SOCIAL SECURITY AND RETIREMENT TIMING:
EVIDENCE FROM A NATIONAL SAMPLE OF TEACHERS

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## ABSTRACT

This study documents an important role for Social Security income in workers' retirement timing. About 40 percent of public school teachers are not covered by Social Security.  This provides an opportunity to analyze the causal impact of Social Security on retirement timing by comparing covered and non-covered teachers.  Using individual-level data from the American Community Survey, we find robust evidence of higher rates of retirement among covered teachers at Social Security eligibility ages. This pattern is confirmed using an alternative regression model of participation in the teacher labor force. These estimates suggest that, should the federal government mandate full inclusion in Social Security for all public sector workers, the retirement timing patterns of newly covered teachers and other public sector workers would likely change.

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# 1 Introduction

Roughly 40 percent of teachers are not currently covered by Social Security (Kan and Aldeman, 2014). Originally, the Social Security Act of 1935 only covered private sector workers. Concerns about the constitutionality of the federal government collecting taxes from state and local governments prevented their inclusion. Section 218 of the Social Security Act, passed in 1950, allowed states to decide whether to bring their employees into Social Security. Subsequent changes to the Act mandated Social Security coverage for any state or local government employees not included in another pension system (Gale et al., 2015). State or local governments can alter their Section 218 agreements and join Social Security, but are no longer allowed to withdraw if currently covered. In total, approximately 25% of public employees are not covered by Social Security of which most are public safety officers and teachers (GAO-05-786T, 2005).

Prior work on the role of Social Security in retirement has estimated elasticities with respect to benefit levels (e.g., Coile and Gruber, 2007; Coile, 2015; Liebman et al., 2009). This study instead measures whether the age pattern of retirement is affected by Social Security coverage on the extensive margin. We estimate the individual-level probability of retiring within the past year leveraging pension plan level variation in Social Security inclusion. There is no statistically significant difference in retirement probabilities for individuals in their 50's by Social Security coverage, although the confidence intervals contain economically meaningful values. We find evidence that teachers respond to Social Security incentives through statistically signifcantly higher retirement rates between ages 62 and 70. Social Security eligibility is associated with about a 12 percent higher probability of retiring among 62-70 year olds. We confirm these findings by illustrating that the teacher labor force participation rate, which is defined as the age $\times$ state $\times$ year $\times$ gender cell probability that an individual with at least a bachelor's degree is currently working as a teacher, follows a similar pattern.

Our approach is similar to Asch et al. (2005), who estimate logit models of retirement

regressed on peak and option value of retirement benefits along with a set of age-specific dummies. While the results do suggest "excess" retirements at key Social Security eligibility ages, they do not provide evidence of whether retirements occur earlier or later under Social Security. Using age-specific survival probabilities in a cohort-level analysis, we provide suggestive evidence that Social Security inclusion is associated with earlier retirements.

## 2 Background and Literature

Teachers were among the first public sector workers to be covered under employer-provided pensions.[1] Almost all teacher pension plans are some form of a defined benefit (DB) plan.[2] DB plans have their own unique rules regarding such parameters as pension benefit formulas, ages at which benefits can be received, years of service required to claim benefits, years of service until employees are vested, levels of inflation adjustment, and eligibility for Social Security benefits, among others. Koedel and Podgursky (2016) provide a comprehensive overview of teacher pensions and their role in the teacher labor market.

The incentives generated by pension parameters are generally grouped into two categories: "pull" incentives that attract and retain new employees and "push" incentives that promote retirement of employees when they reach a certain age (Lazear, 1986). These incentives are often modeled as an "option-value" of work where, for an additional year of work, pensions levels increase but at a cost of foregone pension receipt within that year (Stock and Wise, 1990). Individuals retire when the utility from an additional year of income and retirement wealth accruals is exceeded by the disutility of work and the opportunity cost of an additional year of foregone retirement benefits. Costrell and Podgursky (2009) illustrate the sharp patterns of pension wealth accruals for six teacher pension plans. On the other hand, Clark and McDermed (1986) show that earnings rise after pension el-

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[1]For an in-depth discussion of the history and structure of teacher pensions across states see Clark and Craig (2011).

[2]Alaska is the only state to provide a pure defined-contribution (DC) plan to teachers, but that plan only applies to those hired after 2006.

igibility ages, supporting the notion that compensation is more of a spot market than a Lazear-type lifetime contract.

Coile and Gruber (2007) adapted the forward looking, option-value framework to the modeling of Social Security wealth accrual patterns. Similar to the models of employer-provided pension wealth, one must forgo Social Security income to qualify for a higher benefit the following year. Coile and Gruber (2007) compute the option value of work using employment history and pension parameter data from the Health and Retirement Survey (HRS). Using a similar framework to ours, with a retirement probability as the dependent variable, they find that Social Security incentives are a significant determinant of retirement decisions and have an impact similar to private pension incentives. Liebman et al. (2009) uses the HRS in conjunction with discontinuities in Social Security rules and conclude that individuals are responsive to marginal changes in Social Security benefits. Mastrobuoni (2011) also use the HRS and finds that retirement timing responds to both perceived and actual changes in Social Security incentives. Fetter and Lockwood (2016) show that an additional program, the Old Age Assistance Program (OAA), which is means tested, reduced the labor force participation rate among men in their late 60's and early 70's. No paper to our knowledge specifically examines the impact of Social Security inclusion on teachers' retirement decisions. Rather than relying on structural estimates of variation in the intensity of Social Security wealth changes, this study instead utilizes variation on the extensive margin: having any Social Security wealth or not.

Prior work has found strong evidence that teachers' retirement decisions are influenced by pension wealth. Asch et al. (2005) explore retirement timing among federal workers in the Civil Service Retirement System (CSRS), who are not covered by Social Security. Using administrative records, Asch et al. (2005) estimate retirement hazards over 7 years as a function of forward-looking measures of pension wealth incentives. They find workers are responsive to financial incentives for retirement with no evidence of "excess" retirements at key Social Security eligibility ages 62 and 65. Ni and Podgursky (2016) estimate a

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structural model of teacher retirement and illustrate an important role for pension wealth in retirement timing.

Recent work on retirement timing has investigated the role of pension modifications and enhancements on encouraging delayed retirement. Teachers' responsiveness to changes in financial incentives is typically small. Koedel and Xiang (2017) leverage variation in how a pension enhancement in St. Louis affected pension wealth for teachers differentially by years until retirement eligibility. Similarly, Brown (2013) exploits a change for California teachers and finds a significant but small elasticity of lifetime labor supply with respect to the return to work. Fitzpatrick (2015) finds that teachers' willingness-to-pay for retirement benefits is small relative to the cost of providing them. Furgeson et al. (2006) estimate that Pennsylvania public school teachers responded to early retirement incentives with women having a higher elasticity than men.

With the Social Security system facing potential future solvency issues, policymakers have considered mandating the coverage of all public sector workers to increase the Social Security tax base (GAO-HEHS-98-196, 1998; GAO-03-710T, 2003; GAO-05-786T, 2005; Munnell, 2000, 2005; Nuschler et al., 2011) and changing rules that determine the level of spousal and survivor benefits for those not covered by Social Security (Diamond and Orszag, 2003; Haltzel, 2004; Kilgour, 2009; Gustman et al., 2013). Because public sector pensions generally have full retirement ages that are much younger than those of Social Security and private sector pension plans, past research into the impact of Social Security on retirement timing may not be extendable to teachers. Gale et al. (2015) provide a comprehensive analysis of the issues associated with a potential federal mandate to include all state and local government employers in Social Security. Teachers with short tenures are likely better off when covered by Social Security, but it is less clear whether long tenure teachers would benefit.[3]

Public sector workers who are not included in Social Security may still be eligible for

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[3]This argument is in contrast with enhancements to public sector pensions, which typically will benefit long tenure teachers at the cost of short tenure teachers (e.g. Koedel et al., 2014).

benefits either through a spouse's earnings or through other covered employment. For these individuals, two programs are used to adjust benefits to account for the non-covered service. The Windfall Elimination Program (WEP) reduces one's own Social Security benefits earned under covered employment to account for the period of non-covered employment. The Government Pension Offset (GPO) program reduces the spousal benefit that individuals with non-covered employment history can receive. Both programs are designed to ensure individuals who do not contribute to the Social Security system via Federal Insurance Contributions Act (FICA) taxes do not receive unfair compensation from Social Security benefits. These programs have somewhat complicated rules, and often individuals are not aware that their benefits will be reduced until the point of claiming. Congress has debated repealing these unpopular programs. For example, the H.R.1205 - Social Security Fairness Act of 2017 proposed repeal.[4] Gustman et al. (2014) estimate that about 3.5 percent of households in the HRS are affected by either the WEP or the GPO. These programs impact the joint retirement decisions of households and apply to a substantial proportion of teachers (Diamond and Orszag, 2003; Haltzel, 2004; Kilgour, 2009; Gustman et al., 2013). When considering the implications of extending Social Security coverage to public sector workers, it is important to not only consider the impacts on Social Security solvency, but also how structural changes in public sector workers' retirement incentives will change their own and their spouses' labor supply decisions.

