Health and Retirement: New Evidence from Public Sector Employees

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Abstract:

We study the importance of health in public sector workers' retirement timing using survey responses linked to panel data derived from administrative records. While workers are responsive to financial incentives to work until eligible for retirement benefit on average, we do not find strong evidence that own or spouse's health status mediates the relationship between financial incentives and working longer. However, concerns about health insurance access and health care costs in retirement do dampen workers' responsiveness to pension-related financial incentives. Our findings suggest that, beyond poor health status, concerns about financial risk from health shocks affect retirement timing directly.

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1. Introduction

In the United States and around the world, increases in longevity have created serious concerns about the sustainability of employer-provided defined benefit pension plans and public programs, such as Social Security and Medicare. The U.S. government has implemented policies aimed at encouraging workers to delay retirements and to ease the financial burden on Social Security.[1] Likewise, public sector employers have pursued reforms to increase early and normal retirement ages under their defined benefit pensions (Thom, 2017). Despite this push to incentivize working longer, many workers retire at relatively young ages. For example, among a sample of recent retirees in the public sector, about one-third claimed benefits under early (reduced) pension benefit eligibility (Clark, et al. 2015). Projecting retirement timing is key for designing public policies to best suit the needs of public sector workers and to ensure adequate resources to service pension obligations. It may be that workers choose to retire under early benefits due to poor own or spousal health, indicating that pension-related financial incentives are less effective at influencing retirement timing for this group. This paper considers the role of own and spousal health in mediating how workers respond to pension-related financial incentives to retire under two large public-sector defined benefit pension plans.

Further, in addition to changes in pension benefits that might encourage later retirements, many public sector employers are reducing or eliminating their retiree health insurance benefits to save costs. For example, North Carolina recently passed legislation removing retiree health

[1] The 1983 Amendments to the Social Security Act introduced a gradual increase in the age of eligibility for full benefits from 65 to 67 by 2027. Details can be found her http://www.ssa.gov/pressoffice/IncRetAge.html

insurance benefits for workers starting after January 1, 2021.[2] This paper illustrates the important interactive role of retiree health insurance access with pension-related financial incentives to retire.

To provide evidence on the role of health status and health insurance access on retirement timing, we leverage data from the North Carolina Retirement Transitions Study (NCRTS) covering public sector workers in the two largest public pension plans in North Carolina. The data consist of a short panel derived from detailed administrative records linked over time that allow a more precise projection of financial incentives and benefit eligibility. We combine these records with data from a survey conducted prior to the retirement decision. The survey contains data about respondents' families, including own and spousal health, family structure, household finances, and subject reports of preferences (i.e., reports of the importance of health insurance). We consider both the crossing of thresholds for pension eligibility as well as forward-looking option-value measures.

We model the effects of becoming eligible for early (reduced) and normal (full) pension benefits. Theoretically, it is ambiguous whether the effect of financial incentives on the decision to retire should be bigger or smaller for those in worse health; and the effect of crossing early and normal thresholds need not be the same. On the one hand, those in poor health may opt to retire as soon as eligible for early (reduced) benefits because physical limitations hinder continued work or their value of leisure is higher. On the other hand, when people are in poor health but still working, they may be doing so because they are resource constrained and may continue to work past pension eligibility. The health of one's spouse may also influence

[2] See the Wall Street Journal article "As Retiree Health-Care Bills Mount, Some States Have a Solution: Stop Paying," by Heather Gillers, published May 1, 2019. https://www.wsj.com/articles/as-retiree-health-care-bills-mount-some-states-have-a-solution-stop-paying-11556703001

retirement timing, although the direction of this effect is also ambiguous. If one needs to provide spousal care, that may lead to earlier retirement. Alternatively, if family finances are constrained or access to health insurance is important, then having a spouse in poor health may make one less likely to terminate employment. Finally, we consider the importance of health insurance access and concerns over medical expenses in retirement. Workers concerned about medical expenses, either because of insufficient access to health insurance in retirement or because of poor underlying health, may postpone retirement and may not respond to financial incentives to retire at certain ages.

We study the probability of continued work among active workers ages 50-65 as of April 2016. Work status is measured in December 2017, allowing for the measurement of retirement transitions over 19 months. Raw means show that pension benefit eligibility impacts the decision to work longer: 94 percent of those not yet eligible for a pension continued active employment, while only 60 percent of those newly eligible for full retirement benefits did so. Estimates from a logit model of retirement confirm the raw means: financial incentives do influence retirement timing. Surprisingly, however, self-reported health status does not generally predict retirement in our models; we find only weak evidence that own health, and no evidence that spouse's health, mediates the role of financial incentives in retirement timing on average. One limitation of this study is variation is necessarily cross-sectional. Our measure of health is self-reported prior to the retirement decision. If a worker anticipates retiring soon, she may be more likely to report poor health as a justification for her plans. However, this would bias results away from zero. Because all the workers in our data are covered by the same pension plan, there is no bias from selection into a plan with certain characteristics.

