Minimum Wages and Retirement *

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Abstract

We study the effect of the minimum wage on the employment outcomes and Social Security claiming of older US workers from 1983 to 2016. The probability of work at or near the minimum wage increases substantially near retirement, and previous researchers and policies suggest that older workers may be particularly vulnerable to any disemployment effects of the minimum wage. We find no evidence that the minimum wage causes earlier retirements. Instead, our estimates suggest that higher minimum wages increase earnings and may have small positive effects on the labor supply of workers in the key ages of 62 to 70. Consistent with increased earnings and delayed retirement, higher minimum wages decrease the number of Social Security beneficiaries and amount of benefits disbursed. Minimum wages appear to increase financial resources for workers near retirement.

Keywords: minimum wage, retirement, Social Security claiming

JEL Classifications: H55, J26, J38, J42

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In an era of rising inequality and aging populations, the effect of the minimum wage on the labor market for older workers is increasingly important. The minimum wage reduces lower-tail wage inequality, but may do so at the cost of lost employment and earnings to other workers. Rising rates of minimum wage work above age 50, depicted in Figure 1, imply that workers may be especially vulnerable to any negative effects. Consistent with the possibility of negative effects on older workers, state-level exemptions to the minimum wage for workers over age 65 appeared in the United States until the late 1980s.[1]

In this paper, we examine the effect of the minimum wage on retirement in the United States. The analysis focuses on two common markers of transition to retirement, employment in the ages of 62 to 70, observed in the Current Population Survey (CPS), and receipt of Social Security retirement income, taken from the Social Security Administration's (SSA) Master Beneficiary File. We apply two methodologies commonly used in the recent minimum wage literature: the canonical state-panel model, and a county border-pairs design where the data permits. Standard specification checks motivate the choice of controls for time-varying heterogeneity, and we investigate the possibility of dynamic responses that appear over longer time spans. To explore the explanations for these effects, we also document the response of earnings, hours, wages, job flows (hires and separations), and sources of retirement income aside from Social Security.

In our analysis of employment outcomes for people between the ages of 62 and 70, we find evidence of increased earnings and no disemployment effects. Contrary to the hypothesis of higher minimum wages forcing earlier retirements, the point estimates suggest that higher minimum wages moderately increase employment rates in the ages at which workers are eligible for Social Security, when rates of minimum wage work spike. We estimate employment elasticities with respect to the minimum wage between 0.06 and 0.13 in the 1983 to 2016 period in our preferred specifications. These estimates are marginally significant, and we can rule out negative employment effects larger than -0.05. Positive effects on employment are concentrated among wage and

[1] Explicit minimum wage exemptions for workers over age 65 were phased out around the time of the end of mandatory retirement and other formal age discrimination: in Michigan in 1978, Oregon in 1981, Oklahoma in 1983, and Kansas in 1988 (Nelson 1979, Nelson 1982, Nelson 1984, and Nelson 1989).

salary workers, with no detectable response on self-employment. The employment response is larger for men and workers in their mid-60s; estimates for other low-wage groups, such as less educated workers and single women are of similar magnitude but less precise. We also find evidence of an increased probability of full-time work, hours worked in the previous week, and weekly earnings. For workers in their late 50s, we find suggestive evidence that the minimum wage depresses hours with no effect on employment or earnings, suggesting a shift to part-time work at a higher minimum wage.

To explore the implications of these findings for public programs and resources in retirement, we next analyze how minimum wages affect Social Security retirement benefit claiming, a novel outcome in the minimum wage literature. Although modern SSA benefit formulas contain few work disincentives, claiming of benefits continues to represent an important marker of withdrawal from the labor force in the United States. In addition, changes in the timing of benefit claiming in response to changes in current income implicitly reflect a need for financial resources, since individuals should otherwise optimize the timing of claiming with respect to life expectancy. This analysis uses 1983 to 2016 SSA data, and focuses on retirement benefits drawn through the Old Age and Survivors Insurance program. We find that higher minimum wages are associated with fewer Social Security beneficiaries and corresponding reductions in total benefits paid. Quantitatively, a 10 percent increase in the minimum wage is associated with a 0.11 to 0.33 percent reduction in the number of Social Security recipients, with a slightly larger response in benefit payments. For reference, the flow of new recipients of Social Security is around 6 percent of the stock, so this change is equivalent to 1.8 to 5.5 percent of new beneficiaries shifting the timing of claiming by one year. Similar results are found in both the state-panel model with controls for time-varying heterogeneity, and using a county border-pairs design. We also find reductions in retirement income from other sources in the 1983 to 2016 CPS. Our findings are consistent with increased labor market income and delayed retirement allowing workers to defer claiming or drawing down retirement income accounts.

In sum, our empirical findings provide little to no support for the hypothesis that the minimum wage pushes workers into early retirement. These findings are consistent with Fang and Gunderson (2009), which finds employment of workers over 50 rose following provincial minimum wage increases between 1993 and 1999 in Canada.

Many previous studies of the minimum wage in the general population find small negative or zero employment elasticities.[2] At least three explanations can rationalize our results with this previous literature. First, many studies of the minimum wage assume a fixed market-level labor supply curve, and interpret changes in employment as reductions in labor demand.[3] However, workers at or near retirement may have higher labor supply elasticities along both the extensive and intensive margins, particularly when changes in incentives are salient, as with changes in wages (Gelber, Isen and Song 2016 and Gelber et al. 2017). Substitution effects engaged by a higher minimum wage would push workers toward longer careers, while income effects suggest a shift to lower intensive margin labor supply, with an increase or no change in total earnings. These predictions broadly describe our findings. Second, it is well known that the minimum wage can improve the functioning of monopsonistic labor markets characterized by high firm-level labor supply elasticities (Stigler 1946 and Brown, Merkl and Snower 2014). As pointed out by Fang and Gunderson (2009), older workers' restricted mobility and preferences to work for a local employer are consistent with monopsony power in this labor market. We find no evidence for the dynamic monopsony models in our examination of worker flows, but cannot rule out small, statistically undetectable responses. Third, there is a possibility that the increased employment of older workers substitutes for the employment of other, similar workers. We find suggestive evidence of labor-labor substitution, in that the minimum wage appears to reduce total working hours among workers in their late 50s, the closest substitutes for workers in the ages of 62 to 70. The estimated effects of the minimum wage on employment we report in this paper are likely a combination of these three mechanisms.

[2] For extensive reviews of the literature, see Brown, Gilroy and Kohen (1982), Card and Krueger (1995) and Neumark, Wascher et al. (2007). Neumark (2017) discusses recent papers finding negative effects of the minimum wage; published examples include Thompson (2009) and Meer and West (2016).

[3] See Burdett and Mortensen (1998) and Flinn (2006) for how the minimum wage can affect labor supply behavior.

1 Patterns in Minimum Wage Work Near Retirement

The effect of the minimum wage on employment in the United States remains a controversial subject, even as minimum wages bind for only a small share of workers, 2.7 percent in 2016 (Bureau of Labor Statistics (2017)). One reason for the continued interest in the subject is that the minimum wage is thought to raise pay for low-wage workers earning near-minimum wages, compressing the lower tail of the wage distribution (Lee (1999) and Autor, Manning and Smith (2016)). For example, spillovers to other workers can occur through relative pay differentials within firms, which may particularly affect tenured (i.e. older) workers. It is also possible that the minimum wage may affect the employment of older workers above the minimum, if employers expect these workers to experience declining productivity. In most of our summary statistics and discussion, we consider workers earning up to 120 percent of the minimum wage to be affected, to capture these "ripple" effects on other workers in the low wage labor market, and to allow for measurement error.[4]

Older workers are significantly more likely than the middle aged to work for a wage at or near the minimum, though rates have declined significantly over the past two decades. Figure 1 depicts the 1990, 2000 and 2010 age profiles of the share of workers employed at or near the minimum wage, measured by an hourly wage within 120 percent of the minimum. We include the age profile of employment for the three decades, as well. A U-shaped pattern in minimum wage work appears in all three decades. In the 1990s, rates of minimum wage work among older workers rose markedly after age 50, with close to 20 percent for workers in their late 60s working for near minimum wages. In the subsequent two decades, the share of older workers near the minimum has shifted to lower levels and later ages. Minimum wages rose again in the 2010s, leading to a small reversal of the trend towards reduced exposure; however, rising retirement ages during this

[4]We report the full range of statistics for the share of population, share of employed, and share of total hours at or below the minimum for the 62-70 age group in the Appendix. The share at or below the minimum is around half of the share at or below 120 percent of the minimum for all three measures throughout the sample period. See Grossman (1983) and Autor, Manning and Smith (2016) for discussions of ripple effects and measurement error.

era muted these effects on the share of older workers exposed to the minimum wage.[5] In the time series, the declining share of older workers earning near-minimum wages is associated with rising retirement ages.

Some of the economic reasons that older workers may be more likely to work in jobs that pay at or near the minimum wage also imply that their employment may be particularly vulnerable to increases in the minimum. Many economic theories of retirement explain both falling wages and withdrawal from the labor force as responses to decreasing productivity, health limitations, or other types of human capital depreciation. Life-cycle models of human capital investment often feature a period of declining productivity at older ages (Ben-Porath 1967 and Rogerson and Wallenius 2009), and theories of decreasing productivity and retirement play a central role in the literature on mandatory retirement (Lazear, 1979). An older literature in labor economics hypothesized negative effects among older workers in an efficiency wage model due to their inability to increase their productivity in response to increases in the minimum wage (see Mincer (1976) and United States Minimum Wage Study Commission (1983)).[6] If productivity losses lead to lower wages, then classical economic theory predicts a wage floor will cause some older workers to reach the minimum wage and be forced out of the labor force sooner than they would have otherwise chosen. Minimum wages may also increase retirement hazards as a result of changing worker preferences, if a higher minimum wage reduces the availability of flexible low wage jobs. For example, Maestas et al. (2017) and Ameriks et al. (2017) document older workers' willingness to trade off wages for other job amenities, such as flexible hours.

The trends towards lower and later-in-life exposure to the minimum wage reflect both changes in the real value of the minimum wage, as well as later retirements of workers in the middle of the income distribution. Figure 2 plots the time series of the average real minimum wage (population-

[5]If we included teenagers and workers in their early 20s, we would see substantially higher rates of minimum wage work in these ages. Many minimum wage studies examine the effects of the minimum wage on youth; for recent studies in the United States, see Dube, Lester and Reich (2010), Giuliano (2013), Neumark, Salas and Wascher (2014), and Gittings and Schmutte (2016).

[6]It is important to note that empirical evidence on how aging affects productivity is mixed. For recent evidence on falling wages at older ages, see van Ours (2009), Van Ours and Stoeldraijer (2011), and Burtless et al. (2013).

weighted across states) and its ratio to the median wage for workers aged 62 to 70 from 1983 to 2016. The real minimum wage exhibits a sawtooth pattern, with periodic increases to nominal minimum wages eroded by inflation. The real value of the minimum wage gradually declined during the decade preceding the Great Recession, before federal legislation raised minimum wages to levels last seen in the early 1980s. In contrast, the minimum-to-median wage ratio shows a pattern of steady deterioration, which was slowed but not reversed by recent increases. Between 1990 and 2000, the minimum wage was approximately half of the median wage. That figure has fallen to below 40 percent in recent years, and remains at this low level. Recent reforms have proposed raising the minimum wage to real levels above those of the 1980s. For example, a $15 minimum wage would expose 35 percent of workers over age 65 to near minimum wages.