# 3   Data

## 3.1   Pension Plan Data

All state and local government employers, including the District of Columbia (DC), have Section 218 agreements with the Social Security Administration (SSA) that stipulate Social Security coverage. There can be significant confusion about which state and local govern-

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[4]More information can be found at: https://www.congress.gov/bill/115th-congress/house-bill/1205, [accessed July 2018]

ment employees are covered by Social Security, even within SSA (GAO-10-938, 2010). Our teacher pension plan data come from the Center for Retirement Research, Public Pensions Database (PPD).[5]

Table 1 lists the Social Security coverage status of teachers in each state and DC. There are 12 states plus DC where teachers are not covered by Social Security and 35 states where teachers are covered. The remaining 3 states, Georgia, Missouri, and Rhode Island, allow local school districts to enter into Section 218 agreements with SSA. Because teachers in those states cannot reliably be classified as covered or not, they are excluded from our sample.

## 3.2 Teacher Employment Data

Data on the retirements are from the American Community Survey (ACS) from 2010 to 2016.[6] The ACS allows for the estimation of a large sample of teachers representative at the state level. Unlike administrative datasets, the ACS includes detailed demographics, marital status and household structure, and socioeconomic characteristics. Furthermore, the ACS allows for cross-state comparisons not possible with data from individual states. Because employer can be imputed by state of residence, we can merge on detailed information about pension coverage with reasonable accuracy. Longitudinal data, such as the HRS, provides a better indication of teaching history and teacher retirement. However, the ACS has a substantially larger sample size and allows for a more precise estimation of differences by public employer.

Following Harris and Adams (2007), teachers are defined as any individual who reported their most recent occupation as one of the the following and who was also working in the last year: kindergarten teachers, primary and secondary school teachers, special education teachers, and other teachers not otherwise classified. This excludes all post-secondary

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[5]Data are available at: http://publicplansdata.org/public-plans-database/, [accessed July 2018].

[6]Steven Ruggles, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek. Integrated Public Use Microdata Series: Version 7.0 American Community Survey. Minneapolis: University of Minnesota, 2017

teachers. We further restrict to those who report working for a state or local government employer.[7]

The ACS contains limited information on work history necessitating an approximation of retirement. Failure to observe retirements will bias our estimates of the impact of Social Security inclusion if there is any correlation between the coverage of teachers by Social Security and moving into other work directly after leaving teaching. For example, the number of "unobserved" retirements would be lower in non-covered states if individuals must work after retirement to supplement income. Similarly, Haider and Loughran (2008) find that the Social Security Earnings Test reduces labor supply in retirement, although they do not consider specifically the timing of the return to paid employment. When a retirement is "missed" by our measure, the denominator (i.e., the population of teachers) will also be lowered as that person is not identified as a teacher by our definition. As a robustness check, we confirm our main findings using a parallel analysis of teacher labor force participation rates. Labor force participation rates will not be biased by individuals transitioning directly from teaching to another position.

### 3.3   Means and Descriptive Statistics

Table 2 contains descriptive statistics for our sample of teachers by Social Security inclusion. Our sample is 88,788 teachers ages 50-70. Column (1) is the full sample. Column (2) includes teachers who are not covered by Social Security, as listed in Table 1. About 40 percent of teachers in our sample are not covered by Social Security. Column (3) includes

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[7]Results are similar without making this restriction, although because private school teachers are also included the magnitudes are diminished. We include individuals regardless of self-reported hours of work so as to better capture retirement transitions. We benchmark the implied population from ACS weights against data from the National Center for Education Statistics (NCES, Data available at: https://nces.ed. gov/programs/digest/d16/tables/dt16_105.40.asp?current=yes, [accessed August 2018]). To better match with the NCES data, for this exercise we do not make an age restriction in the ACS and further restrict the ACS population to only include public primary and secondary school teachers. In the NCES, the population of teachers ranges from 3.1 million in 2010 to 3.2 million 2016 (projected). The implied one year population in the ACS is 3.2 million. Restricting to those working 30 or more hours per week, the implied population size is 2.8 million. In results not shown, when making this more stringent restriction on hours of work, the age pattern is similar but with implied magnitudes that are substantially larger.

teachers who are covered by Social Security. Column (4) provides the difference between Columns (3) and (2). To calculate the difference in means we conduct two-sided t-tests with the null hypothesis that Column (3) − Column (2) = 0. Standard errors are in brackets.

The first row of Table 2 provides the average probability of retiring, i.e., teaching at some point in the prior year but no longer teaching at the time of the survey. On average, teachers ages 50-70 who are covered by Social Security are 0.65 percentage points (about 5 percent of the mean of the not-covered sample) more likely to retire than their peers who are not covered by Social Security. Given this, it is not surprising to see that, among 50-70 year olds who were working within the past year, the population of teachers covered by Social Security is slightly younger. Importantly, teachers in states covered by Social Security are 4.5 percentage points more likely to have an advanced degree. If Social Security inclusion is viewed as an amenity or state pensions are in better financial health in those states, teachers covered by Social Security may be positively selected. States where teachers are included in Social Security have more non-Hispanic African American teachers, while there are fewer Hispanic teachers. This is primarily driven by the fact that California and Texas are two large states not included in Social Security. The probability of being married is very slightly higher in states covered by Social Security, while the probability of being never married or divorced is lower. The regression estimates are insensitive to controlling for these demographic characteristics.

## 4    Methods and Results

### 4.1    Age-Specific Retirement Rates and Survival Probabilities

Figure 1 shows the retirement patterns of teachers separately by Social Security inclusion. This is contrasted with workers in "other occupations," most of whom will be covered by Social Security.[8]   Note that some workers in this latter group will have had prior

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[8]See the data appendix for details on which occupations are included here.

experience as a teacher, so we anticipate that the difference in retirement patterns in this other category of workers will be smaller but not necessarily zero.

Figure 1 illustrates that teachers are more likely than their private sector counterparts to retire between age 50 and 70 with the gap growing at about age 57 and increasing through the 60's. Second, there is a slightly higher rate of retirement after age 66 for other workers in states with Social Security coverage for teachers. This difference is much smaller than for those actively working as teachers and is likely due to prior public sector work among these "other" workers. Most importantly, there is a striking difference in retirement rates between teachers covered by Social Security and those not covered. There is a jump at age 62, which coincides with the earliest age of eligibility to claim Social Security. The differences continue throughout the 60's with those covered by Social Security having a higher probability of retirement at each age except age 63.

To capture a clearer picture of the cumulative probability of retirement, Table 3 presents age-specific probabilities alongside a cumulative retirement rate.[9] Using a life table approach, we model the cumulative failure probability of a cohort of 1,000 workers actively employed at age 50. This approach is similar to Dudel and Myrskyl (2017) except it does not include adjustments for mortality. In Table 3, Column (1), we present age-specific retirement rates for teachers not included in Social Security, while retirement rates for those included in Social Security are in Column (4). To aid in interpreting these numbers, Columns (2) and (5) apply the age-specific probability of retirement to get a "failure" rate that is the cumulative probability of retiring by the age in each row. We observe that the surviving number of teachers is always higher in states where they are excluded from Social Security. Furthermore, the cumulative retirement rate is always higher for teachers covered by Social Security. Importantly, the most dramatic differences occur at ages 62 and 66. We explore this further in a multivariate regression analysis below. Overall, this exercise provides suggestive evidence that Social Security coverage is associated with earlier

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[9]Populating this table with regression-estimated coefficients yields similar patterns. Results are available upon request.

retirements.

## 4.2 Multivariate Regression Analysis

In the raw means presented in Table 3, we observe that retirement rates are generally higher for teachers who are covered by Social Security after age 62. We model this more formally by estimating versions of the following regression equation.

$$Pr(Retired_{ist} = 1) = F(\beta_{ss}SSInc_s + \gamma_a\mathbf{1}(Age62 - 70)_{ist} + \beta_a\mathbf{1}(Age62 - 70)_{ist} \times SSIncl_s$$
$$+ X_{ist}\delta + P_{ist}\psi + M_{st}\theta + \tau_t)$$

(1)

where $i$, $s$, and $t$ index individuals, states, and years respectively. $SSIncl_s$ equals 1 if an individual is in a state where teachers are covered by Social Security. $\mathbf{1}(Age62 - 70)$ is an indicator for whether the individual is between ages 62 and 70. $X_{ist}$ is a vector of individual characteristics. $P_{ist}$ is a vector of state pension plan parameters that vary either across individuals or over time. $M_{st}$ is a vector of state-level measures of macroeconomic conditions. Standard errors are clustered at the state level. The $\beta_a$'s are the parameters of interest.[10]

We then present a more disaggregated model by age categories.

$$Pr(Retired_{ist} = 1) = F(\beta_{ss}SSInc_s + \sum_{a=60}^{69} \gamma_a\mathbf{1}(Age_{ist} = a) + \sum_{a=60}^{69} \beta_a\mathbf{1}(Age_{ist} = a) \times SSIncl_s$$
$$+ X_{ist}\delta + P_{ist}\psi + M_{st}\theta + \tau_t)$$

(2)

$Age_{ist}$ is the age of individual $i$ in state $s$ in year $t$. This approach is similar to Asch et al. (2005), where the authors estimate logit models of retirement regressed on peak and option

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[10]Estimates are coefficients from a logistic model. In results not shown, estimates from a complementary-log-log (cloglog) specification are nearly identical.

value of retirement benefits along with a set of age-specific dummies.