While we do not find health to be a major factor in predicting retirement timing in this

population on average, these results mask important heterogeneity by access to health insurance. We find that those who report that access to health insurance is an important factor in retirement timing, as well as individuals who are not confident that they will have sufficient savings to cover health care costs in retirement, are less responsive to pension-related financial incentives to retire. Among the population of workers who will not have access to retiree health benefits, those in good health are significantly more responsive to pension-related financial incentives than those in poor health. This suggests that retiree health insurance access interacts with pension incentives in determining how individuals determine when to retire.

While there are long literatures regarding both the causal effect of health on retirement and on the labor supply responses to financial incentives to work longer, relatively little work has focused on the interactions between health and financial incentives. The primary contribution of our paper is to illustrate the important interactive effects of health insurance access, own and spousal health status, and pension-related financial incentives to retire. By leveraging a panel of administrative data from two large public sector retirement systems merged with survey data conducted prior to the retirement decision, we can better model how health status and concerns over health care costs in retirement interact.

Section 2 provides a detailed review of prior work. Here, we highlight several additional contributions of this paper relative to the current literature. First, this study leverages data on health status prior to the retirement decision to address concerns over reverse causality. Second, it is difficult to correctly measure financial incentives and pension eligibility in survey data, so this study combines survey data with administrative records to obtain a more precise estimate of eligibility and financial incentives. We also explore how the calculation of financial incentives might be altered by health status itself. Third, spouse's health status may directly affect

retirement timing and may also be correlated with own health status. Our survey contains information about the workers' households, enabling a more complete analysis of the importance of spousal health and access to health insurance. Fourth, using responses to questions regarding health insurance access and concerns over medical expense risk exposure, we are able to directly model the individuals' perceived significance of retiree health insurance in the decision of when to retire.

A final contribution of this paper relative to the literature is the focus on public sector workers. Most previous studies analyze private sector employees, but those insights may not apply in the public sector. In the public sector, workers often reach full eligibility at relatively young ages. In addition, many public sector retirees have access to retiree health insurance from their employer, which is not common in the private sector (Clark and Morrill 2010). Because of the high cost of pension and retiree health insurance plans in the public sector, understanding the retirement behavior of public sector workers is of particular policy relevance.

2. Background and Literature

2.1 Health and Retirement Timing

Currie and Madrian (1999) and Lindeboom (2006) provide summaries of the work exploring the complex relationship between health and retirement. Three main issues arise in studying the causal effect of health on retirement. First, retirement likely affects health through a reduction in stress coupled with a less cognitive stimulation and social contact leading to concerns over reverse causality.[3] Second, "justification bias" may arise as individuals seek to

[3] For example, using variation in pension eligibility across countries, Muller and Shaikh (2018) show how own and spousal retirement affects health and health behaviors. Similarly, Insler (2014) uses predicted retirement at ages 62 and 65 as an instrument for retirement to determine the causal effect of retirement on health and health behaviors.

justify a desired retirement by interpreting their own health as poor.[4] Third, poor health might be the result of unobserved behavioral characteristics, such as a high personal discount rate, that could create a spurious correlation between earlier retirement and health. Lindeboom and Kerkhofs (2009) present a useful discussion of these issues and potential solutions.

The most common measure of health used in early studies is the subjective measure of self-assessed health (e.g., Bazzoli, 1985; Kerkhofs, et al., 1999; Quinn, 1977). An alternative approach is to analyze temporal changes to an underlying "health stock" to examine the impact of health on the retirement decision.[5] Most closely related to our study, Garcia-Gomez et al. (2017) uses administrative data from the Dutch healthcare sector to estimate how unanticipated hospitalizations affect retirement decisions. They leverage cross-sectional variation in individual pension-related financial incentives and find that pension eligibility reinforces the effects of health shocks.

In this paper, to account for the endogeneity of self-reported health status and retirement, we construct a measure of lagged health status using survey data prior to retirement. This measure is less likely to suffer from justification bias but may still reflect the intention to retire shortly. In that case, one might view our estimates as an upper bound that includes both the causal effect and any 'justification' effect. Because all the workers in our data are covered by the same pension plan, there is no bias from selection into a plan with certain characteristics.