2 Data and Descriptive Statistics

Our primary analysis focuses on the impact of the minimum wage on employment outcomes, with outcome variables obtained from the basic monthly data of the Current Population Survey (1983-2016) of the Integrated Public Use Microdata Series (Flood et al., 2015). The individual-level CPS data provides the most flexibility, allowing estimation of the full model at the monthly or quarterly level, with outcomes disaggregated by age, education, race, and other characteristics. Data on state-level minimum wages is taken from the Bureau of Labor Statistics' Historical Minimum Wages page.[7]

Because the key explanatory variable, the level of the minimum wage, varies only by state and time, we group the individual CPS data into cells by state, quarters, and age for our main analysis. The CPS sampling weights are utilized when collapsing the data. We limit the samples to individuals aged 25 through 70, primarily focusing on the workers between the usual retirement ages of 62 through 70 and the near-retirement ages of 50 through 61. We use 62 as the lower bound of our retirement-age group, since Social Security early retirement benefits are first available at age

[7] Downloaded June 2016. Our data are nearly identical to those of Autor, Manning and Smith (2016).

62, and retirements measured by exit from the labor force increase sharply at this age. Incentives for later claiming turn off at age 70, and only 10-15 percent of workers remain in the labor force past this age.

Wage and income variables are constructed from only the wage or salary employed (CPS does not report earnings of the self-employed), where we multiply top-coded values by 1.5 (as in Autor, Manning and Smith (2016)). Hourly wages for workers who are not paid by the hour are calculated by dividing weekly earnings by the hours worked during the past week.

The retirement data are obtained from the Social Security Administration's (SSA) annual publications of Old-Age, Survivors and Disability Insurance (OASDI) Beneficiaries Statistics. The data are derived from the Master Beneficiary Record, which is the principal administrative file of Social Security beneficiaries. We specifically focus on the county-level number of claimants of retirement (Old Age and Survivors Insurance) benefits, and the total benefits paid out to them.[8]

Descriptive statistics of the CPS data from 1983 to 2016 are presented in Table 1. The retirement age group (62 to 70) has significantly lower employment-to-population ratio compared to the near-retirement age group (50 to 61) and the younger group (25 to 49). A high proportion of employed workers around the retirement age is self-employed; about 30 percent are identified as self-employed in our CPS sample. Also, the retirement age group has lower hourly wages and weekly earnings than the near-retirement age group, but higher hourly wages than the younger group. Not surprisingly, the retirement age group has the largest amount of Social Security income and other retirement income.[9] Minimum wage work at older ages is more common for women, the less educated, and blacks and Hispanics compared to white non-Hispanics.

[8]In the Appendix, we additionally utilize the Annual Social and Economic Supplement (ASEC) of the CPS to get individual level information on Social Security income and other retirement income.

[9]Other retirement income is a composite category that includes income from (description taken from IPUMS): company or union pension, including profit sharing; annuities; U.S. military retirement; federal government employee pensions; state or local government employee pensions; U.S. Railroad Retirement; regular payments from annuities or paid-up insurance policies; and other sources such as IRA or KEOUGH accounts.

3 Empirical Strategy

We conduct closely related analyses in the CPS and SSA data. Following Card and Krueger (1995), Neumark, Salas and Wascher (2014), and Allegretto et al. (2017), we estimate variations of the following panel data model:

$$y_{ast} = \beta \cdot MW_{st} + \phi_s + \phi_{at} + \varepsilon_{ast}, \tag{1}$$

where a indexes age, s indexes geographic unit (state), and t indexes time (year-quarter).[10] The unit of observation for the CPS data is state/age/time cells, and each cell is weighted by the number of observations. The variable of interest is the log of effective minimum wages, MW_{st}, in state s and at time t. Outcome variables, y_{ast}, for age group a in state s at time t are the log of employment-to-population ratio, the log of weekly earnings, and the hours worked in the previous week. We control for state fixed effects, ϕ_s, and age $\times$ time fixed effects, ϕ_{at}, to capture the shift towards older retirement changes over the sample period. In particular, the age $\times$ time fixed effects absorbs time-varying, age-specific retirement incentives, such as Social Security rules (e.g., changes in the earnings test and rising normal retirement age). Standard errors are clustered at the state level throughout the analysis. We report our main results for the primary sample (aged 62 to 70), reflecting patterns in retirement discussed above.

Identification in this model depends on the conditional independence of state minimum wage laws and the employment outcomes of older workers. As discussed above, previous work has questioned this assumption for other groups, and suggested that researchers should include controls for either or both trends in state employment and interactions of the time period with sub-national geographic aggregations, such as Census region or division. Thus, we include both division $\times$ age

[10] Due to the limited number of observations of the CPS, we pool age groups 62-63, 64-65, 66-67 and 68-70 whenever we further stratify our samples by full/part time status, class of work, sex or education.

$\times$ time and state linear trends in our preferred specifications:

$$y_{ast} = \beta \cdot MW_{st} + \phi_s + \phi_{d(s)at} + \tau_s I_s \cdot t + \varepsilon_{ast} \quad (2)$$

where d indexes Census divisions, and I_s is a dummy for state s. We will show in Section 3.1 that the common time effects model (Equation 1) exhibits pre-existing trends for the retirement age group also (our main focus here), and accounting for time-varying heterogeneity, as we do in Equation 2, eliminates such bias.

We next allow the coefficients of the minimum wage, β, to vary across age groups. We do this because we are interested in which particular age groups are affected the most by the changes in the minimum wage. Based on Equation 2, the estimating equation is

$$y_{ast} = \sum_{a=50}^{70} \beta_a \cdot (AGE_a \cdot MW_{st}) + \phi_{as} + \phi_{ad(s)t} + \tau_{as} I_{as} \cdot t + \varepsilon_{ast} \quad (3)$$

where we fully interact age group dummies, AGE_a, with the log of minimum wage variable, MW_{st}. Here, we restrict our samples to the retirement age group and the near-retirement age group ranging from ages 50 to 70. Thus, we get separate coefficients β_a for each age group a, representing the heterogeneous effects of minimum wage for each age. We add fixed effects for state by age, ϕ_{as}, and state-age specific linear trends, $\tau_{as} I_{as} \cdot t$, as we now have multiple age groups in the model. Thus, our estimates β_a are based on variation within state-age groups across time. We plot β_a to show the age-profiles of the effects of minimum wages on employment, earnings, and hours worked.

For the Social Security analysis, we make use of aggregated county-level data, though the SSA data is only available at an annual frequency, and does not contain information on age. We focus on the number of retirement beneficiaries and the total amount of benefits since they are closely related to retirement decision of older workers. We run both state-panel models consistent with the CPS analysis (Equation 2), and county border-pairs specifications (Dube, Lester and Reich 2010 and Aaronson et al. 2018). To implement the county border-pair, we drop all non-border counties, and add fixed effects for border pairs by time. Following Kroft et al. (2017), we weight counties by population and the inverse of appearances in the sample, since the same county can pair with multiple other counties. Standard errors are two-way clustered at the state and pair level (Cameron, Gelbach and Miller 2011 and Dube, Lester and Reich 2010). The county border-pair design has the advantage of controlling for local economic conditions at the county-level, greatly reducing the concern that minimum wage reforms are confounded with broader changes in economic conditions. We can also compare the estimates from the state-panel model to estimates with the county border-pairs design, to assess potential biases in the CPS analysis.

3.1 Choosing the Right Specification

To inform the selection of our empirical model, we conduct tests of pre-existing trends in a basic state-year panel specification and the heterogeneous time effects model. The presence of pre-existing trends indicates that the estimated coefficients are likely to be biased. Formally, we estimate the following equation as in Dube, Lester and Reich (2010):

$$y_{ast} = \alpha + \eta_{12}(MW_{s,t+12} - MW_{s,t+4}) + \eta_4(MW_{s,t+4} - MW_{as,t}) + \eta_0 MW_{s,t} + \phi_s + (TimeControls) + \varepsilon_{ast} \quad (4)$$

where y_{ast} denotes the log of employment rate, the log of probability of full-time and part-time work, the hours worked in the previous week (without log) and the log of weekly earnings of age-state-time cells, respectively.[11] The explanatory variables, $MW_{s,t+j}$, are the log of minimum wage in state s at j quarters after time t. Thus, η_{12} represents the effects of minimum wage shocks on outcome variables, y_{ast}, 12 quarters (3 years) prior to the shock, η_4 the effects on outcomes 4 quarters (1 year) prior to the shocks, and η_0 the effects on contemporaneous outcomes. We

[11] In addition, we restrict our attention to the wage and salary employed by excluding the self-employed in Table A3, and the results are qualitatively unchanged.

report η_{12}, η_4 and $\eta_4 - \eta_{12}$ (the trend between $t-12$ and $t-4$). If the coefficients are statistically different from 0, it suggests that there exist pretrends in the model specification. We estimate Equation 4 separately for different $TimeControls$: the common time effects model (age $\times$ time fixed effects) and the heterogeneous time effects model (age $\times$ division $\times$ time fixed effects and state specific linear trends), respectively.

We report results for Equation 4 in Table 2. We find some evidence of pretrends in the canonical common time effects model for retirement-related outcomes, particularly when the dependent variables are hours and weekly earnings (columns 7 and 9). Statistically significant estimates of η_4, η_{12} or $\eta_4 - \eta_{12}$ indicate that there exist pretrends in the traditional fixed effects model. Here, lower earnings of older workers four quarters before the minimum wage reforms predict a change in the minimum wage, while a negative trend in hours of work also predicts a change. These patterns disappear and become insignificant after we include heterogeneous time effects (columns 8 and 10). This result motivates our preferred specification in our estimating equations. It is also consistent with the previous minimum wage literature, which finds pre-existing trends in the traditional fixed effects specifications for other groups of workers.[12]

While the pretrend analysis suggests we require more than just state and year effects as controls, previous researchers have cautioned that the inclusion of overly flexible time-varying controls may absorb the variation necessary to estimate the effects of interest. State linear trends may be particularly problematic if effects of the minimum wage appear slowly over time. To address these concerns, we report results for models which sequentially add controls, allowing direct assessment of alternative specifications. We also replicate the main empirical analysis of Meer and West (2016), which allows for effects that appear over longer time spans than in a standard panel setup. To preview the results, we find that estimates in our setting are not very sensitive to these methodological issues.

[12] We also examined evidence of endogeneity in the distributional effects of minimum wage reforms, with results reported in the Appendix. Consistent with our findings above, controlling for time-varying heterogeneity eliminates effects of minimum wage reforms on earnings above the range affected by minimum wages (Figure A1).

4 Effects of the Minimum Wage on Older Workers

4.1 Effects of the Minimum Wage on Employment, Hours and Earnings

Table 3 reports the effects of the minimum wage on labor market outcomes of older workers, aged 62 to 70, where we estimate Equations 1 and 2 using the CPS. The labor market outcomes are the log of employment to population ratio (Panel A), the probability of full-time (using a 35-hour cutoff, Panel B) and part-time (Panel C) work, the hours worked in the previous week (Panel D), and the log of weekly earnings (Panel E).

Column 1 of Table 3 implements the state-panel model with the canonical model of state and time fixed effects (Equation 1), and finds minimum wages are associated with positive employment outcomes for the older group. However, we have shown in the pretrend analysis that this specification exhibits a bias due to time-varying heterogeneity, so in column 2, we account for time-varying heterogeneity in the form of division $\times$ age $\times$ time effects and state linear trends; this is our preferred specification (Equation 2). Regardless of the choice of controls, the employment coefficients from columns 1 and 2 are non-negative, contrary to the hypothesis of adverse employment effects on older workers. Reading column 2, a 10 percent minimum wage increase predicts a 0.6 percent increase in employment, which can be translated into a 0.2 percentage point increase across the retirement group.[13] From the results, we can rule out negative employment effects larger than -0.05.