We first estimate a baseline model with individual controls for sex, marital status, and education level. Social Security coverage is not the only aspect of retirement income that differs by state. To test the sensitivity of our findings, we add three pension characteristics and three proxies for state-level economic conditions to the baseline model. Means of these variables are provided in Appendix Table A1. We expect that states where teachers are not included in Social Security have different pension benefits. To capture some of the variation in plan characteristics, we define an indicator variable for theoretically being eligible for full retirement at the individual's age. For each pension plan in the data, we calculate the age at which a teacher who began working in the pension system at age 24 and had no breaks in service would be eligible for a full and unreduced pension. For this exercise, we utilize plan-specific retirement eligibility rules from the Urban Institute's State and Local Employee Pension Plan Database (SLEPP).[11] We define the theoretical eligibility indicator as whether the individual is younger or older than that earliest full retirement eligibility age within their pension plan. Note that measure is just a theoretical construct as each individual's eligibility will be a function of age at hire and any prior service that might be used to purchase service. As shown in Appendix Table A1, among teachers who worked within the past year those covered by Social Security are more likely to be "eligible" for a full retirement benefit, by this definition. This is consistent with teachers who are covered by Social Security being more influenced by Social Security eligibility than by pension plan parameters.

Additionally, we include two measures of pension plan health from the PPD: the funding ratio and the percent of employer's required contributions that was paid. The funding ratio measures the ratio of a pension plan's assets to its liabilities, so a higher funding ratio indicates a healthier pension. The percent of employer's required contributions that was

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[11]For more information on the Urban Institute's Public Pension Project, see: https://www.urban.org/policy-centers/cross-center-initiatives/program-retirement-policy/projects/public-pension-project [accessed May 2018].

paid measures the extent to which the pension plan sponsor pays its required contributions. A low value for this measure indicates that the cost of funding the pension plan may be causing fiscal stress for the sponsor. Along these two dimensions, plans included in Social Security are in better financial health.[12]

To account for variation in macroeconomic conditions across states and over time we include controls for annual state unemployment rates, real GDP per capita, and per capita personal income. Again, means of these variables are provided in Appendix Table A1.[13] Note that while the unemployment rate is lower among states included in Social Security, real income per capita and real GDP per capita are both lower as well.

Table 4 presents estimated coefficients from a logit model estimating equation (1), with robust standard errors clustered by state of residence. The main estimated coefficients of interest are the age group indicator, the Social Security inclusion dummy variable, and the interaction between age and Social Security inclusion. All models also include year fixed effects, educational attainment (graduate degree), race/ethnicity, gender, and marital status. Marginal effects are reported in brackets at the bottom of the table. The marginal effects are calculated as the average change in probability from being included in Social Security for individuals ages 50-61 and for individuals ages 62-70. Column (1) includes only the baseline characteristics. Column (2) adds the three pension plan characteristics

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[12]A potential mechanism through which Social Security inclusion could affect retirement timing is its impact on the generosity of pension benefits. In particular, we would expect teachers not included in Social Security to receive some form of compensating wage differential, perhaps through a higher replacement rate from their employer-provided pensions. To estimate the full policy effect of Social Security inclusion, we do not include controls for pension generosity such as average benefit, replacement rate, or normal cost. To account for other pension plan characteristics that may be related to Social Security inclusion and retirement timing, but which we do not believe are mediating factors, we include a proxy for full benefit eligibility and two measures of pension plan health. In results not shown, the results are similar when including normal cost as a covariate for the subset of state by year combinations that this variable is available in the PPD data.

[13]Data on annual state level unemployment rates are from the Bureau of Labor Statistics' Local Area Unemployment Statistics, https://www.bls.gov/lau/rdscnp16.htm [accessed August 2018]. Annual state level real GDP per capita and personal income per capita are from the Bureau of Economic Analysis' Regional Economic Accounts, "Per capita real GDP by state (chained 2009 dollars)," [accessed August 2018] and "SA1 Personal Income Summary: Personal Income, Population, Per Capita Personal Income," [accessed August 2018].

described above. The final column adds the three macroeconomic variables.

First, the estimated coefficients on Social Security inclusion for the reference group (ages 50-61) are not statistically significantly different from zero. However, the confidence intervals on these estimates are large and include economically meaningful positive or negative differences. The bottom of the table presents the estimated marginal effects for ages 50-61 year olds. Again, these are economically small and not statistically significant. As expected, the estimated coefficient on the age group indicator suggests a large and statistically significant difference in retirement rates between the younger (ages 50-61) and older (ages 62-70) age groups. Importantly, the interaction term between the older age group and Social Security inclusion is positive and statistically significant. The marginal effects, reported at the bottom of Table 4, are calculated as the average change in probability of retirement from being included in Social Security for those ages 62-70. In the baseline Column (1), Social Security inclusion is associated with a 3 percentage point higher probability of retirement. The average probability of retiring among 62-70 year olds who are not covered by Social Security is 25 percent. Thus, the marginal effect suggests that, for teachers, Social Security eligibility is associated with a 12 percent higher probability of retirement, all else equal.

Because some teachers will be eligible for Social Security benefits through other jobs or through their spouse, this estimates represents a lower bound of the effect of Social Security eligibility on retirement. However, these estimates rely on cross-sectional variation across states. To determine the extent to which other omitted characteristics could explain these findings, we include three measures of pension characteristics in Column (2). As discussed in detail above, differences in employer-provided pension plan characteristics may be due to Social Security inclusion. Still, when controlling for these characteristics we observe a slightly larger effect of Social Security eligibility on retirement. Column (3) further includes macroeconomic conditions that vary by state and year. Again, including these controls suggests an even larger marginal effect. Note also that including the macroe-

conomic condition control variables changes the estimated time pattern of retirements. The constructed measure of "theoretical eligibility" for full retirement benefits strongly predicts retirement, while the other two pension health measures do not. A higher unemployment rate is associated with an increased probability of retirement, but the other two proxies for macroeconomic conditions do not predict retirement, all else equal.

The results in Table 4 illustrate a statistically significant difference in retirement rates for individuals 62-70 by Social Security inclusion status. To further explore whether the age pattern of retirement rates differs by Social Security inclusion, we next disaggregate the age categories further as in Equation (2). This more closely mirrors Figure 1. For this exercise, we construct the omitted age group as ages 50-59 and include age-specific dummy variables for ages 60-70. Column (1) of Table 5 presents these results. The specification here includes all covariates from Table 4, Column (3).

For the group of teachers not covered by Social Security, we observe that retirement rates increase monotonically in age except at age 69. Note that although most teachers with sufficient tenure will be covered by some form of retiree health insurance, Medicare is likely still an important component of health insurance support (see, e.g., Clark and Morrill, 2010).

The estimated coefficient on Social Security inclusion is again not statistically significant for the excluded age group (here ages 50-59), although the confidence intervals are large. The interaction terms between Social Security inclusion and age reveal a statistically significant difference in the retirement patterns of teachers. The estimated coefficients for the age-specific retirement rates are statistically significantly higher under Social Security eligibility at ages 62, 64, and 66. In Column (1), a Wald-test of the null hypothesis that the age 62 to 70 interaction coefficients are jointly equal to zero is rejected with $p < 0.001$. To give a sense of magnitude, in results not reported in the table, the average marginal effect of Social Security inclusion for a 62 year old (the sum of the baseline estimate plus the interacted term) is 4.8 percentage points. Table 3 showed the age-specific retirement rate

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for individuals age 62 who are not covered by Social Security is 19.14 percent. Thus, Social Security coverage is associated with about a 25 percent higher risk of retirement at age 62. To bolster our confidence in this conclusion, we perform a Wald-test of the joint null hypothesis that each of the age 63-70 interaction coefficients is equal to the age 62 interaction coefficient. We reject this null hypothesis at the $< 10\%$ level with a $p = 0.0693$. These results indicate a clear impact of Social Security inclusion on the timing of retirement.[14]

## 4.3   Labor Force Participation Rates

So far, we have considered individual's transitions from working to not working. This "flow" measure will capture all workers who retire from teaching and do not immediately begin a new job. The measure will not detect individuals who move directly from teaching to a new job without a period time spent not working. An alternative measure is a "stock" of who is actively working as a teacher. For this exercise, we collapse the data into age $\times$ state $\times$ year $\times$ gender cells. We define the teacher labor force participation rate as the fraction of individuals in each cell who are actively working as a teacher.[15] We include in the numerator individuals who are currently employed or unemployed and report their current or most recent occupation to be teacher. Individuals who report being out of the labor force are excluded from the numerator. The denominator is all individuals in that age $\times$ state $\times$ year $\times$ gender cell who have at least a bachelor's degree. All estimates are weighted by the population size of each cell. For age groups where the flow to stock ratio is small, it will be more difficult to detect a statistically significant change in the outflow from teaching. Still, we anticipate that the sign and approximate magnitude of the change will be similar to that from the preferred age-specific retirement rates analysis above.

To begin, we illustrate the teacher labor force participation rate for ages 25 through

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[14]In results not shown, we confirm that these estimates are robust to dropping Texas or California, both large states where teachers are not covered.

[15]Over the summer months a teacher may not be actively working but may still have a job as a teacher. The ACS is collected year-round, but the public use version does not indicate the survey month. It is possible that this type of measurement error varies by state, but we have no way to test this directly.

