatory variables include log wage for the sex-age-region pair in the corresponding year and age dummies. Let the predicted value of the dependent variable from these regressions be $E\hat{P}R_{jt}$. Then,

$\{E\hat{P}R_{j,1990}(1-E\hat{P}R_{j,1990})/pop_{j,1990} + E\hat{P}R_{j,2000}(1-E\hat{P}R_{j,2000})/pop_{j,2000}\}^{-1}$ is used as the weight. This feasible GLS procedure yields results that are similar to the ones reported in Table 2. Although this procedure has the advantage of taking into account the heteroscedasticity due to $EPR_{jt}(1-EPR_{jt})$, the cross-sectional regressions in the first step are specified in a somewhat arbitrary way.

[19] If equation (3) is understood as a labor supply function measuring participation (extensive margin), the coefficient α is a labor supply elasticity. Kuroda and Yamamoto (2007) estimate labor supply elasticities using aggregate data for Japan and find that elasticities are generally positive. However, their specification differs from ours in a number of respects. First, our estimates are based on extensive margin only. Second, our estimates are based on separate regressions for different education and age groups. Third, we use differential wage growth across regions to identify α.

regional aggregates across all educational levels, so we are not relating the wage growth for each educational group to their participation changes.

5.3 Does age twist remain after controlling for wage growth?

The coefficients shown in Table 2, together with the wage growth patterns in Figure 2, suggest that the age-twist pattern is partly explained by wage growth. Higher wage growth in the low-wage regions than in the high-wage regions is associated with lower employment growth in the low-wage regions through the negative α for the younger group. At the same time, the similar wage growth pattern is associated with higher employment growth in the low-wage regions through the positive α for the older group.[20] These opposite signs of α could create the age-twist pattern in employment growth. The next question is whether the age-twist remains after controlling for wage growth.

To understand the extent to which age-twist is explained by regional differences in wage growth, residuals from equation (3) are regressed on the minimum wage rank dummies or on the log wage in 1990, and the estimates are compared to those in Table 1 (estimates from equation (2a) or (2b)). Specifically, let $\hat{u}_j$ be the

[20] Figures 2 and 5 indicate that there is an age-twist in changes in participation, while no twist is observed for wage growth. Therefore, we have opposite signs for α for the young and the older groups.

residuals from equation (3). Then the following equations are estimated:

$$\hat{u}_j = \gamma_1 \cdot (\textit{Minimum wage rank Dummies}) + \varepsilon\ , \qquad (4a)$$

$$\hat{u}_j = \gamma_2 \cdot LogWage_{1990j} + \varepsilon\ . \qquad (4b)$$

The coefficients of the minimum wage rank dummies in equations (2a) and (4a), β_1 and γ_1, are compared: if the coefficients change significantly, age-twist is mostly explained by the differential regional wage growth and responses to it. Likewise, the coefficients of the log wage in 1990 (β_2 and γ_2) are compared to investigate whether the age-twist is explained by differential wage growth. In this subsection, we report results for male and female junior high school graduates and female senior high school graduates, for whom the age-twist is most apparent. For the dependent variables of equations (4a) and (4b) ($\hat{u}_j$), we use residuals from two specifications of equation (3): the weighted least squares regression and the IV regression that uses 46 prefecture dummies as instruments.

Results from the regressions of (4a) and (4b) are reported in Panel A and Panel B of Table 3, respectively. Age-twist is a combination of a relative employment decline for the young and a relative increase for the old in the low-wage regions compared to the high-wage regions. Thus we first discuss whether the larger fall in employment for the younger group in the low-wage regions is explained by wage growth, and then