Next, we restrict our focus on the wage and salary employed by excluding the self-employed in columns 4 to 6. As we have shown in Table 1, workers in the retirement age group have a higher probability of being self-employed (30 percent) compared to other age groups. It is possible that minimum wages may push older workers who are unable to find flexible low-wage jobs from the wage and salary employed into the self-employed. However, we find a positive and marginally significant coefficient of 0.13 for the wage and salary employment of the retirement age group (column 5 in Panel A). We also test for a direct effect on self-employment, and find no evidence

[13]Recall in Table 1 that the mean employment rate of the 62-70 age group is 0.3.

that higher minimum wages shift older workers to self-employment (Table A5). Thus, positive employment effects of minimum wages on older workers are likely to be driven by the wage and salary employed.

The impact of the minimum wages on full-time and part-time status are reported in Panels B and C, with estimates on hours and earnings in Panels D and E. Using the controls for time-varying heterogeneity in columns 2 and 5, we find that employment response of for ages 62 to 70 is associated with an increase in full-time work, with no effect on part-time status. These effects are larger for the wage and salary employed; a 10 percent increase in minimum wages is associated with a 2.5 percent increase in full time employment. The increase in full-time employment is reflected in the increase in hours worked in the previous week, in Panel D, and increase in weekly earnings, in Panel E. The estimates for weekly earnings are large, with a 10 percent increase in the minimum wage leading to a 3 percent increase in weekly earnings. These effects suggest both intensive and extensive margin responses, as they appear larger than the intensive margin estimates.

We restrict the sample to employed individuals in columns 3 and 6 and study the effect on earnings and hours. We find smaller effects on earnings among the employed, which may be explained by a combination of intensive and extensive margin effects. These results should be interpreted with caution, as the restriction to employed individuals introduces the possibility of selection into the sample. Specifically, the increase in the employment rate of older workers in response to higher minimum wages (Row 1) suggests compositional changes may partially explain the smaller earnings effects among the employed compared to the whole population.

We run the same analysis on the age 50-61 group in the Appendix. We find no negative effect of minimum wages on overall employment in this group. However, the age 50 to 61 group shows modest evidence of a shift to part time work. Minimum wages seem to increase their part-time employment, which is contrary to the age 62-70 group where the positive effects are concentrated on the full-time. This is also reflected in the modest decrease in hours for employed individiuals in their 50s (Table A4).[14]

[14] Results for the 25 to 49 age group are shown in Table A7, and largely follow previous findings in the literature.

Next, we decompose the effects of minimum wages by fully interacting age dummies (age 50-70) with the log of minimum wages to estimate β_a in Equation 3. We plot these age $\times$ minimum wage coefficients separately for different labor market outcomes in Figure 3 to illustrate the age-profiles of the minimum wage impacts. The outcomes considered are employment to population ratio, labor force participation rate, earnings, and hours of work. We additionally control for state $\times$ age fixed effects and state-age specific linear trends, so our source of variation comes from within age group a in state s across time periods. The first panel shows the positive effects on employment are explained by responses of individuals in their mid-60s. The second panel replaces employment with labor force participation, an alternative measure of retirement that accounts for unemployment. The results are unchanged, indicating that unemployment is not an important margin of adjustment.

In the second row, we report the effect on hours worked the previous week for the whole population and for employed workers. Hours responses, again, are concentrated in the mid-60s, peaking at an increase of nearly 2 hours of work per week for those between ages 64-66. Workers in their late 50s also reduce their hours slightly. This is consistent with our results shown in Table A4, where we find modest decreases in the work hours. Again, this may suggest that there exists a shift to part-time work in response to increases in minimum wages, consistent with combined income and substitution effects of changes in the minimum wage. In the final row, we report earnings elasticities. As with the previous analysis, we find modest evidence of a shift to part-time work and reduced earnings in the late 50s, followed by larger increases in earnings in the mid-60s.

In the Appendix, we report the results of an analysis of employment and worker flows in the Quarterly Workforce Indicators (QWI) data. The QWI allows us to estimate a county border-pairs design, at the cost of a shorter panel and more aggregated age groups. Specifically, we run Equation 2 for county-quarters from 2000 to 2015 and the aggregated ages 55 to 64, and 65 and over. It is shown that the minimum wage has no effect on employment of workers age 65 and over once time-varying heterogeneity is accounted for, through either the inclusion of controls or the use of the county border-pairs design (Table A8). The effect is a precisely estimated zero, though confidence intervals cannot generally exclude the estimates found in the CPS analysis. Figure 1 and Figure 2 also show that minimum wages are less binding for older workers during 2000-2015, which may diminish the positive employment coefficients that possibly appeared in the 1980s and 1990s.[15] Unlike the results for teenagers and food service workers in Dube, Lester and Reich (2016), we also find no evidence that the minimum wage has altered flows among older workers.[16] The absence of changes in worker flows argues against a dynamic monopsony story, and suggests any increase in employment results from labor supply effects. These results lead us to strengthen our conclusion that the minimum wage has no disemployment effects on older workers.

4.2 Heterogeneity and Robustness

In Table 4 we explore the heterogeneity and robustness of the employment estimates. While the literature considers a range of outcomes, we focus on employment elasticities, as these are the most commonly proposed channel by which the minimum wage may have perverse consequences.

We first discuss heterogeneous effects of minimum wages on the retirement age group (62 to 70) by sex, and for the less educated. We mainly focus on our preferred specification of columns 4 and 9, which fully control for time-varying heterogeneity. We include the self-employed in our regressions in column 4, but not in column 9. In Panels B and C, we document heterogeneous minimum wage effects on men and women. Accounting for time-varying heterogeneity in column 4, we show that men overall respond more strongly to minimum wage reforms with a large positive and significant employment coefficient; a 10 percent increase in minimum wages leads to a 1.6 percent increase (3.2 percent for the wage and salary employed) in the employment rate of men. We further stratify the samples by marital status in the Appendix, where we again find that men and women show distinct patterns in terms of employment elasticities. For men, the positive effects

[15] Clemens and Wither (2014) also show that there were larger increases in productivity among low-skilled workers in the earlier periods (comparing 1994-2002 and 2006-2014), which might also explain larger effects in the 1980s and 1990s.

[16] Notice that given the aggregation of QWI data to broad age ranges, we cannot isolate the ages in which we examined employment effects in the CPS.

become larger and more significant for married men, particularly if we restrict our attention to the wage/salary employed. For women, on the other hand, those without a spouse generally have larger positive employment coefficients. (Table A6).

We also explore heterogeneity by education and industry. In Panel D of Table 4, we report results for those with high school education or below, where 18 percent of employed workers earn near-minimum wages. Again, we do not find any evidence of disemployment effects, though we lose precision with the focus on a subgroup.[17] We further explore heterogeneous effects of minimum wages on older workers by industries in the Appendix. For industry-level analysis, it is necessary to utilize the state-level QWI data (2000-2015) because of the limited sample size of the CPS. In accordance with the employment results for the QWI (Table A8), we do not find evidence of disemployment in the heterogeneous effects across NAICS private sectors. One exception appears—we do observe statistically significant and negative employment effects of minimum wages on public sectors (Figure A2). This may reflect inflexible public sector budgets for wages and salaries, and is worthy of attention for future research.

In the other columns in Table 4, we conduct robustness checks to our employment estimates, considering various specifications with different sets of controls. Neumark, Salas and Wascher (2014) argue that the use of "local controls" in our preferred specification may lead to faulty conclusions, since this incorrectly captures unobserved heterogeneity and throws out valid controls. To address this critique, we include coarser geographic controls in columns 1 to 3 and 6 to 8 of Table 4. We start from the traditional common time effects model without any control for heterogeneity (columns 1 and 6). In columns 2 to 3 and 7 to 8, we include more controls, by adding age $\times$ time and division $\times$ age $\times$ time fixed effects, respectively. Columns 4 and 9 are our preferred specification with state linear trends. Finally, we add time-varying covariates (the log of unemployment rate and the log of the total population) in columns 5 and 10. Reading across the top row of estimates (Panel A), we find no evidence of disemployment effects; none of the coefficients are

[17]The effects on the high-educated counterpart (some college or more) are also non-negative and statistically indistinguishable from the low-educated group (not reported).

less than zero regardless of the specifications. This absence of adverse employment effect is also found in other sub-groups across the specifications.

The validity of location specific trends variable used in our preferred specification has been debated in the minimum wage literature. Dube, Lester and Reich (2010) and Allegretto et al. (2017) argue that it is necessary to account for spatial heterogeneity of pretrends in employment growth by including state-specific time trends. On the other hand, several studies criticize this specification, pointing out that it may fail to capture important identifying variation of minimum wages (Sabia 2009). Meer and West (2016) also argue that minimum wages have dynamic treatment effects on employment growth which the specifications with state-linear trends cannot fully capture.

Nevertheless, we find that the specifications promoted as alternatives to those with state linear trends do not alter the findings. First, unlike the previous studies, the inclusion of state-specific linear trends in the regression do not significantly change our employment elasticities (columns 3 and 4 of Table 4). To formally show that state-specific trends do not bias our employment coefficients for older workers, we replicate the long difference specifications by Meer and West (2016). We regress the long difference in the log of employment rate on the long difference in the log of minimum wages, with and without state linear trends, respectively (Table A9). If state linear trends are biasing our estimates due to not fully accounting for dynamic minimum wage effects, the employment elasticities are expected to change as the time span is increased. However, we find that the employment elasticities are consistent across different duration of time spans (from 1 year to 8 year) and specifications (with and without linear trends).

For an additional check on robustness, we utilize the interactive fixed effects model to account for unobserved heterogeneity (Bai 2009 and Totty 2017). We have assumed that unobserved heterogeneity can be controlled for in the standard OLS framework by including division $\times$ age $\times$ time fixed effects and state linear trends in our regression equation. Instead of making this specific assumption about the form of heterogeneity, the interactive fixed effects model jointly estimates unobserved common factors and factor loadings that capture unit-specific responses to the common shocks. In the Appendix, we compare the coefficients of the previous OLS results (common time effects and heterogeneous time effects) and the new interactive fixed effects results with various number of unobserved common factors (up to 10). Overall, we observe that the interactive fixed effects model exhibits positive coefficients of labor market outcomes that follow the patterns estimated by the heterogeneous time effects OLS model (Table A10).

From the evidence in the analysis, we conclude that minimum wages have not reduced the employment of workers around retirement, but rather, may have modestly increased employment.

4.3 Effects on Social Security and Retirement Income

In our final section of analysis, we use the county-level data of Social Security Administration's (SSA) annual publications of Old-Age, Survivals and Disability Insurance (OASDI) Beneficiaries Statistics to examine the effects of the minimum wage on Social Security income of older workers. Since the OASDI Beneficiaries Statistics are reported annually, we use the mean value of the minimum wages for each year as our explanatory variable.[18]

Table 5 shows the results for the OASDI county-level data on the log of retirement beneficiaries (columns 1 to 4) and the log of payments (columns 5 to 8) by the Social Security system. In columns 1 to 2 and 5 to 6, we utilize all counties in the regression analysis, where we control for common time effects using Equation 1 (columns 1 and 5), and heterogeneous time effects using Equation 2 (columns 2 and 6), respectively. The regression models in this analysis closely resemble the previous CPS specifications. Here, the bias from time-varying heterogeneity pushes towards larger decreases in beneficiaries and payments. Once we account for time-varying heterogeneity, we still find statistically significant negative effects of minimum wages on retirement beneficiaries and benefits—a 10 percent increase in minimum wages leads to a 0.11 percent decrease in beneficiaries. Effects on benefits are slightly larger, with a 10 percent higher minimum wage associated with a 0.2 percent decrease.

[18] One concern for our analysis is the possibility of a migration response, since retirees may be more sensitive to the cost of living than other people. We test for this using data from the Surveillance, Epidemiology and End Results data, finding that minimum wages are not associated with size of the age 65+ county population.