70. Means are presented for each age individually with population weights used in the calculation of the mean.[16] Figure 2 illustrates that the teacher labor force is actually higher in states covered by Social Security for ages 25 through about age 55. For that age range, about 10 percent of individuals in states where teachers are covered by Social Security are working as teachers, compared to closer to 9 percent in non-covered states. This could be due to a labor supply effect indicating that Social Security is a benefit valued by potential teachers, or it could indicate something about the financial wellness of the state. This pattern switches starting at about age 55. Interestingly, from about age 55 through age 63, the teacher labor force participation rates are much more similar between the two groups of states. Starting at age 63, states where teachers are covered by Social Security have lower teacher labor force participation rates.

Table 5, Column (2) presents estimates from an OLS regression with the same age-specific rate specification as in Column (1). Estimates weight each age×state×year×gender cell by the population size. The first row indicates that the teacher labor force participation rate does not significantly differ by Social Security inclusion for the omitted age group, ages 50-59. This is consistent with the labor force participation rate figure above. Similar to the retirement rate regressions presented above, the teacher labor force participation rates drop as individuals age. The estimated coefficients on age suggest a smooth decline in the probability of being a teacher by age with only a slightly larger decline at age 65.

To see the difference in participation in the teacher labor force by Social Security coverage, Table 5, Column (2) includes interaction terms with age and Social Security inclusion. Confirming the results above, Social Security is associated with lower teacher labor force participation rates starting at age 64. The estimate at age 62 is similar in magnitude but not statistically significant. Considering the most saturated model, shown in Table 5, Column (2), for individuals age 67, Social Security inclusion is associated with a 0.46 percentage point lower teacher labor force participation rate. The average labor

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[16]Appendix Table A3 presents the statistics on teacher labor force participation.

force participation rate for non-covered teachers age 67 is 2.0 percent, shown in Appendix Table A3. This implies an approximately 23 percent lower teacher labor force participation rate among 67 year olds associated with Social Security coverage. Although not always statistically significant, the magnitudes are quite similar to that found analyzing retirement rates above. To put this number into perspective, Fetter and Lockwood (2016) find that the Old Age Assistance Program (OAA) reduced the labor force participation rate of men in their late 60's by 8.5 percentage points.

The second half of Table 5 presents the estimated coefficients for the other covariates in the regression model. The time pattern for participation in the teacher labor force suggests a decline in teaching over time. Parallel to the results above, the unemployment rate is associated with a lower teacher labor force participation, potentially due to lower demand. Real GDP per capita (measured in thousands of dollars) is associated with a significantly lower teacher labor force participation rate.

## 4.4 Marital Status

There are several reasons to expect retirement patterns for married individuals to be less sensitive to Social Security inclusion. First, own Social Security income may be a smaller portion of total household income and, thus, may be less important in timing retirement. Second, couples may consider other non-financial factors in timing their retirement, such as joint leisure. If so, we expect to see a smaller impact of financial incentives on retirement. Retirement coordination is well established in the data: married couples tend to retire at the same time (Blau, 1998; Gustman and Steinmeier, 2000; Coile, 2004). This result is often explained by the joint budget set faced by couples and leisure complementarities between spouses. This intuition runs counter to recent empirical evidence which suggests that the returns to additional years of work later in life are greater for married women than for married men (Maestas, 2017). Henriques (2018) uses Social Security records to estimate whether men and women claim Social Security benefits in a way that maximizes benefit

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levels. Her analysis shows that, despite the increase in women's labor force participation and wages, wives are still dependent on their husbands' Social Security benefits. Further, she finds that husbands respond to their own incentives but do not claim in a way that maximizes dependent benefits.

One benefit of the ACS is that we can observe marital status and, if married, characteristics of the spouse. In Appendix Table A4, we present estimates for the samples of married women and married men, with controls for spouse's age and labor supply, parallel to our preferred model from Table 4, Column (3). Our empirical results lack sufficient power to estimate meaningful differences by gender and marital status. However, the estimates are suggestive that the impact of Social Security eligibility is larger for single women at younger ages and larger for married women and men later in their 60's.

In Appendix Table A4, Column (1), the marginal effect of Social Security coverage at age 67 indicates an 11.17 percentage point higher probability of retirement. Not shown in the table, the average retirement rate for married female teachers not covered by Social Security who are age 67 is 31.7 percent. Thus, Social Security coverage is associated with about a 35 percent higher probability of retirement among 67 year old married female teachers, but not at other ages. Married male teachers age 66 also have a statistically significantly higher probability of retiring if covered by Social Security. Here, the marginal effect of 10.50 percent represents about 47 percent of the non-covered mean of 22.3 percent. For married male teachers there are also statistically significant differences by Social Security coverage at ages 69 and 70. The fact that we do not see similar jumps at the early Social Security claiming ages for married men or women suggests that factors impacting the joint retirement decisions of couples might outweigh the effects of Social Security incentives. There is also evidence of a desire for joint leisure as having a spouse who is not in the labor force is associated with a large and statistically significantly higher probability of retirement for both men and women. Still, the standard errors on these estimates are large, so we do not explore this further in this context.

# 5    Discussion and Conclusion

The evidence presented here supports the hypothesis that Social Security inclusion influences age-specific probabilities of retirement for individuals ages 62-70. These results are confirmed in a supplemental analysis of the participation in the teacher labor force. On average, teachers eligible for Social Security (ages 62-70) have about a 12 percent higher probability of retiring than teachers ages 62-70 who are not covered by Social Security. In the American Community Survey (ACS) data, we can only observe a retirement if an individual moves from working as a teacher to not working. If the teacher terminates employment and begins a new career without a break, our method will not capture that retirement. Our estimates will be inaccurate if this type of measurement error is correlated with Social Security coverage. We therefore confirm our main estimates by instead analyzing participation in the teacher labor force. This measure is not sensitive to retirement transition type. Using this measure, we find that Social Security coverage is associated with lower participation in the teacher labor force starting at age 64.

Many public employees are not currently covered by Social Security. Many public pension plans are in crisis due to lower investment returns, historic underfunding, and rising life expectancies. One option a plan sponsor might consider is transitioning to a DC plan plus Social Security. This leads to several key questions. Which public employees would benefit and which may not? What are the labor supply impacts of pension reforms? What are the implications on costs for Social Security?

The results in this paper indicate that Social Security coverage is associated with increased retirement rates between ages 62 and 70. However, we can only provide suggestive evidence that this is consistent with earlier not later retirements. Further, we cannot provide evidence on whether teachers are better or worse off when covered by Social Security. It may be that the income support that Social Security provides allows individuals to retire at younger ages. Engelhardt et al. (2018) show that the introduction of early Social Security claiming led to a decline in retirement income and a subsequent rise in old age

poverty for male-headed households. Snyder and Evans (2006) leverage variation in retirement income induced by the notch and find that the larger benefit group experienced higher mortality rates. One potential mechanism for this is that the lower benefit group engaged in post-retirement work, which may have yielded a health benefit to those workers. In addition, we cannot provide evidence on whether these earlier departures are helpful or harmful to the education system as a whole. Fitzpatrick and Lovenheim (2014) estimate that when a teacher early retirement incentive is introduced, student test scores do not drop as a result of the induced retirements.

In this study, we cannot distinguish between whether Social Security allows individuals to retire when desired or whether workers are being pulled out of the labor force. Coile and Levine (2007) show that Social Security can help alleviate the income loss associated with a weak labor market. They find that when a labor market downturn occurs, individuals eligible for Social Security are more likely to retire. The evidence presented here strongly suggests that Social Security influences retirement timing. Should a teacher pension plan opt to join Social Security in the future, these newly covered teachers may increase their retirement rates in their 60's. We find no evidence that retirement rates of teachers in their 50's differ by Social Security coverage, with the exception of single men. If Social Security does hasten retirements, these earlier retirements would, in turn, put further strain on the public sector pensions.

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Figure 1: Age-Specific Retirement Rates for Teachers and Other Workers
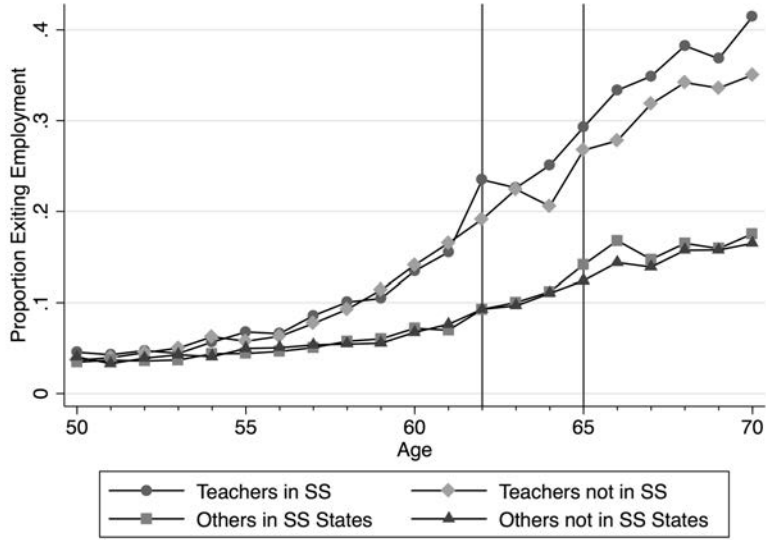


Figure 2: Teacher Labor Force Participation Rates
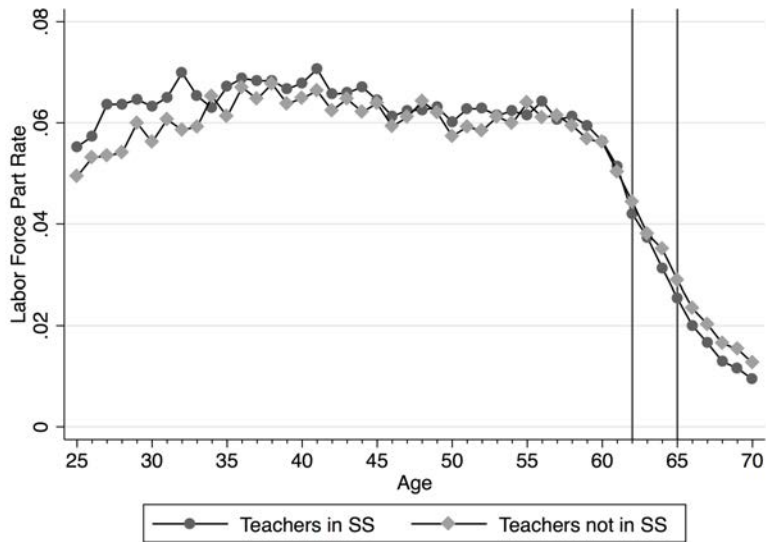
Table 1: Teachers' Social Security Coverage by State

| State | Are Teachers Included in Social Security? |
| --- | --- |
| Alabama | Yes |
| Alaska | No |
| Arizona | Yes |
| Arkansas | Yes |
| California | No |
| Colorado | No |
| Connecticut | No |
| Delaware | Yes |
| District of Columbia | No |
| Florida | Yes |
| Georgia[†] | Partial Inclusion |
| Hawaii | Yes |
| Idaho | Yes |
| Illinois | No |
| Indiana | Yes |
| Iowa | Yes |
| Kansas | Yes |
| Kentucky | No |
| Louisiana | No |
| Maine | No |
| Maryland | Yes |
| Massachusetts | No |
| Michigan | Yes |
| Minnesota | Yes |
| Mississippi | Yes |
| Missouri[†] | Partial Inclusion |
| Montana | Yes |
| Nebraska | Yes |
| Nevada | No |
| New Hampshire | Yes |
| New Jersey | Yes |
| New Mexico | Yes |
| New York | Yes |
| North Carolina | Yes |
| North Dakota | Yes |
| Ohio | No |
| Oklahoma | Yes |
| Oregon | Yes |
| Pennsylvania | Yes |
| Rhode Island[†] | Partial Inclusion |
| South Carolina | Yes |
| South Dakota | Yes |
| Tennessee | Yes |
| Texas | No |
| Utah | Yes |
| Vermont | Yes |
| Virginia | Yes |
| Washington | Yes |
| West Virginia | Yes |
| Wisconsin | Yes |
| Wyoming | Yes |

† States where only some teachers are covered are excluded.

Notes: Pension plan data is derived from the the Center for Retirement Research at Boston College's Public Plan Database. See Section 3.1 for details.

Table 2: Summary Statistics

| | (1)<br>All | (2)<br>Not included in SS | (3)<br>Included in SS | (4)<br>Difference:(3)-(2) |
|---|---|---|---|---|
| Retired | 0.1221<br>(0.3275) | 0.1182<br>(0.3228) | 0.1247<br>(0.3304) | 0.0065**<br>[0.0026] |
| Age | 57.5320<br>(5.0464) | 57.5852<br>(5.0923) | 57.4978<br>(5.0165) | -0.0875**<br>[0.0417] |
| Advanced Degree | 0.6017<br>(0.4896) | 0.5743<br>(0.4944) | 0.6192<br>(0.4856) | 0.0449***<br>[0.0041] |
| White | 0.8710<br>(0.3352) | 0.8711<br>(0.3351) | 0.8709<br>(0.3353) | -0.0002<br>[0.0030] |
| African American | 0.0846<br>(0.2783) | 0.0757<br>(0.2646) | 0.0903<br>(0.2866) | 0.0146***<br>[0.0025] |
| Other Race | 0.0444<br>(0.2060) | 0.0531<br>(0.2243) | 0.0388<br>(0.1931) | -0.0143***<br>[0.0018] |
| Hispanic Origin | 0.0599<br>(0.2374) | 0.0891<br>(0.2849) | 0.0412<br>(0.1988) | -0.0479***<br>[0.0023] |
| Female | 0.7667<br>(0.4230) | 0.7597<br>(0.4273) | 0.7712<br>(0.4201) | 0.0115***<br>[0.0036] |
| Married | 0.7129<br>(0.4524) | 0.6994<br>(0.4585) | 0.7216<br>(0.4482) | 0.0223***<br>[0.0039] |
| Never Married | 0.0760<br>(0.2651) | 0.0805<br>(0.2720) | 0.0732<br>(0.2605) | -0.0073***<br>[0.0023] |
| Separated | 0.0138<br>(0.1165) | 0.0130<br>(0.1134) | 0.0142<br>(0.1184) | 0.0012<br>[0.0011] |
| Divorced | 0.1606<br>(0.3672) | 0.1718<br>(0.3772) | 0.1535<br>(0.3604) | -0.0183***<br>[0.0032] |
| Widowed | 0.0367<br>(0.1879) | 0.0354<br>(0.1847) | 0.0375<br>(0.1899) | 0.0021<br>[0.0016] |
| Divorced in Past Year | 0.0069<br>(0.0829) | 0.0073<br>(0.0850) | 0.0067<br>(0.0815) | -0.0006<br>[0.0007] |
| Widowed in Past Year | 0.0044<br>(0.0660) | 0.0044<br>(0.0663) | 0.0043<br>(0.0658) | -0.0001<br>[0.0005] |
| Observations | 88788 | 34356 | 54432 | 88788 |

Sample of all teachers. Means weighted at the person level with SD in parentheses and SE in brackets.

Notes: Teacher retirement data are derived from the 2010-2016 American Community Surveys, see text for details.

Table 3: Cumulative Retirement Probabilities by Social Security Inclusion

| | **Not Included in Social Security** | | | **Included in Social Security** | | |
|---|---|---|---|---|---|---|
| Age | Pct Retiring | Remaining Workers | Cum. Ret.. Rate | Pct Retiring | Remaining Workers | Cum. Ret. Rate |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 50 | 3.67% | 1000 | 0.0000 | 4.55% | 1000 | 0.0000 |
| 51 | 3.95% | 963 | 0.0367 | 4.28% | 954 | 0.0455 |
| 52 | 4.51% | 925 | 0.0748 | 4.74% | 914 | 0.0864 |
| 53 | 5.01% | 883 | 0.1113 | 4.43% | 870 | 0.1255 |
| 54 | 6.26% | 839 | 0.1559 | 5.67% | 832 | 0.1642 |
| 55 | 5.77% | 787 | 0.2087 | 6.78% | 785 | 0.2116 |
| 56 | 6.31% | 741 | 0.2543 | 6.60% | 731 | 0.2651 |
| 57 | 7.72% | 695 | 0.3014 | 8.58% | 683 | 0.3136 |
| 58 | 9.28% | 641 | 0.3553 | 10.06% | 624 | 0.3726 |
| 59 | 11.39% | 581 | 0.4151 | 10.47% | 562 | 0.4357 |
| 60 | 14.09% | 515 | 0.4817 | 13.44% | 503 | 0.4947 |
| 61 | 16.52% | 443 | 0.5548 | 15.51% | 435 | 0.5627 |
| 62 | 19.14% | 370 | 0.6283 | 23.48% | 368 | 0.6305 |
| 63 | 22.43% | 299 | 0.6994 | 22.60% | 281 | 0.7172 |
| 64 | 20.58% | 232 | 0.7668 | 25.08% | 218 | 0.7811 |
| 65 | 26.75% | 184 | 0.8148 | 29.27% | 163 | 0.8360 |
| 66 | 27.79% | 135 | 0.8643 | 33.34% | 115 | 0.8840 |
| 67 | 31.84% | 97 | 0.9020 | 34.89% | 77 | 0.9227 |
| 68 | 34.19% | 66 | 0.9332 | 38.24% | 50 | 0.9497 |
| 69 | 33.59% | 44 | 0.9561 | 36.83% | 31 | 0.9689 |
| 70 | 35.02% | 29 | 0.9708 | 41.45% | 20 | 0.9804 |

Notes: Teacher retirement data are derived from the 2010-2016 American Community Surveys, see text for details. Age-specific retirement probabilities are presented in Columns (1) and (4). Using life table methodology, Columns (2) and (5) present the implied population remaining from a fictitious cohort of 1,000 teachers. Columns (3) and (6) translate these statistics into a cumulative retirement rate for the population.