In columns 3 to 4 and 7 to 8, we restrict our samples to counties that are located along state borders. For columns 3 and 7, we control for division × year fixed effects and state linear trends, as in the all counties samples. In columns 4 and 8, we instead control for border pair × year fixed effects. This is our preferred specification, with the largest set of controls for time-varying heterogeneity. In this specification the estimates are based on only the variation within county border pairs, where each bordering county is used as the control for their counterpart. We find that a 10 percent increase in the minimum wage leads to about a 0.3 percent decrease and 0.5 percent decrease in beneficiaries and payments, respectively. The estimated coefficients for border counties are similar across columns, and consistent with the estimates from the model that parallels the CPS analysis.

Comparing these results with the employment analysis, we find that the magnitudes of the previous CPS analysis on employment coincide with those of the Social Security analysis. From Section 4.1, we show that the employment elasticity for the age group 62-70 using our preferred specification is 0.06 (column 2 of Table 3); with an employment rate around 0.3 (Table 1), this implies a 0.2 percentage point increase in employment from a 10 percent increase in the minimum wage. In addition, we find that 80 percent of our samples in the ASEC whose age is over 62 report that they receive some forms of the Social Security benefits. Using the Social Security elasticity of -0.03 (column 4 of Table 5), this translates into a decrease of similar absolute magnitude in the probability of claiming the Social Security benefits from a 10 percent increase in the minimum wage. Since the minimum wage may have effects beyond increasing employment (for example, increasing the earnings for the already-employed and other members of the household), we have no reason to expect that these coefficients would be exactly equal. However, it is reassuring that they are similar in magnitude.

In the Appendix, we report the analysis of Social Security outcomes and other retirement income in the CPS-ASEC data. The CPS is largely uninformative about the effects of the minimum wage on Social Security, as the standard errors would not allow us to detect the magnitude of effects we find in the OASDI data. However, we find that minimum wages induce significant decreases in other retirement income (defined by the CPS). Most of these other sources resemble Social Security in that they reward individuals for delayed withdrawals (Table A11).

Thus, we conclude that higher minimum wages delay Social Security claiming, consistent with an increase in financial resources for workers approaching retirement.

5 Conclusion

Population aging will pose an unprecedented challenge to fiscal budgets over the coming decades. In response, encouraging longer working lives is a near-universal policy prescription among economists. Working longer increases both the resources of individual workers and tax receipts, while also reducing the burden on Social Security programs. Therefore, the potential disemployment effects of recent proposals to increase the minimum wage deserve particular scrutiny. When policymakers and researchers have considered the differential effects of the minimum wage on older workers, the presumption has been that the minimum wage may be particularly harmful to this group. The strongest evidence of this belief is minimum wage exemptions for older workers, which were phased out with the end of formal age discrimination in the 1980s.

We find no evidence of disemployment effects of the minimum wage on older workers, despite high rates of exposure to the minimum wage. Instead of disemployment effects, higher minimum wages have been associated with marginally longer working lives and delayed retirement, with effects concentrated in the mid-60s. The estimates of positive effects on employment are small and marginally significant; however, the combined evidence on employment, hours, and wages, supports the finding of increased labor force attachment. Our most robust finding is a decrease in Social Security recipients and benefits.

A pattern of positive effects on older workers' employment and earnings mirrors the findings of increased employment among older workers in Canada, documented in Fang and Gunderson (2009). As is usual in studies of minimum wages, we must caveat the results by noting that the minimum wage may have non-linear effects. The results in this paper apply to the range of minimum wages observed in the sample period, and may not be entirely applicable for proposal to raise the minimum wage above previous levels. For example, we calculate that a $15 minimum wage would bind above the 30th percentile of wages for workers over age 62. Allaying this concern, we find our positive employment effects are largely explained by responses in the 1980s and 1990s, when minimum wages were binding at a higher percentile of the wage distribution, and consequently affected a larger share of older workers. We conclude that the minimum wage appears to be an effective tool to increase the incomes of older workers.

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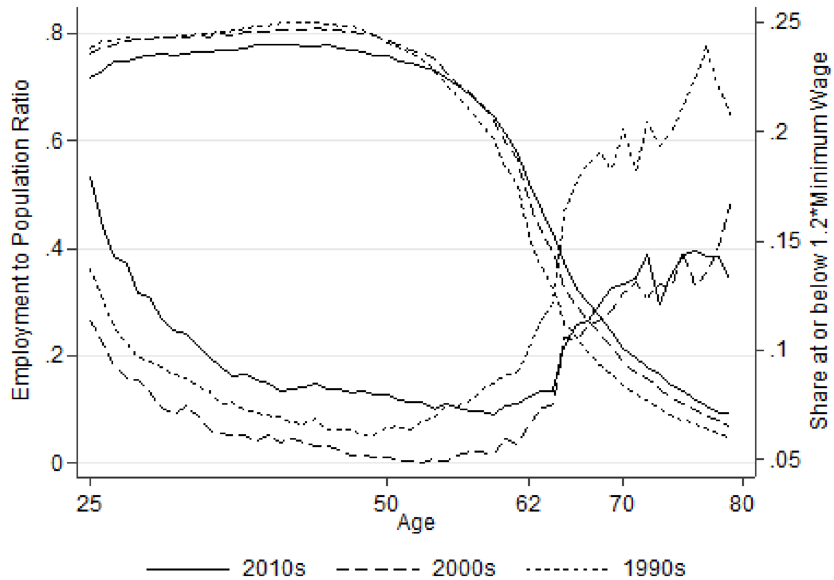
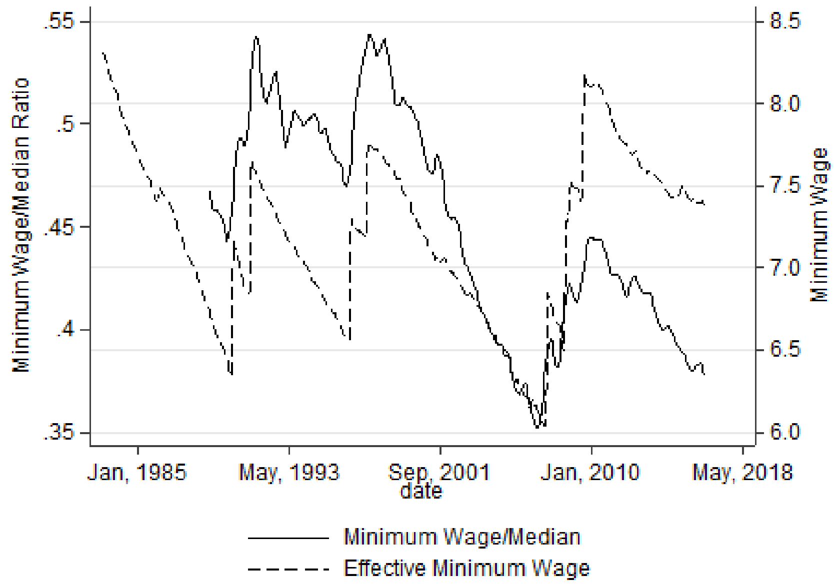
Figures and Tables

Figure 1: Age Profiles of Employment to Population Ratio & Share of Workers Earning at or Below 120% of Minimum Wage (CPS)



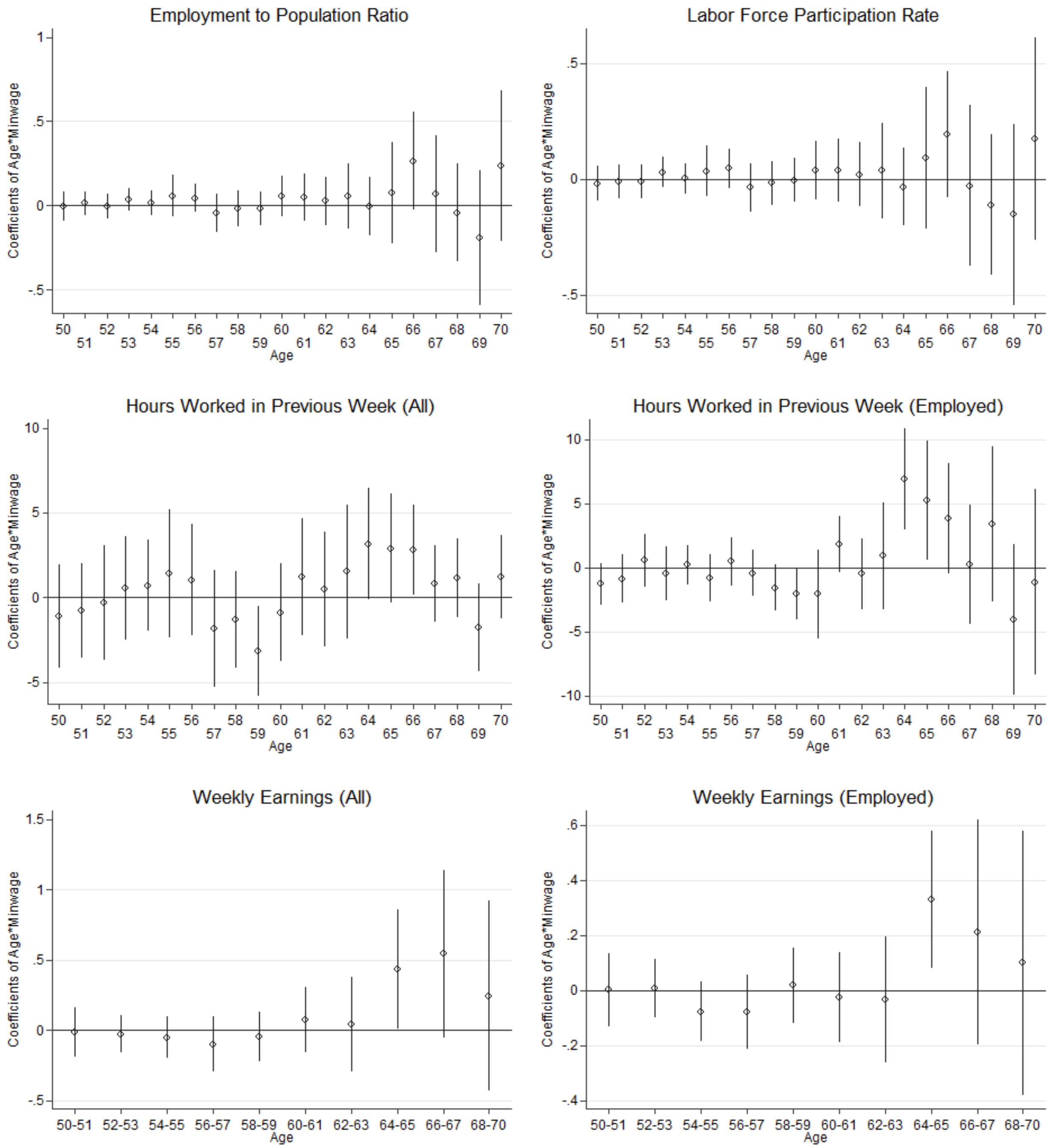
Notes: The figure plots the age profile (25-79) of employment to population ratio (starting from top-left) and the share of workers earning wages equal to or less than the 120% of the applicable state or federal minimum wages (starting from bottom-left). Utilizing the CPS data, 1990s refers to 1990-1999; 2000s refers to 2000-2009; 2010s refers to 2010-2016.

Figure 2: Trend of Real Minimum Wage and Minimum-to-Median Ratio (1983-2016 CPS)



Notes: The figure plots the change in the effective minimum wage in 2016 dollars (dashed line), and the minimum-to-median ratio of 62 to 70 (solid line). The effective minimum wage is the applicable state or federal minimum wages, whichever is greater. Effective minimum wages here are monthly averages, weighted by the CPS weights of the retirement-age group (age 62-70).

Figure 3: Age Profile of the Minimum Wage Effects (CPS)



Notes: The figures plot the coefficients of age*minwage from equation 3, where the dependent variables are employment to population ratio, labor force participation rate, the hours worked and weekly earnings, respectively. Here we include state × age fixed effects, division × age × time fixed effects and state-age specific linear trends. The samples are restricted to age groups ranging from 50 to 70. Weekly earnings and hours worked variables are constructed using all the observations (left) and using only employed workers (right). Due to the limited number of observations of the CPS, we collapse by state/age/quarter and pool age groups 62-63, 64-65, 66-67 and 68-70 together for weekly earnings.

Table 1: Summary Statistics (1983-2016 CPS)

	62-70		50-61		25-49	
	Mean	SD	Mean	SD	Mean	SD
CPS Monthly (All)						
Federal Minimum Wage	7.23	0.51	7.22	0.53	7.20	0.51
Effective Minimum Wage	7.56	0.72	7.58	0.74	7.52	0.72
Employed	0.30		0.69		0.79	
Wage/Salary Employed	0.23		0.59		0.71	
Self-Employed	0.07		0.11		0.08	
Hours Worked (Employed)	34.65	15.50	40.44	13.11	40.75	12.61
Observations	4,275,319		7,562,979		19,811,725	
CPS Monthly (Earner Study)						
Hourly Wage (Employed)	26.39	75.90	28.60	76.44	24.82	60.41
Weekly Earnings (Employed)	862.40	875.62	1,068.34	870.81	956.13	754.28
Share Earning $\leq$ Minwage	0.05		0.03		0.03	
Share Earning $\leq$ 1.2*Minwage	0.14		0.09		0.10	
Male	0.11		0.07		0.08	
Female	0.17		0.12		0.13	
HS Dropouts+Graduates	0.18		0.12		0.15	
College+	0.10		0.07		0.07	
Non-Hispanic White	0.12		0.07		0.08	
Black	0.22		0.14		0.14	
Hispanic	0.23		0.18		0.19	
Observations	1,077,108		1,903,167		4,975,321	
CPS ASEC Yearly						
Social Security Income	8,688.59	8,025.37	924.07	3,800.59	275.61	2,090.12
% Getting Social Security	0.69		0.07		0.02	
Other Retirement Income	5,487.08	13,978.36	1,810.46	8,915.87	129.97	2,246.82
% Getting Other Retirement Income	0.27		0.07		0.01	
Observations	433,372		816,678		2,251,696	

Notes: The table shows descriptive statistics of main variables from the Current Population Survey (1983-2016). Employed and hours variables are derived from the monthly CPS, whereas hourly wage, weekly earnings, and share of workers earning at or below the minimum wage (120% of minimum wage) are generated from the earner study of the monthly CPS (1989-2016). Social security income and other retirement income variables are constructed from the CPS Annual Social and Economic Supplement (ASEC). Sample statistics are weighted by the applicable CPS weights. Hours worked and weekly earnings restrict to employed workers. All wage and income variables are in 2016 dollars. Effective minimum wage is the applicable federal or state minimum wage, whichever is greater. Hourly wages are calculated using the weekly earnings and hours worked data for the workers who are not working hourly. Other retirement income refers to pre-tax retirement, survivor, and disability pension income, other than social security, that a respondent receive.

Table 2: Pre-Existing Trends in Employment and Earnings

	Log(Emp/Pop)		Log(Full Emp/Pop)		Log(Part Emp/Pop)		Hours		Log(Earnings)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
η_{12}	0.044	0.066	0.027	0.026	0.063	0.051	0.280	0.516	-0.149	0.090
	(0.058)	(0.066)	(0.067)	(0.083)	(0.073)	(0.113)	(0.517)	(0.595)	(0.122)	(0.138)
η_4	-0.042	-0.027	-0.055	-0.031	0.011	-0.094	-0.807	-0.025	-0.439**	-0.088
	(0.069)	(0.106)	(0.112)	(0.135)	(0.077)	(0.180)	(0.718)	(0.978)	(0.169)	(0.213)
η_0	0.092	0.115	0.066	0.190	0.167	-0.062	0.901	2.224**	-0.255	0.378*
	(0.084)	(0.092)	(0.113)	(0.129)	(0.162)	(0.211)	(0.783)	(0.989)	(0.198)	(0.212)
$\eta_4 - \eta_{12}$	-0.086*	-0.094	-0.083	-0.057	-0.052	-0.145	-1.088*	-0.541	-0.290	-0.179
	(0.048)	(0.069)	(0.101)	(0.133)	(0.060)	(0.105)	(0.636)	(0.702)	(0.173)	(0.195)
State Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Age x Time Fixed Effects	Y		Y		Y		Y		Y	
Division x Age x Time Fixed Effects		Y		Y		Y		Y		Y
State Linear Trends		Y		Y		Y		Y		Y

Notes: Robust standard errors are clustered by states and shown in parenthesis. Here we estimate Equation 4, collapsing CPS observations (1983-2016) by state/age/quarter (62-70). $ln(MW_{s,t+j})$ denotes the log of minimum wage in state s at j quarters after time t . η_{12} is the coefficient associated with $(ln(MW_{s,t+12}) - ln(MW_{s,t}))$; η_4 is the coefficient associated with $ln(MW_{s,t+4}) - ln(MW_{as,t}))$; η_0 is the coefficient associated with $ln(MW_{s,t})$. $\eta_4 - \eta_{12}$ represents the trend. The dependent variables are the log of employment to population ratio in columns 1 to 2, the log of full time employment rate in columns 3 to 4, the log of part time employment rate in columns 5 to 6, hours worked in previous week in columns 7 to 8, and the log of weekly earnings in columns 9 to 10. The self-employed is excluded for earnings (columns 9-10). For all specifications, we include state fixed effects. Columns 1, 3, 5, 7, 9 include age $\times$ time fixed effects, whereas in columns 2,4, 6, 8 and 10 we include division $\times$ age $\times$ time fixed effects with state linear trends.

Table 3: Minimum Wage Effects on Employment, Earnings and Hours of Age Groups 62-70 (1983-2016 CPS)

	All			Wage and Salary		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	Employed	All	All	Employed
Panel A: Log(Employment/Population)						
Log(Minimum Wage)	0.110*	0.059		0.018	0.126*	
	(0.062)	(0.052)		(0.070)	(0.069)	
Panel B: Log(Full Time Employment/Population)						
Log(Minimum Wage)	0.090	0.144		-0.029	0.249**	
	(0.084)	(0.086)		(0.102)	(0.095)	
Panel C: Log(Part Time Employment/Population)						
Log(Minimum Wage)	0.162	-0.092		0.096	-0.054	
	(0.126)	(0.112)		(0.132)	(0.119)	
Panel D: Hours Worked in Previous Week						
Log(Minimum Wage)	1.168*	1.477**	1.769	0.515	1.269**	2.625**
	(0.684)	(0.648)	(1.188)	(0.586)	(0.601)	(1.040)
Panel E: Log(Weekly Earnings)						
Log(Minimum Wage)				-0.056	0.301**	0.145
				(0.140)	(0.140)	(0.113)
State Fixed Effects	Y	Y	Y	Y	Y	Y
Time Fixed Effects	Y			Y		
Division x Age x Time Fixed Effects		Y	Y		Y	Y
State Linear Trends		Y	Y		Y	Y

Notes: Robust standard errors are clustered by states and reported in parentheses. Estimates are weighted by the number of observations in each cells. The sample includes monthly CPS data from 1983-2016 (age 62-70). The unit of observation is an state/age/quarter cell, collapsed from the CPS data. Employment in column 1 to 3 refers to wage/salary employed and self employed, whereas columns 4 to 6 only to wage/salary employed. The main explanatory variable is the log of effective minimum wage. The dependent variable for Panel A is the log of employment rate, for Panel B, the log of full time employment rate, for Panel C, the log of part time employment rate, for Panel D, hours worked in previous week, and for Panel E, the log of weekly earning. Working full-time and part-time are defined as working 35 hours or more and working less than 35 hours, respectively. For all specifications, we control for state fixed effects. In columns 1 and 4, we include time fixed effects. In columns 2 to 3 and 5 to 6, on the other hand, we include division $\times$ age $\times$ time fixed effects and state linear trends. We restrict our samples to the employed workers in columns 3 and 6.

Table 4: Heterogeneity and Robustness Checks for Employment Effects on Age Groups 62-70 (1983-2016 CPS)

Dependent Variable: Log(Employment/Population)	All					Wage and Salary				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: All Cohorts										
Log(Minimum Wage)	0.110*	0.100	0.043	0.059	0.046	0.018	0.002	0.029	0.126*	0.117*
	(0.062)	(0.065)	(0.089)	(0.052)	(0.052)	(0.070)	(0.074)	(0.121)	(0.069)	(0.065)
Panel B: Male										
Log(Minimum Wage)	0.126**	0.119*	0.089	0.160**	0.151**	-0.032	-0.043	0.146	0.315***	0.313***
	(0.060)	(0.060)	(0.078)	(0.066)	(0.064)	(0.091)	(0.094)	(0.123)	(0.092)	(0.089)
Panel C: Female										
Log(Minimum Wage)	0.137	0.127	0.048	0.021	0.004	0.079	0.070	-0.038	-0.004	-0.022
	(0.091)	(0.093)	(0.132)	(0.084)	(0.087)	(0.093)	(0.096)	(0.153)	(0.092)	(0.093)
Panel D: High School Dropouts + High School Graduates										
Log(Minimum Wage)	0.183**	0.174**	0.026	0.072	0.059	0.075	0.066	-0.011	0.086	0.070
	(0.083)	(0.085)	(0.142)	(0.099)	(0.091)	(0.104)	(0.106)	(0.173)	(0.137)	(0.128)
Fixed Effects										
State	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time	Y					Y				Y
Age x Time		Y					Y			
Division x Age x Time			Y	Y	Y			Y	Y	Y
State Linear Trends				Y	Y				Y	Y
Time-Varying Controls										
Log(Unemployment Rate)					Y					Y
Log(Total Population)					Y					Y

Notes: Robust standard errors are clustered by states and reported in parentheses. The sample includes monthly CPS data from 1983-2016. The unit of observation is an state/age/quarter, collapsed from the CPS data. Estimates are weighted by the number of observations in each cells. The main explanatory variable is the log of effective minimum wage, which is defined as the applicable federal or state level minimum wage, whichever is greater. The dependent variables are the log of employment to population ratio in columns 1 to 5 and the log of wage/salary employment to population ratio in columns 6-10, respectively. Panel A uses all cohorts at age 62-70. Panel B, C and D restrict the samples to male, female, high school dropouts/graduates, respectively. Columns 4 and 9 are our preferred specifications that are shown in columns 2 and 5 of Table 3.