Table 4: Logit Regression Coefficient Estimates

| | (1) Baseline | | (2) + Pension Characteristics | | (3) + Macroeconomic Conditions | |
|---|---|---|---|---|---|---|
| Included in SS | 0.0013 | (0.0808) | 0.0086 | (0.0977) | 0.0268 | (0.0837) |
| 62-70 Years Old | 1.4150*** | (0.0795) | 1.1498*** | (0.0603) | 1.1264*** | (0.0663) |
| Included SS x 62-70 | 0.1473* | (0.0866) | 0.1543* | (0.0788) | 0.1669** | (0.0835) |
| 2011 | -0.0003 | (0.0509) | 0.0016 | (0.0519) | 0.0444 | (0.0460) |
| 2012 | 0.0385 | (0.0545) | 0.0439 | (0.0573) | 0.1446** | (0.0598) |
| 2013 | -0.0368 | (0.0669) | -0.0278 | (0.0710) | 0.1280* | (0.0772) |
| 2014 | -0.1127 | (0.0767) | -0.1038 | (0.0742) | 0.1306 | (0.0974) |
| 2015 | -0.1354** | (0.0677) | -0.1174* | (0.0683) | 0.1658 | (0.1092) |
| 2016 | -0.1770*** | (0.0678) | -0.1532** | (0.0671) | 0.1610 | (0.1123) |
| Demographics | X | | X | | X | |
| Full Retirement Eligible | | | 0.6781*** | (0.0570) | 0.7169*** | (0.0518) |
| Funding Ratio | | | 0.1119 | (0.3310) | 0.1888 | (0.3126) |
| Percent ARC Paid | | | -0.0938 | (0.1183) | -0.0474 | (0.1280) |
| Unemployment Rate | | | | | 0.0768*** | (0.0246) |
| Real Income Per 1,000 | | | | | 0.0111 | (0.0090) |
| Real GDP Per 1,000 | | | | | -0.0045 | (0.0040) |
| Marginal Effects 50-61 | [0.0001] | | [0.0006] | | [0.0019] | |
| Marginal Effects 62-70 | [0.0289]* | | [0.0316]* | | [0.0374]** | |
| Observations | 88788 | | 88788 | | 88788 | |

Notes: Teacher retirement data are derived from the 2010-2016 American Community Surveys, see text for details. The dependent variable is the probability of retiring in the past year. The specifications also include controls for gender and marital status, education, race/ethnicity. Standard errors clustered at the state level in parentheses. $^*p < 0.10,^{**} p < 0.05,^{***} p < 0.01$.

Table 5: Age-Specific Retirement Patterns

| | (1) Pr(Retired) | | (2) Labor Force Part. | |
|---|---|---|---|---|
| Included in SS | 0.0324 | (0.0758) | -0.0022 | (0.0031) |
| 60 Years Old | 0.6299*** | (0.1415) | -0.0049 | (0.0031) |
| 61 Years Old | 0.8197*** | (0.0797) | -0.0105*** | (0.0032) |
| 62 Years Old | 1.0130*** | (0.0626) | -0.0151*** | (0.0035) |
| 63 Years Old | 1.2223*** | (0.1007) | -0.0212*** | (0.0029) |
| 64 Years Old | 1.1300*** | (0.0525) | -0.0236*** | (0.0025) |
| 65 Years Old | 1.4606*** | (0.1117) | -0.0282*** | (0.0037) |
| 66 Years Old | 1.5227*** | (0.1017) | -0.0327*** | (0.0026) |
| 67 Years Old | 1.7270*** | (0.1272) | -0.0347*** | (0.0030) |
| 68 Years Old | 1.8395*** | (0.1026) | -0.0385*** | (0.0033) |
| 69 Years Old | 1.8112*** | (0.0998) | -0.0379*** | (0.0040) |
| 70 Years Old | 1.8889*** | (0.1375) | -0.0385*** | (0.0032) |
| Included in SS and 60 Years Old | -0.0092 | (0.1462) | -0.0001 | (0.0028) |
| Included in SS and 61 Years Old | -0.0234 | (0.0890) | 0.0004 | (0.0027) |
| Included in SS and 62 Years Old | 0.2553*** | (0.0909) | -0.0042 | (0.0030) |
| Included in SS and 63 Years Old | 0.0057 | (0.1243) | -0.0014 | (0.0023) |
| Included in SS and 64 Years Old | 0.2382** | (0.0955) | -0.0049** | (0.0021) |
| Included in SS and 65 Years Old | 0.1172 | (0.1305) | -0.0050 | (0.0031) |
| Included in SS and 66 Years Old | 0.2536** | (0.1198) | -0.0046** | (0.0022) |
| Included in SS and 67 Years Old | 0.1191 | (0.1416) | -0.0056** | (0.0024) |
| Included in SS and 68 Years Old | 0.1536 | (0.1293) | -0.0047* | (0.0026) |
| Included in SS and 69 Years Old | 0.1166 | (0.1310) | -0.0061* | (0.0033) |
| Included in SS and 70 Years Old | 0.2512 | (0.1564) | -0.0064** | (0.0024) |
| 2011 | 0.0369 | (0.0449) | -0.0052*** | (0.0011) |
| 2012 | 0.1174* | (0.0618) | -0.0100*** | (0.0019) |
| 2013 | 0.0910 | (0.0797) | -0.0139*** | (0.0023) |
| 2014 | 0.0707 | (0.1002) | -0.0195*** | (0.0030) |
| 2015 | 0.0924 | (0.1120) | -0.0238*** | (0.0036) |
| 2016 | 0.0825 | (0.1135) | -0.0254*** | (0.0039) |
| Eligible for Full Retirement | 0.5027*** | (0.0572) | 0.0060 | (0.0038) |
| Funding Ratio | 0.1239 | (0.2929) | 0.0052 | (0.0063) |
| Percent of Required Contribution Paid | -0.0021 | (0.1133) | 0.0059 | (0.0044) |
| Unemployment Rate | 0.0646*** | (0.0233) | -0.0023*** | (0.0007) |
| Real Income Per 1,000 | 0.0095 | (0.0095) | -0.0001 | (0.0004) |
| Real GDP Per 1,000 | -0.0050 | (0.0043) | -0.0002* | (0.0001) |
| Observations | 88788 | | 8064 | |

Notes: Teacher retirement data are derived from the 2010-2016 American Community Surveys, see text for details. In Column (1), the dependent variable is the probability of retiring in the past year. Logit estimates are reported with marginal effects in brackets. In Column (2), the dependent variable is the teacher labor force participation rate, which is defined as the age×state×year×gender cell probability that an individual with at least a bachelor's degree is currently working as a teacher. Estimates are from an OLS regression. Both specifications also include controls for gender and marital status, education, race/ethnicity. Standard errors clustered at the state level in parentheses. $^*p < 0.10,^{**}p < 0.05,^{***}p < 0.01$.

# Data Appendix

## A    Retirement Data

Data on the retirement of teachers comes from the American Community Survey (ACS) from 2010 to 2016.[17]

**Classifying teachers:**

> Describe clearly this person's chief job activity or business last week. If this person had more than one job, describe the one at which this person worked the most hours. If this person had no job or business last week, give information for his/her last job or business.

We classify an individual as a teacher following Harris and Adams (2007). This includes: kindergarten teachers, primary and secondary school teachers, special education teachers, and other teachers not otherwise classified. This excludes all post-secondary teachers.

**Worked within the last year:**

> When did this person last work, even for a few days?

> 1. Within the past 12 months
> 2. 1 to 5 years ago −  SKIP to [L]
> 3. Over 5 years ago or never worked −  SKIP to question 47

The population of teachers is restricted to those who report working in the last year. Retired teachers are defined as individuals whose most recent reported occupation was a teacher and who worked last year, but are currently not in the labor force.

**Retirement status:**

> LAST WEEK, did this person work for pay at a job (or business)?

> 1. Yes → SKIP to question 30
> 2. No  Did not work (or retired)

> LAST WEEK, was this person on layoff from a job?

---

1. Yes → SKIP to question 35c
2. No

Has this person been informed that he or she will be recalled to work within the next 6 months OR been given a date to return to work?

1. Yes → SKIP to question 37
2. No

During the LAST 4 WEEKS, has this person been ACTIVELY looking for work?

1. Yes
2. No → SKIP to question 38

LAST WEEK, could this person have started a job if offered one, or returned to work if recalled?

1. Yes, could have gone to work
2. No, because of own temporary illness
3. No, because of all other reasons (in school, etc.)

We use employment status from the ACS to determine whether an individual is employed. Employment status in the ACS is categorized as (1) employed, (2) unemployed, or (3) not in the labor force. It is determined by the respondents answers to the above questions.

# B   Other Occupation Categories

We define two occupation groups as counterfactuals for teachers. The first are state government employees who are not teachers. We identify state government employees using the following ACS question:

Was this person Mark (X) ONE box.

1. an employee of a PRIVATE FOR-PROFIT company or business, or of an individual, for wages, salary, or commissions?
2. an employee of a PRIVATE NOT-FOR-PROFIT, tax-exempt, or charitable organization?
3. a local GOVERNMENT employee (city, county, etc.)?
4. a state GOVERNMENT employee?

5. a Federal GOVERNMENT employee?

6. SELF-EMPLOYED in own NOT INCORPORATED business, professional practice, or farm?

7. SELF-EMPLOYED in own INCORPORATED business, professional practice, or farm?

8. working WITHOUT PAY in family business or farm?

The second, and broader, counterfactual group consist of individuals from the following occupation categories: management, business, science, and arts occupations; business operations specialists; financial specialists; computer and mathematical occupations; architecture and engineering occupations; life, physical, and social science occupations; community and social services occupations; legal occupations; arts, design, entertainment, sports, and media occupations; sales and related occupations; and office and administrative support occupations. We classify individuals into these categories using the "most recent occupation" question listed above.

# C    Accuracy of Retirement Classification

Because the ACS does not contain a precise measure of retirement, there is some noise in our constructed measure. We define an individual as retired if she worked within the last year but was not working at the time of the survey. This definition of retirement will not capture individuals who retire from teaching and immediately start working elsewhere without a break in service. Note that in the window of time observed in the ACS, an individual must not be currently working but may later return to work. Most teacher pension plans require a break in service before returning to a covered or non-covered employment within that same plan. Thus, our measure of retirement should capture most job separations.

As evidence that there is not differential measurement error in our definition of retirement by Social Security inclusion, we conduct a study of "observed" versus "unobserved" exits. We begin by calculating the weighted total number of teachers age 25 to 75 by age, first for the years 2011-2016 then for 2010-2015. Teachers are defined as individuals whose most recent primary occupation is teaching and who reported working in the last year. This includes individuals who are currently teachers or who are unemployed or not in the labor force. We then calculate the "loss" of teachers from age $a-1$ in year $t-1$ to $a$ in $t$, which we term unobserved exits.

$$\widehat{\text{Unobserved Exits}}_{a,t} = \text{Teachers}_{a-1,t-1} - \text{Teachers}_{a,t} \qquad (3)$$

Note that unobserved exits could theoretically be negative if there are new entrants to teaching. This measure of unobserved exits will include teachers who move directly into another occupation after retiring as well as sampling errors. To make our estimate of unobserved exits comparable by age group, we scale it by the sum of observed exits from

teaching and our estimate of unobserved exits. This produces a fraction of exits that are "missed" by our measure of retirement.

$$\text{Percent of Exits Missed}_{a,t} = \frac{\widehat{\text{Unobserved Exits}}_{a,t}}{\widehat{\text{Unobserved Exits}}_{a,t} + \text{Observed Exits}_{a,t}} \tag{4}$$

For younger ages, we anticipate a large number of missed exits due to job switching without a period of non-employment. However, as individuals age, we expect that departures will be more likely to lead to a termination of employment, at least for some period of time. Note that even if a teacher returns to work at a later age, we will observe the exit if she spends a period of not working first. Figure A1 presents graphically the measured "missed" exits by age at time $t$. For younger ages, the data are noisier and indicate not only unobserved exits but also new entrants (i.e., negative values). However, by age 56, where we begin our analysis, nearly all missing teachers are captured by our definition of retirement. The dark line represents states where teachers are covered by Social Security, while the lighter line includes teachers not part of Social Security. Importantly, we observe that the age-specific loss rates are nearly identical between the two groups of states from age 55 through age 70. We do not observe any systematic difference in missing teachers between to the two groups of states at any age. We interpret these findings as strong evidence that our measure of retirement is a good approximation and that Social Security inclusion is not correlated with better quality measures of retirement.

Figure A1: Estimates of Missed Teachers by Age
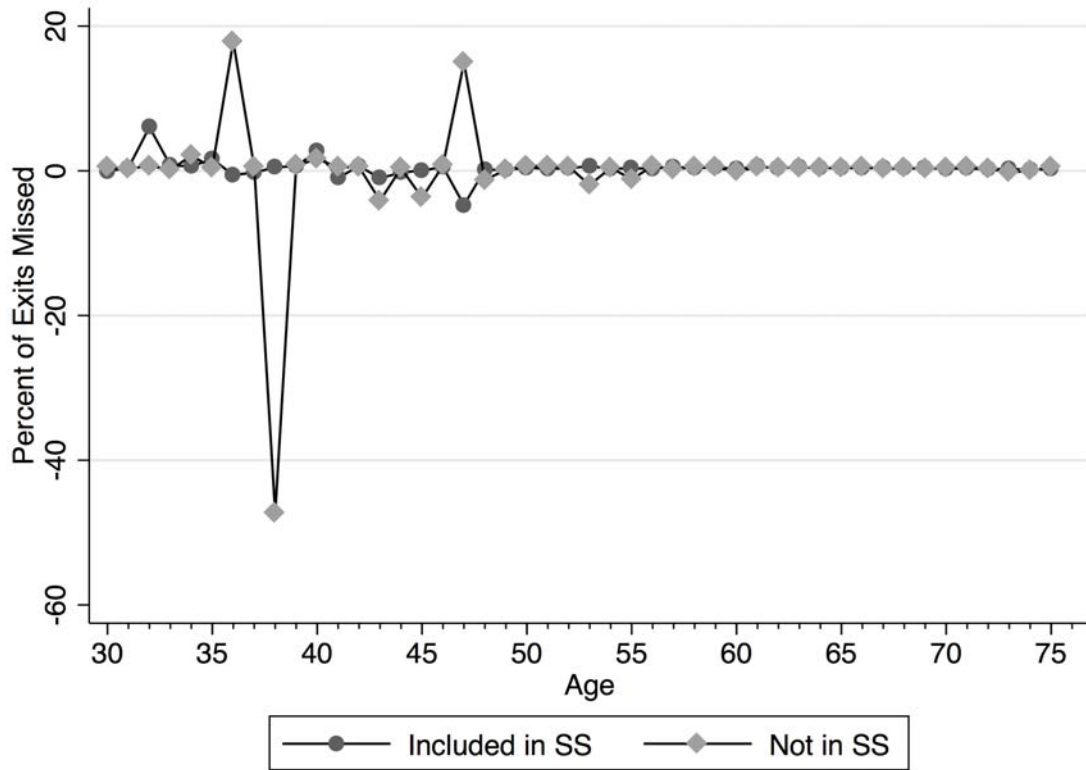
Table A1: Summary Statistics: Pension Parameters and Macroeconomic Conditions

|  | (1)<br>All | (2)<br>Not included in SS | (3)<br>Included in SS | (4)<br>Difference:(3)-(2) |
|---|---|---|---|---|
| Eligible for Full Retirement | 0.6341 | 0.6462 | 0.6264 | -0.0198*** |
|  | (0.4817) | (0.4782) | (0.4838) | [0.0040] |
| Funding Ratio | 0.7280 | 0.6612 | 0.7709 | 0.1097*** |
|  | (0.1547) | (0.1185) | (0.1600) | [0.0011] |
| Percent of Required Contribution Paid | 0.8192 | 0.7674 | 0.8524 | 0.0850*** |
|  | (0.2582) | (0.2589) | (0.2522) | [0.0023] |
| Unemployment Rate (%) | 7.1839 | 7.5727 | 6.9340 | -0.6387*** |
|  | (2.1206) | (2.2326) | (2.0059) | [0.0177] |
| Real Income Per Capita | 42.3953 | 43.0516 | 41.9734 | -1.0782*** |
| (In Thousands of Dollars) | (4.1823) | (4.4842) | (3.9184) | [0.0346] |
| Real GDP Per Capita | 49.3823 | 52.6089 | 47.3083 | -5.3005*** |
| (In Thousands of Dollars) | (9.0726) | (8.8783) | (8.5768) | [0.0716] |
| Observations | 88788 | 34356 | 54432 | 88788 |

Sample of all teachers. Means weighted at the person level with SD in parentheses and SE in brackets.

Table A2: Age-Specific Retirement Rates

| | (1)<br>All | (2)<br>Not included in SS | (3)<br>Included in SS | (4)<br>Difference:(3)-(2) |
|---|---|---|---|---|
| 50-59 Years Old | 0.0649 | 0.0633 | 0.0659 | 0.0026 |
| | (0.2463) | (0.2435) | (0.2481) | [0.0025] |
| 60 Years Old | 0.1370 | 0.1409 | 0.1344 | -0.0065 |
| | (0.3438) | (0.3480) | (0.3411) | [0.0112] |
| 61 Years Old | 0.1590 | 0.1652 | 0.1551 | -0.0100 |
| | (0.3657) | (0.3713) | (0.3620) | [0.0129] |
| 62 Years Old | 0.2180 | 0.1914 | 0.2348 | 0.0434*** |
| | (0.4129) | (0.3934) | (0.4238) | [0.0144] |
| 63 Years Old | 0.2253 | 0.2243 | 0.2260 | 0.0017 |
| | (0.4178) | (0.4171) | (0.4182) | [0.0156] |
| 64 Years Old | 0.2331 | 0.2058 | 0.2508 | 0.0450*** |
| | (0.4228) | (0.4043) | (0.4335) | [0.0169] |
| 65 Years Old | 0.2825 | 0.2675 | 0.2927 | 0.0252 |
| | (0.4502) | (0.4426) | (0.4550) | [0.0207] |
| 66 Years Old | 0.3113 | 0.2779 | 0.3334 | 0.0556** |
| | (0.4630) | (0.4480) | (0.4714) | [0.0233] |
| 67 Years Old | 0.3361 | 0.3184 | 0.3489 | 0.0305 |
| | (0.4724) | (0.4658) | (0.4766) | [0.0276] |
| 68 Years Old | 0.3654 | 0.3419 | 0.3824 | 0.0405 |
| | (0.4815) | (0.4744) | (0.4860) | [0.0308] |
| 69 Years Old | 0.3543 | 0.3359 | 0.3683 | 0.0324 |
| | (0.4783) | (0.4723) | (0.4824) | [0.0332] |
| 70 Years Old | 0.3871 | 0.3502 | 0.4145 | 0.0643 |
| | (0.4871) | (0.4770) | (0.4926) | [0.0395] |
| Total | 0.1221 | 0.1182 | 0.1247 | 0.0065** |
| | (0.3275) | (0.3228) | (0.3304) | [0.0026] |
| Observations | 88788 | 34356 | 54432 | 88788 |

Sample of all teachers. Weighted at the person level with SD in parentheses and SE in brackets.