Table 5: Minimum Wage Effects on Social Security Beneficiaries and Income (1983-2016 OASDI)

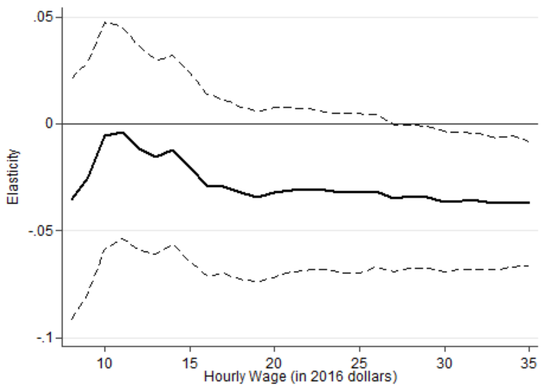
	Log(Retirement Beneficiaries)				Log(Retirement Benefits)			
	All Counties		Border Counties		All Counties		Border Counties	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log(Minimum Wage)	-0.146***	-0.011*	-0.022***	-0.033**	-0.228***	-0.019**	-0.031***	-0.051***
	(0.025)	(0.006)	(0.008)	(0.016)	(0.038)	(0.008)	(0.010)	(0.019)
County Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y				Y			
Division x Year Fixed Effects		Y	Y			Y	Y	
State Linear Trends		Y	Y			Y	Y	
Border Pair x Year Fixed Effects				Y				Y

Notes: Robust standard errors are clustered by states in columns 1, 2, 5 and 6 two-way clustered by states and border segments in columns 3,4,7 and 8. The sample includes the SSA's yearly OASDI (old age, survivors, and disability insurance) data from 1983 to 2015. The main explanatory variable is the log of effective minimum wage, which is defined as federal or state level minimum wage, whichever is greater. The dependent variables are the log of retirement beneficiaries (columns 1 to 4), the log of total retirement benefits (column 5 to 8). For all specifications, we control for county fixed effects and the log of 65+ county population. For columns 1 and 5, we include year fixed effects, whereas in columns 2 and 6, we include division × year fixed effects with state linear trends. Columns 3 to 4 and 7 to 8 restrict the samples to border counties. In columns 3 and 7, we include division × year fixed effects with state linear trends, whereas in 4 and 8, we include county pair × year fixed effects. The estimates are weighted by age 65+ county population in columns 1 to 2 and 5 to 6. For columns 3 to 4 and 7 to 8, the estimates are weighed by (number of 65+ population in a county) * (the inverse of the number of pairs a county is part of). Refer to Dube, Lester and Reich (2010) on how to construct the border-county samples.

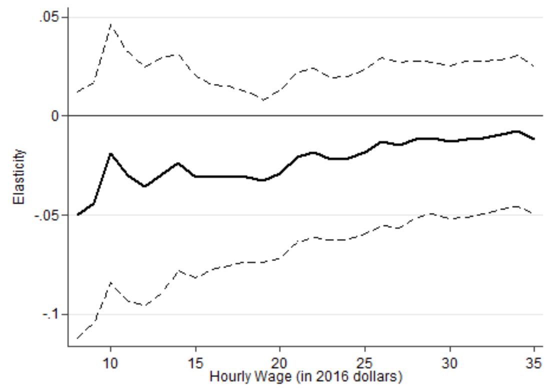
Appendix Figures and Tables

Figure A1: Minimum Wage Effects on the Proportion of Earning Below Certain Cutoffs

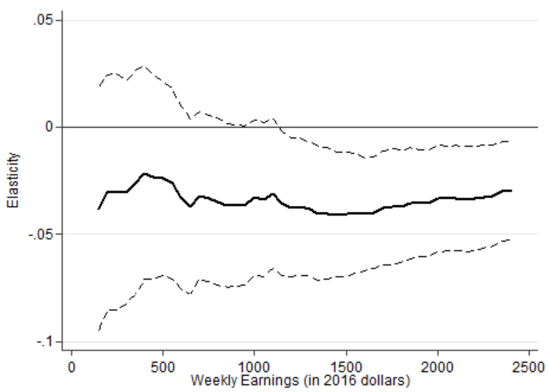
(a) Hourly Wage (Common Time Effects)



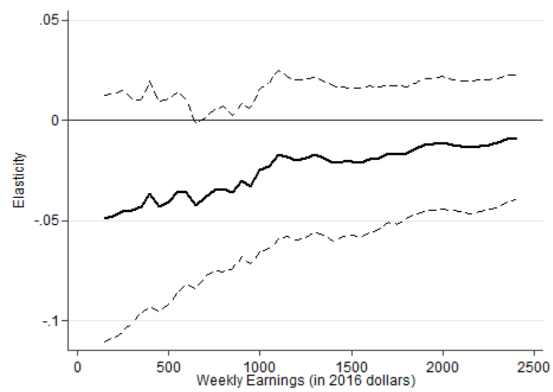
(b) Hourly Wage (Heterogeneous Time Effects)



(c) Weekly Earnings (Common Time Effects)



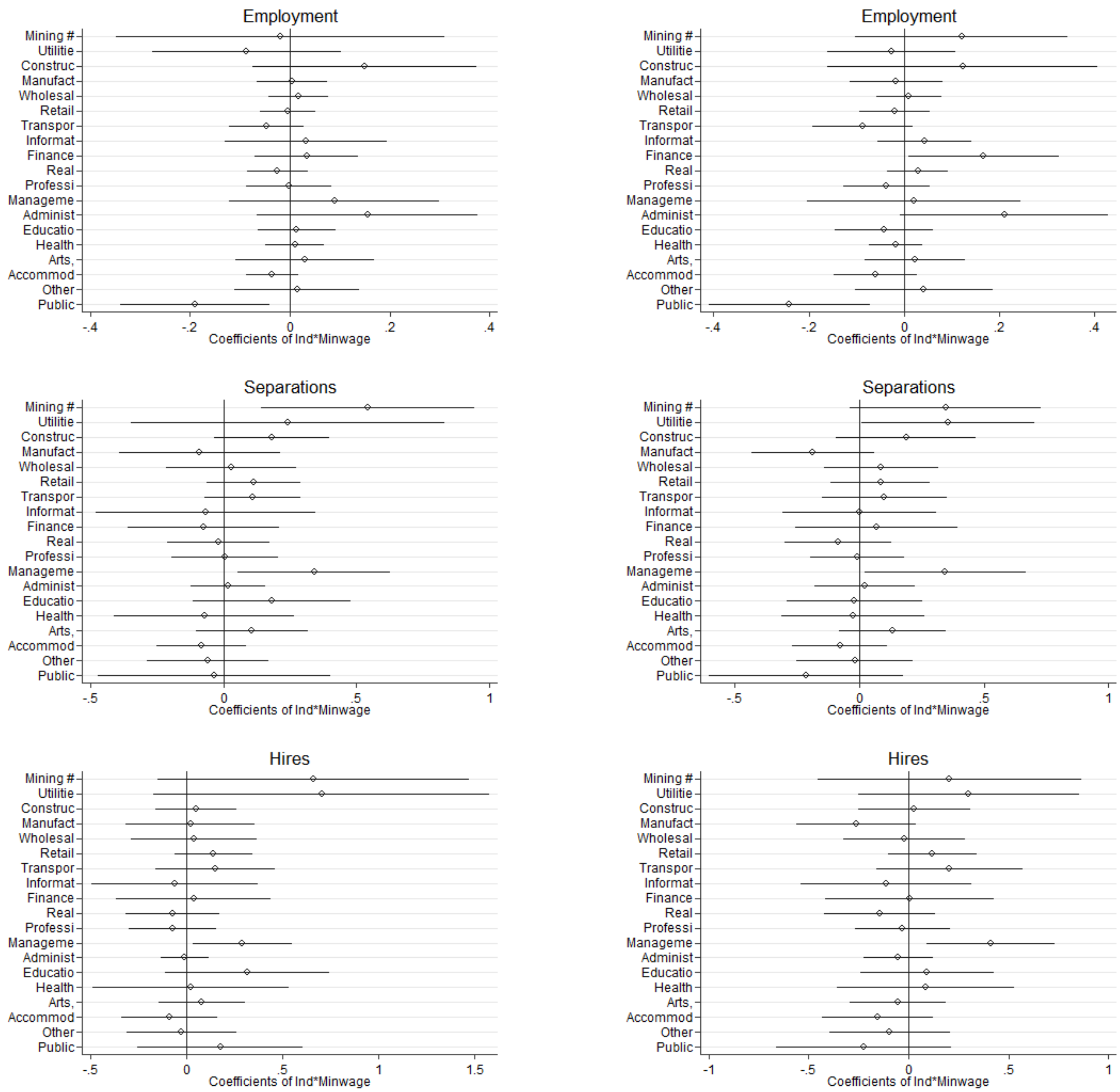
(d) Weekly Earnings (Heterogeneous Time Effects)



Notes: We estimate $ln(y_{cast}) = \beta_c ln(MW_{st}) + \phi_s + \phi_{adt} + \pi_s I_s \cdot t + \varepsilon_{cast}$ where c denotes wage or earnings cutoffs and y_{cst} is the percent earning below c in an age $\times$ state $\times$ time cell. Thus, we estimate the impact of minimum wages on the proportion of earning below certain hourly wage or weekly earnings for different cutoffs. In particular, the cutoffs c are 8, 9, 10 ... 35 for the left graph (hourly wage), and 150 200 250...2400 for the right graph (weekly earnings), in 2016 dollars. The figures plot the coefficients β_c (solid lines) and corresponding 95% confidence intervals (dashed lines). The samples are restricted to age groups ranging from 62 to 70 from the CPS data (1989-2016). Robust standard errors are clustered by states. The dependent variables are the percent earning below cutoffs c in an age $\times$ state $\times$ time cell. For those who are not working, their hourly wages or weekly earnings are considered to be 0.

Figure A2: Heterogeneous Effects of Minimum Wages by Industries

(a) Age 55-64 (b) Age 65+



Notes: The graphs plot industry specific minimum wage effects with 95% confidence intervals. Robust standard errors are clustered by states. The sample includes the Quarterly Workforce Indicator data from 2000 to 2016, weighted by state population. The dependent variables are Log(Employment) (row 1), Log(Separations) (row 2) and Log(Hires) (row 3), respectively. We run separate regressions for age groups 55-64 (left) and age groups 65+. We interact the log of minimum wage with industry dummies (NAICS codes) and plot the coefficients for each industries in the above graphs. Also, we control for state $\times$ industry fixed effects, division $\times$ industry $\times$ time fixed effects and state $\times$ industry specific time trends.

Table A1: Summary Statistics for QWI and OASDI

	All Counties Samples				Border Counties Samples			
	65-99		55-64		65-99		55-64	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Quarterly Workforce Indicators								
Employment	21,581	40,071	67,812	116,757	16,233	27,751	51,237	83,840
Seaparations	3,935	7,570	7,949	14,002	2,799	5,101	5,684	9,243
Hires	3,493	6,871	7,357	13,053	2,410	4,461	5,162	8,332
# of Counties	3,141		3,141		1,136		1,136	
Observations	203,256		203,256		73,158		73,158	
Social Security (Retirement)								
Beneficiaries	80,192	130,735			66,864	107,789		
Benefits (in 1,000 dollars)	98,639	161,766			82,730	135,442		
# of Counties	3,150				1,137			
Observations	140,772				51,078			

Notes: The table shows descriptive statistics of main variables from the Quarterly Workforce Indicators (2000-2015) and the SSA's Old Age, Survivors, and Disability Insurance Data (1983-2015). The statistics are shown for all counties samples in columns 1 to 4, and border counties samples in columns 5 to 8. We focus on employment, separations and hires for the QWI data, and retirement beneficiaries and benefits for the SSA/OASDI data. The QWI are reported quarterly and are categorized into several age groups; here we focus on 65-99 and 55-64. The OASDI retirement data are reported annually without any age stratification as in the QWI.

Table A2: Yearly Summary Statistics of Minimum Wages and Employment for Population at Age 62-70 (CPS)

			At or Below Minimum Wage			At or Below 1.2*Minimum Wage		
Year	Effective minwage	Emp to pop	Emp to pop	Share of worekrs	Share of hours	Emp to pop	Share of worekrs	Share of hours
1983	8.18	0.247						
1984	7.84	0.243						
1985	7.57	0.237						
1986	7.43	0.240						
1987	7.19	0.242						
1988	7.04	0.245						
1989	6.89	0.251						
1990	7.05	0.254	0.015	0.059	0.056	0.032	0.124	0.108
1991	7.43	0.246	0.020	0.080	0.070	0.040	0.163	0.137
1992	7.42	0.246	0.017	0.070	0.066	0.038	0.155	0.138
1993	7.22	0.249	0.014	0.057	0.050	0.034	0.135	0.113
1994	7.06	0.260	0.016	0.063	0.058	0.037	0.143	0.125
1995	6.87	0.258	0.017	0.064	0.063	0.036	0.138	0.126
1996	6.86	0.258	0.016	0.061	0.062	0.033	0.129	0.117
1997	7.46	0.269	0.022	0.081	0.078	0.043	0.163	0.150
1998	7.78	0.274	0.021	0.079	0.074	0.045	0.164	0.145
1999	7.66	0.279	0.018	0.065	0.065	0.039	0.142	0.129
2000	7.46	0.287	0.017	0.059	0.056	0.036	0.126	0.112
2001	7.37	0.298	0.014	0.048	0.047	0.029	0.100	0.092
2002	7.32	0.306	0.015	0.050	0.049	0.028	0.094	0.087
2003	7.21	0.314	0.013	0.041	0.037	0.025	0.079	0.069
2004	7.07	0.322	0.012	0.039	0.038	0.024	0.075	0.068
2005	7.03	0.334	0.011	0.032	0.029	0.023	0.068	0.061
2006	7.05	0.343	0.012	0.034	0.032	0.023	0.069	0.063
2007	7.59	0.345	0.016	0.046	0.044	0.034	0.099	0.086
2008	7.78	0.348	0.015	0.043	0.038	0.034	0.100	0.086
2009	8.23	0.350	0.017	0.049	0.045	0.036	0.102	0.089
2010	8.31	0.354	0.017	0.047	0.042	0.039	0.111	0.099
2011	8.08	0.360	0.016	0.044	0.040	0.035	0.098	0.083
2012	7.99	0.361	0.014	0.040	0.040	0.035	0.098	0.086
2013	7.90	0.362	0.014	0.038	0.037	0.032	0.090	0.079
2014	7.96	0.366	0.014	0.038	0.036	0.033	0.092	0.081
2015	8.18	0.371	0.015	0.041	0.039	0.035	0.095	0.084
2016	8.34	0.378	0.017	0.046	0.044	0.039	0.103	0.092

Notes: The table shows yearly descriptive statistics from the Current Population Survey (1983-2016), focusing on employment of population with age 62-70. Sample statistics are weighted by the CPS weights. Effective minimum wage is the applicable federal or state minimum wage, adjusted in 2016 dollars. Column 3 shows the employment to population ratio for all workers. Columns 4 to 6 show the employment to population ratio for workers at or below minimum wage, share of workers at or below minimum wage, and share of hours at or below minimum wage. Columns 7 to 9 also show similar statistics with columns 4 to 6, focusing on workers at or below 120% of minimum wage. Wage information is not available prior to 1990 from the IPUMS CPS data, so columns 4 to 9 are left blank.

Table A3: Pre-Existing Trends in Employment and Earnings (Excluding Self-Employed)

	Log(Emp/Pop)		Log(Full Emp/Pop)		Log(Part Emp/Pop)		Hours		Log(Earnings)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
η_{12}	-0.064	0.033	-0.071	0.040	-0.054	0.000	0.140	0.615	-0.149	0.090
	(0.070)	(0.076)	(0.094)	(0.104)	(0.082)	(0.130)	(0.403)	(0.461)	(0.122)	(0.138)
η_4	-0.134	-0.054	-0.122	-0.005	-0.058	-0.132	-1.110*	0.018	-0.439**	-0.088
	(0.092)	(0.125)	(0.147)	(0.175)	(0.118)	(0.211)	(0.654)	(0.838)	(0.169)	(0.213)
η_0	-0.073	0.156	-0.113	0.319*	0.042	-0.057	0.087	1.839**	-0.255	0.378*
	(0.107)	(0.134)	(0.159)	(0.171)	(0.190)	(0.246)	(0.671)	(0.842)	(0.198)	(0.212)
$\eta_4 - \eta_{12}$	-0.070	-0.087	-0.051	-0.045	-0.005	-0.133	-1.250*	-0.597	-0.290*	-0.179
	(0.065)	(0.087)	(0.110)	(0.158)	(0.089)	(0.132)	(0.677)	(0.780)	(0.173)	(0.195)
State Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Age x Time Fixed Effects	Y		Y		Y		Y		Y	
Division x Age x Time Fixed Effects		Y		Y		Y		Y		Y
State Linear Trends		Y		Y		Y		Y		Y

Notes: Robust standard errors are clustered by states and shown in parenthesis. Here we estimate Equation 4, collapsing CPS observations (1983-2016) by state/age/quarter (62-70). $ln(MW_{s,t+j})$ denotes the log of minimum wage in state s at j quarters after time t . η_{12} is the coefficient associated with $(ln(MW_{s,t+12}) - ln(MW_{s,t}))$; η_4 is the coefficient associated with $ln(MW_{s,t+4}) - ln(MW_{as,t}))$; η_0 is the coefficient associated with $ln(MW_{s,t})$. $\eta_4 - \eta_{12}$ represents the trend. The dependent variables are the log of employment to population ratio in columns 1 to 2, the log of full time employment rate in columns 3 to 4, the log of part time employment rate in columns 5 to 6, hours worked in previous week in columns 7 to 8, and the log of weekly earnings in columns 9 to 10. We exclude the self-employed when constructing the above variables. For all specifications, we include state fixed effects. Columns 1, 3, 5, 7, 9 include age $\times$ time fixed effects, whereas in columns 2,4, 6, 8 and 10 we include division $\times$ age $\times$ time fixed effects with state linear trends.

Table A4: Minimum Wage Effects on Employment, Earnings and Hours of Age Groups 50-61 (1983-2016 CPS)

	All			Wage and Salary		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	Employed	All	All	Employed
Panel A: Log(Employment/Population)						
Log(Minimum Wage)	-0.021	0.014		-0.103***	0.010	
	(0.025)	(0.019)		(0.036)	(0.028)	
Panel B: Log(Full Time Employment/Population)						
Log(Minimum Wage)	-0.076**	-0.006		-0.152***	-0.004	
	(0.034)	(0.026)		(0.045)	(0.034)	
Panel C: Log(Part Time Employment/Population)						
Log(Minimum Wage)	0.177***	0.094*		0.086	0.065	
	(0.059)	(0.053)		(0.065)	(0.063)	
Panel D: Hours Worked in Previous Week						
Log(Minimum Wage)	-0.250	-0.333	-0.568**	-1.367*	-0.610	-0.441
	(0.689)	(0.555)	(0.277)	(0.734)	(0.748)	(0.368)
Panel E: Log(Weekly Earnings)						
Log(Minimum Wage)				-0.084*	-0.014	-0.025
				(0.044)	(0.053)	(0.036)
State Fixed Effects	Y	Y	Y	Y	Y	Y
Time Fixed Effects	Y			Y		
Division x Age x Time Fixed Effects		Y	Y		Y	Y
State Linear Trends		Y	Y		Y	Y

Notes: Robust standard errors are clustered by states and reported in parentheses. Estimates are weighted by the number of observations in each cells. The sample includes monthly CPS data from 1983-2016 (age 50-61). The unit of observation is an state/age/quarter cell, collapsed from the CPS data. Employment in column 1 to 3 refers to wage/salary employed and self employed, whereas columns 4 to 6 only to wage/salary employed. The main explanatory variable is the log of effective minimum wage. The dependent variable for Panel A is the log of employment rate, for Panel B, the log of full time employment rate, for Panel C, the log of part time employment rate, for Panel D, hours worked in previous week, and for Panel E, the log of weekly earning. Working full-time and part-time are defined as working 35 hours or more and working less than 35 hours, respectively. For all specifications, we control for state fixed effects. In columns 1 and 4, we include time fixed effects. In columns 2 to 3 and 5 to 6, on the other hand, we include division $\times$ age $\times$ time fixed effects and state linear trends. We restrict our samples to the employed workers in columns 3 and 6.

Table A5: Minimum Wage Effects on Wage/Salary Employment and Self-Employment (1983-2016 CPS)

	Retirement Age Group (62-70)				Near-Retirement Age Group (50-61)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	Employed	Employed	All	All	Employed	Employed
Panel A: Log(Employment/Population)								
Log(Minimum Wage)	0.110*	0.059			-0.021	0.014		
	(0.062)	(0.052)			(0.025)	(0.019)		
Panel B: Log(Wage & Salary-Employment/Population)								
Log(Minimum Wage)	0.018	0.116*			-0.099***	0.011		
	(0.075)	(0.064)			(0.035)	(0.027)		
Panel C: Log(Self-Employment/Population)								
Log(Minimum Wage)	0.364***	0.033			0.254***	-0.004		
	(0.119)	(0.189)			(0.070)	(0.106)		
Panel D: Hours Worked in Previous Week (Wage & Salary-Employed)								
Log(Minimum Wage)	0.502	1.290**	0.510	2.172*	-1.369*	-0.618	-0.705***	-0.478
	(0.587)	(0.606)	(0.838)	(1.115)	(0.732)	(0.744)	(0.262)	(0.370)
Panel E: Hours Worked in Previous Week (Self-Employed)								
Log(Minimum Wage)	0.606*	0.263	1.844	3.455	0.882**	0.171	-1.139	-1.364
	(0.321)	(0.487)	(2.050)	(2.848)	(0.347)	(0.430)	(0.854)	(1.261)
State Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Time Fixed Effects	Y				Y			
Division x Age x Time Fixed Effects		Y		Y		Y		Y
State Linear Trends		Y		Y	Y	Y		Y

Notes: Robust standard errors are clustered by states and reported in parentheses. Estimates are weighted by the number of observations in each cells. The sample includes monthly CPS data from 1983-2016. The unit of observation is an state/age/quarter cell, collapsed from the CPS data. Columns 1 to 4 restrict the samples to cells with age 62-70 and columns 5 to 8 to 50-61. The main explanatory variable is the log of effective minimum wage. The dependent variable for Panel A is Log(Employment/Population), for Panel B, Log(Wage & Salary-Employment/Population), for Panel C, the Log(Self-Employment/Population), for Panel D, hours worked in previous week for wage & salary-employed, and for Panel E, hours worked in previous week for self-employed. In columns 1,3,5 and 7, we include time fixed effects. In columns 2, 4, 6 and 8, on the other hand, we include division $\times$ age $\times$ time fixed effects and state linear trends. In addition, columns 1 to 2 and 5 to 6 use all observations in the sample, whereas columns 3 to 4 and 7 to 8 restrict the samples to those who are employed.