Table A3: Age-Specific Teacher Labor Force Participation Rates

|  | (1)<br>All | (2)<br>Not included in SS | (3)<br>Included in SS | (4)<br>Difference:(3)-(2) |
|---|---|---|---|---|
| 50-59 Years Old | 0.0610<br>(0.0366) | 0.0599<br>(0.0347) | 0.0617<br>(0.0378) | 0.0018<br>[0.0031] |
| 60 Years Old | 0.0563<br>(0.0417) | 0.0562<br>(0.0402) | 0.0564<br>(0.0426) | 0.0002<br>[0.0035] |
| 61 Years Old | 0.0509<br>(0.0398) | 0.0503<br>(0.0343) | 0.0513<br>(0.0430) | 0.0010<br>[0.0032] |
| 62 Years Old | 0.0429<br>(0.0335) | 0.0444<br>(0.0323) | 0.0420<br>(0.0343) | -0.0024<br>[0.0029] |
| 63 Years Old | 0.0376<br>(0.0323) | 0.0380<br>(0.0296) | 0.0373<br>(0.0340) | -0.0007<br>[0.0027] |
| 64 Years Old | 0.0327<br>(0.0280) | 0.0350<br>(0.0257) | 0.0313<br>(0.0293) | -0.0038<br>[0.0023] |
| 65 Years Old | 0.0268<br>(0.0256) | 0.0289<br>(0.0249) | 0.0254<br>(0.0259) | -0.0035<br>[0.0022] |
| 66 Years Old | 0.0213<br>(0.0213) | 0.0234<br>(0.0195) | 0.0200<br>(0.0223) | -0.0034*<br>[0.0018] |
| 67 Years Old | 0.0180<br>(0.0194) | 0.0203<br>(0.0173) | 0.0166<br>(0.0204) | -0.0037**<br>[0.0016] |
| 68 Years Old | 0.0143<br>(0.0175) | 0.0165<br>(0.0163) | 0.0129<br>(0.0181) | -0.0036**<br>[0.0015] |
| 69 Years Old | 0.0130<br>(0.0185) | 0.0154<br>(0.0166) | 0.0116<br>(0.0195) | -0.0038**<br>[0.0015] |
| 70 Years Old | 0.0106<br>(0.0166) | 0.0127<br>(0.0141) | 0.0094<br>(0.0178) | -0.0033**<br>[0.0013] |
| Total | 0.0478<br>(0.0378) | 0.0481<br>(0.0354) | 0.0476<br>(0.0393) | -0.0005<br>[0.0009] |
| Observations | 8064 | 2184 | 5880 | 8064 |

Sample of all teachers. Weighted at the person level with SD in parentheses and SE in brackets.

Table A4: Logit Regression Coefficient Estimates for Married Teachers by Gender

|  | (1) Married Women | | (2) Married Men | |
|---|---|---|---|---|
| Included in SS | 0.0833 [0.0053] | (0.0828) | 0.0403 [0.0020] | (0.1238) |
| 60 Years Old | 0.6328*** | (0.1679) | 0.6969*** | (0.2550) |
| 61 Years Old | 0.7722*** | (0.0962) | 0.6852*** | (0.2629) |
| 62 Years Old | 1.0079*** | (0.0803) | 1.0912*** | (0.1881) |
| 63 Years Old | 1.1113*** | (0.1021) | 1.1820*** | (0.3235) |
| 64 Years Old | 0.9174*** | (0.1044) | 0.8712*** | (0.1947) |
| 65 Years Old | 1.4885*** | (0.1681) | 1.1909*** | (0.2033) |
| 66 Years Old | 1.5525*** | (0.1203) | 1.1139*** | (0.2512) |
| 67 Years Old | 1.3906*** | (0.1233) | 1.3585*** | (0.3213) |
| 68 Years Old | 1.5043*** | (0.1992) | 1.7547*** | (0.2169) |
| 69 Years Old | 1.7040*** | (0.2087) | 1.4665*** | (0.1877) |
| 70 Years Old | 1.7089*** | (0.2127) | 1.6123*** | (0.2153) |
| Included in SS and 60 Years Old | -0.2720 [-0.0233] | (0.1842) | -0.1014 [-0.0067] | (0.2832) |
| Included in SS and 61 Years Old | -0.1497 [-0.0095] | (0.1121) | -0.0269 [0.0016] | (0.3044) |
| Included in SS and 62 Years Old | 0.0785 [0.0286] | (0.1250) | -0.0205 [0.0031] | (0.2207) |
| Included in SS and 63 Years Old | -0.0468 [0.0067] | (0.1437) | -0.3472 [-0.0490] | (0.3444) |
| Included in SS and 64 Years Old | 0.1381 [0.0393] | (0.1314) | 0.3682 [0.0639] | (0.2252) |
| Included in SS and 65 Years Old | -0.1287 [-0.0097] | (0.1995) | 0.2150 [0.0466] | (0.2367) |
| Included in SS and 66 Years Old | -0.0265 [0.0125] | (0.1810) | 0.5206* [0.1050] | (0.2976) |
| Included in SS and 67 Years Old | 0.4143*** [0.1117] | (0.1532) | 0.2059 [0.0495] | (0.3483) |
| Included in SS and 68 Years Old | 0.3155 [0.0900] | (0.2541) | 0.1077 [0.0323] | (0.2972) |
| Included in SS and 69 Years Old | -0.1275 [-0.0101] | (0.2513) | 0.5394** [0.1246] | (0.2465) |
| Included in SS and 70 Years Old | 0.0700 [0.0356] | (0.2625) | 0.5582* [0.1344] | (0.3233) |
| Observations | 45717 | | 15196 | |

Table continues on next page.

Table A4: Continued...

| | (1) Married Women | | (2) Married Men | |
|---|---|---|---|---|
| 2011 | 0.0579 | (0.0581) | 0.0874 | (0.1146) |
| 2012 | 0.1308* | (0.0679) | 0.1525 | (0.1259) |
| 2013 | 0.1716* | (0.0961) | -0.1069 | (0.1371) |
| 2014 | 0.0807 | (0.0984) | 0.0359 | (0.1459) |
| 2015 | 0.1345 | (0.1181) | 0.1398 | (0.1762) |
| 2016 | 0.0898 | (0.1284) | 0.1440 | (0.1797) |
| Advanced Degree | -0.2598*** | (0.0398) | -0.1698*** | (0.0658) |
| African American | -0.0043 | (0.2624) | -0.7227*** | (0.2713) |
| Other Race | -0.0406 | (0.1078) | -0.1655 | (0.2935) |
| Hispanic Origin | -0.2540*** | (0.0805) | -0.5570*** | (0.1989) |
| Spouse is < 50 Years Old | -0.1523 | (0.1183) | -0.2439* | (0.1359) |
| Spouse is 60 Years Old | 0.1821*** | (0.0671) | 0.2162* | (0.1262) |
| Spouse is 61 Years Old | 0.1251* | (0.0698) | 0.1040 | (0.1155) |
| Spouse is 62 Years Old | 0.1731*** | (0.0651) | 0.0617 | (0.1368) |
| Spouse is 63 Years Old | 0.0420 | (0.0772) | 0.0902 | (0.1014) |
| Spouse is 64 Years Old | 0.2059*** | (0.0698) | 0.1024 | (0.1379) |
| Spouse is 65 Years Old | 0.1748** | (0.0849) | 0.1548 | (0.1653) |
| Spouse is 66 Years Old | 0.0673 | (0.0879) | -0.2145 | (0.1397) |
| Spouse is 67 Years Old | 0.0314 | (0.1038) | 0.3537** | (0.1737) |
| Spouse is 68 Years Old | 0.0127 | (0.1026) | -0.0578 | (0.2386) |
| Spouse is 69 Years Old | -0.0072 | (0.1140) | -0.1490 | (0.2101) |
| Spouse is 70 Years Old | -0.0045 | (0.1131) | -0.4214 | (0.3320) |
| Spouse is > 70 Years Old | -0.1727* | (0.0916) | -0.0405 | (0.3274) |
| Spouse is a Teacher | -0.0066 | (0.0582) | 0.1789*** | (0.0671) |
| Spouse is Not in Labor Force | 0.6971*** | (0.0426) | 0.9316*** | (0.0622) |
| Spouse Has Advanced Degree | 0.1912*** | (0.0350) | 0.3041*** | (0.0768) |
| Spouse is African American | -0.2552 | (0.2429) | 0.4649* | (0.2692) |
| Spouse is Other Race | -0.2219* | (0.1194) | -0.0069 | (0.1479) |
| Spouse is Hispanic Origin | -0.0765 | (0.0983) | 0.0454 | (0.1648) |
| Eligible for Full Retirement | 0.3805*** | (0.0581) | 0.4909*** | (0.1245) |
| Funding Ratio | 0.1671 | (0.2533) | 0.1206 | (0.3951) |
| Percent of Required Contribution Paid | -0.0276 | (0.1154) | -0.1279 | (0.1510) |
| Unemployment Rate | 0.0396* | (0.0228) | 0.0878** | (0.0386) |
| Real Income Per Capita (In $1,000s) | 0.0037 | (0.0112) | 0.0160 | (0.0149) |
| Real GDP Per Capita (In $1,000s) | -0.0052 | (0.0050) | -0.0005 | (0.0061) |
| Observations | 45717 | | 15196 | |

Standard errors clustered at the state level in parentheses. Marginal effects in brackets.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Teacher retirement data are derived from the 2010-2016 American Community Surveys, see text for details. The dependent variable is the probability of retiring in the past year. The model includes all covariates as presented in Table 4, Column (3), plus additional spousal characteristics as indicated.