Table A6: Heterogeneous Minimum Wage Effects Across Sex and Marital Status (1983-2016 CPS)

Dependent Variable: Log(Employment/Population)										
	All					Wage and Salary				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Male (without spouse)										
Log(Minimum Wage)	0.160	0.173	0.090	0.188	0.192	-0.015	0.000	0.081	0.158	0.162
	(0.124)	(0.123)	(0.157)	(0.160)	(0.153)	(0.169)	(0.167)	(0.236)	(0.205)	(0.200)
Panel B: Male (with spouse)										
Log(Minimum Wage)	0.124**	0.112**	0.095	0.148**	0.138**	0.008	-0.008	0.096	0.270**	0.270**
	(0.054)	(0.055)	(0.086)	(0.067)	(0.066)	(0.091)	(0.095)	(0.136)	(0.105)	(0.103)
Panel C: Female (without spouse)										
Log(Minimum Wage)	0.234**	0.230**	0.063	0.157	0.130	0.114	0.108	-0.026	0.176	0.144
	(0.090)	(0.091)	(0.124)	(0.119)	(0.119)	(0.091)	(0.091)	(0.149)	(0.118)	(0.117)
Panel D: Femlae (with spouse)										
Log(Minimum Wage)	0.050	0.041	-0.018	-0.075	-0.086	-0.042	-0.052	-0.120	-0.167	-0.171
	(0.129)	(0.125)	(0.198)	(0.108)	(0.111)	(0.142)	(0.139)	(0.238)	(0.134)	(0.135)
Fixed Effects										
State	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time	Y					Y				Y
Age x Time		Y					Y			
Division x Age x Time			Y	Y	Y			Y	Y	Y
State Linear Trends				Y	Y				Y	Y
Time-Varying Controls										
Log(Unemployment Rate)					Y					Y
Log(Total Population)					Y					Y

Notes: Robust standard errors are clustered by states and reported in parentheses. We restrict our samples to age 62-70, pooling age groups 62-64 and 65-70 together. Estimates are weighted by the number of observations in each cells. The main explanatory variable is the log of effective minimum wage, which is defined as the applicable federal or state level minimum wage, whichever is greater. The dependent variables are the log of employment to population ratio in columns 1 to 5 and the log of wage/salary employment to population ratio in columns 6-10, respectively. Panel A further restricts the samples to male without spouse (never married, divorced, separated or widowed), Panel B to male with spouse, Panel C to female without spouse, and Panel D to female with spouse, respectively.

Table A7: Minimum Wage Effects on Prime Age Group (1983-2016 CPS)

Dependent Variable: Log(Employment/Population)	All					Wage and Salary				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: All Cohorts										
Log(Minimum Wage)	-0.009	-0.010	-0.003	0.024*	0.014	-0.025	-0.024	-0.011	0.026*	0.014
	(0.014)	(0.014)	(0.021)	(0.013)	(0.009)	(0.020)	(0.020)	(0.029)	(0.014)	(0.012)
Panel B: Male										
Log(Minimum Wage)	0.002	0.002	-0.007	0.012	0.002	-0.013	-0.011	-0.014	0.014	0.004
	(0.017)	(0.017)	(0.020)	(0.013)	(0.009)	(0.025)	(0.025)	(0.032)	(0.018)	(0.014)
Panel C: Female										
Log(Minimum Wage)	-0.022	-0.021	0.006	0.039*	0.027	-0.037	-0.036	-0.002	0.043**	0.030
	(0.026)	(0.026)	(0.026)	(0.020)	(0.018)	(0.030)	(0.030)	(0.033)	(0.021)	(0.022)
Panel D: High School Dropouts + High School Graduates										
Log(Minimum Wage)	0.036	0.034	0.023	0.047**	0.032**	0.013	0.013	0.012	0.044**	0.030*
	(0.026)	(0.026)	(0.028)	(0.022)	(0.015)	(0.031)	(0.031)	(0.035)	(0.021)	(0.018)
Fixed Effects										
State	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time	Y					Y				Y
Age x Time		Y					Y			
Division x Age x Time			Y	Y	Y			Y	Y	Y
State Linear Trends				Y	Y				Y	Y
Time-Varying Controls										
Log(Unemployment Rate)					Y					Y
Log(Total Population)					Y					Y

Notes: Robust standard errors are clustered by states and reported in parentheses. We restrict our monthly CPS data to age group 25-49 (Prime Age). The unit of observation is an state/age/quarter, collapsed from the CPS data. Estimates are weighted by the number of observations in each cells. The main explanatory variable is the log of effective minimum wage, which is defined as the applicable federal or state level minimum wage, whichever is greater. The dependent variables are the log of employment to population ratio in columns 1 to 5 and the log of wage/salary employment to population ratio in columns 6-10, respectively. Panel A uses all cohorts at age 25-49. Panel B, C and D restrict the samples to male, female, high school dropouts/graduates, respectively.

Table A8: Minimum Wage Effects on Employment, Separations and Hires (2000-2016 CPS & QWI)

	65-99			55-64			45-54		
	CPS	QWI		CPS	QWI		CPS	QWI	
	All	All	Borders	All	All	Borders	All	All	Borders
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Log(Employment)									
Log(Minimum Wage)	0.032	0.032	-0.002	-0.017	0.020	-0.007	-0.002	0.009	-0.015
	(0.079)	(0.033)	(0.017)	(0.029)	(0.022)	(0.014)	(0.016)	(0.027)	(0.013)
Panel B: Log(Separations)									
Log(Minimum Wage)		0.065	-0.015		0.074	0.041		0.041	-0.003
		(0.067)	(0.083)		(0.075)	(0.090)		(0.065)	(0.096)
Panel C: Log(Hires)									
Log(Minimum Wage)		-0.008	-0.041		0.044	0.036		0.026	0.009
		(0.087)	(0.105)		(0.102)	(0.116)		(0.081)	(0.109)
State Fixed Effects	Y			Y			Y		
County Fixed Effects		Y	Y		Y	Y		Y	Y
Division x Time Fixed Effects	Y	Y		Y	Y		Y	Y	
State Linear Trends	Y	Y	Y	Y	Y	Y	Y	Y	Y
Border Pair x Time Fixed Effects			Y			Y			Y

Notes: Robust standard errors are clustered by states in columns 1, 2, 4, 5, 7, 8 and two-way clustered by states and border segments in columns 3, 6, 9. The sample includes the CPS data from 2000 to 2016 (columns 1, 4 and 7) and Quarterly Workforce Indicator data from 2000 to 2016 (columns 2 to 3, 5 to 6 and 8 to 9). The estimates are weighted by state population in columns 1, 4, 7, and county population in columns 2, 5, 8. For columns 3,6 and 9, the estimates are weighed by (number of population in a county) * (the inverse of the number of pairs a county is part of). The main explanatory variable is the log of effective minimum wage, which is defined as federal or state level minimum wage, whichever is greater. The dependent variables are the log of employment in Panel A, the log of separations in Panel B, and the log of hires in Panel C. For all specifications, we control for county fixed effects and the log of county population. The QWI samples are stratified into age groups: 65-99 (columns 1 to 3), 55-64 (columns 4 to 6) and 45-54 (columns 7 to 9). For columns 2, 5 and 8, all counties in the samples are used in our regressions with division $\times$ time fixed effects. For columns 3, 6 and 9, only border counties are utilized with border pair $\times$ time fixed effects. Refer to Dube, Lester and Reich (2010) on how to construct the border-county samples.

Table A9: Long Difference Estimates for the Effect of the Minimum Wage on Employment (1983-2016 CPS)

Number of Years	1	2	3	4	5	6	7	8
Panel A: Without State Linear Trends								
Long Difference in Log(MW)	0.086	0.093	0.073	0.058	0.031	0.062	0.080	0.089
	(0.065)	(0.076)	(0.067)	(0.064)	(0.071)	(0.076)	(0.079)	(0.086)
Panel B: With State Linear Trends								
Long Difference in Log(MW)	0.084	0.089	0.068	0.052	0.025	0.054	0.073	0.073
	(0.065)	(0.077)	(0.069)	(0.069)	(0.075)	(0.081)	(0.085)	(0.101)
State Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Division x Age x Time Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Robust standard errors are clustered by states and reported in parentheses. We restrict our samples to age 62-70. Estimates are weighted by the number of observations in each cells. The main explanatory variable is the long difference in the log of effective minimum wage. The dependent variable is the long difference in the log of employment to population ratio. The column numbers correspond to the number of periods over which the long difference is taken. Panel B additionally includes state-specific linear trends.

Table A10: Interactive Fixed Effects Model for Minimum Wage Effects (1983-2016 CPS)

	OLS		Interactive Fixed Effects								
			Number of Unobserved Common Factors								
	0	0	1	2	3	4	5	6	7	8	9
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A: Log(Employment/Population)											
Log(Minimum Wage)	0.098	0.059	0.025	0.056	0.033	0.022	0.013	-0.013	-0.010	-0.002	-0.005
	(0.064)	(0.052)	(0.050)	(0.049)	(0.046)	(0.046)	(0.046)	(0.044)	(0.046)	(0.045)	(0.046)
Panel B: Log(Full Time Employment/Population)											
Log(Minimum Wage)	0.071	0.145*	0.129	0.166**	0.169**	0.173**	0.177**	0.184**	0.158**	0.146*	0.139*
	(0.088)	(0.087)	(0.084)	(0.079)	(0.079)	(0.084)	(0.081)	(0.079)	(0.075)	(0.073)	(0.073)
Panel C: Log(Weekly Earnings)											
Log(Minimum Wage)	-0.077	0.301**	0.146	0.141	0.198*	0.218*	0.205*	0.212*	0.217*	0.219*	0.199
	(0.139)	(0.140)	(0.112)	(0.121)	(0.116)	(0.119)	(0.121)	(0.125)	(0.124)	(0.120)	(0.125)
Panel D: Log(Hourly Wage)											
Log(Minimum Wage)	0.009	0.236*	0.169	0.143	0.156	0.208*	0.210*	0.255**	0.259**	0.236**	0.266**
	(0.142)	(0.134)	(0.119)	(0.123)	(0.114)	(0.113)	(0.113)	(0.106)	(0.108)	(0.111)	(0.118)
State x Age Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time Fixed Effects	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
Division x Age x Time Fixed Effects		Y									
State Linear Trends		Y									

Notes: Robust standard errors are clustered by states and shown in parenthesis. We collapse CPS observations (1983-2016) by state/age/quarter (62-70). Dependent variables are Log(Employment/Population) (Panel A), Log(Full Time Employment/Population) (Panel B), Log(Weekly Earnings) (Panel C) and Log(Hourly Wage) (Panel D), respectively. Earning and wage variables are constructed using the means of whole population in each cells, where only the wage and salary employed have values greater than zero. The key explanatory variable is the log of effective minimum wage. In all specifications, we control for state × age fixed effects. For columns 1 to 2, we use OLS estimation strategy, additionally controlling for time fixed effects (column 1) and division × age × time fixed effects with state linear trends (column 2), respectively. For columns 3 to 11, we estimate interactive fixed effects model with different number of unobserved factors. The number of unobserved common factors used in the regressions are stated above each column numbers.

Table A11: Minimum Wage Effects on Social Security and Retirement Income (1983-2015 CPS)

	Social Security Income				Other Retirement Income			
	Percent Beneficiaries		Amount of Benefits		Percent Beneficiaries		Amount of Benefits	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log(Minimum Wage)	-0.096*	-0.037	-0.195***	0.002	-0.475***	-0.278**	-0.280	-0.509***
	(0.049)	(0.057)	(0.056)	(0.066)	(0.124)	(0.114)	(0.209)	(0.170)
State Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y		Y		Y		Y	
Division x Age x Year Fixed Effects		Y		Y		Y		Y
State Linear Trends		Y		Y		Y		Y

Notes: Robust standard errors are clustered by states and reported in parentheses. We use the yearly CPS ASEC data from 1989-2015, where the samples are restricted to age 62-70 and collapsed by state/age/year. Estimates are weighted by the number of observations in each cells. The main explanatory variable is the log of effective minimum wage, which is defined as federal or state level minimum wage, whichever is greater. The dependent variable for columns 1 to 2 and columns 3 to 4 are the percent beneficiaries and the mean benefits of the Social Security, respectively. The dependent variables for columns 5 to 6 and columns 7 to 8 are the percent beneficiaries and the mean benefits of other retirement income, respectively. Other retirement income refers to pre-tax retirement, survivor, and disability pension income, other than the Social Security, that a respondent receive. For all specifications, we include state fixed effects. In columns 1,3,5 and 7 we include age $\times$ year fixed effects, whereas in columns 2,4,6 and 8, we additionally include division $\times$ age $\times$ year fixed effects and state linear trends.