[4] See McGarry (2004) for a discussion of justification bias.

[5] Using data from several waves of the HRS, Bound, et al. (1999) find that changes in health status predict retirement. They find that it is not poor health per se, but declines in health, that predict retirement. Similarly, adverse health shocks provide a plausibly exogenous source of variation in health status that can be used to identify the causal effects of health on retirement (e.g., Dwyer and Mitchell, 1999). Christensen and Kallestrup-Lamb (2012) show that following new medical claims, workers are more likely to enter disability or early retirement. To separate out the causal effect of disability on employment controlling for unobserved differences, Lindeboom, et al. (2016) leverage data on unscheduled hospitalizations. They find that much of the association between health and employment outcomes is causal, yet there is a substantive contribution to the association deriving from the selection of workers into jobs. Similarly, Disney, et al. (2006) compare several approaches to measuring health and health shocks and find health does predict retirement.

2.2 Financial Incentives, Retirement Timing, and Health Status

It has been well established that financial incentives embedded in pension plans are important determinants of the retirement timing decisions (e.g., Lumsdaine and Mitchell, 1999; Gruber and Wise, 2004). Similarly, Social Security influences retirement timing (e.g., Anderson et al., 1999; Coile and Gruber 2000, 2001, 2007; Samwick, 1998). Recent work illustrates that public sector workers respond to defined benefit plan pension incentives in retirement timing. Using several waves of data from the HRS, Papke (2019) leverages cross-state variation in public sector pension rules to show the impact of early and normal pension eligibility on retirement timing. Asch, et al. (2005) show that federal civil service workers respond to pension eligibility using forward-looking measures of pension wealth. Several recent papers study how changes in teacher pensions affect retirement timing. For example, Koedel and Xiang (2016) show that teachers do respond to changes in pension wealth, but not proportionately to the size of the incentive. Brown (2013) uses plausibly exogenous variation in pension wealth to show teacher retirement is responsive to financial incentives. Similarly, Morrill and Westall (2019) find that teachers' retirement timing is influenced by Social Security eligibility.

In contrast to this extensive literature on retirement timing and that of how health impacts retirement directly, less is known about how health status mediates the responsiveness to pension-related financial incentives.[6] French (2005) estimates a structural model and finds that health status does not moderate the relationship between financial incentives and labor force exit for individuals between ages 55 and 70. He concludes that this may be because general health status is fully captured by other measures of human capital (i.e., wages), and that health declines

[6] Bazzoli (1985) estimates a model of early retirement and finds a larger role for financial incentives than health status, but does not consider the interactions between health and financial incentives.

serious enough to reduce labor supply typically occur after age 70. In a study of how acute health shocks affect retirement across Europe, Trevisan and Zantomio (2016) find that social security systems may play an important role in mediating the labor supply response to a health shock.

2.3 Spousal Health Status

There are conflicting avenues through which spouses' health status might affect workers' retirement timing. Workers might work longer in order to ensure adequate income and/or access to higher quality employer-provided spousal health insurance. Similarly, when a spouse is in good health, workers may choose to retire jointly at younger ages in order to enjoy a period of joint leisure activity. On the other hand, a worker may choose to retire earlier to provide care for an ailing spouse or to spend time together at the end-of-life.[7] McGeary (2009) finds that a health shock to either member of a married couple raises the probability of labor force exit for both partners. Jeon and Pohl (2017) identify the effects of a spouse receiving a cancer diagnosis and find a strong decline in employment and earnings. Our study builds on this work by considering the responsiveness to financial incentives to retire and the key role for health insurance access. We find a large decline in active employment at key eligibility ages for those whose spouse is in poor health, but only among those whose spouse has access to health insurance that is independent of the respondents' public sector employer.

2.4 Health Insurance and Retirement Timing

Another aspect of retirement timing and health is access to health insurance and exposure to medical expense risk (see Shoven and Slavov, 2014). Several studies have estimated

[7] Using linked administrative records from the Dutch hospital system and tax register data, Garcia-Gomez, et al. (2013) find an important role for spillovers. They find the household earnings losses following a health shock are 50 percent more than the income drop of the person experiencing the health event.

structural models to understand how medical expenses and health insurance access affect retirement timing. For example, French and Jones (2011) find a prominent role for Medicare and for medical expense risk in retirement timing. On the other hand, Blau and Gilleskie (2006) and (2008) find a smaller role for health insurance in own and joint retirement decisions.

In early work on this topic, Gruber and Madrian (1995) show how access to COBRA benefits reduces job lock and allows for more retirements. Blau and Gilleskie (2001) use data from the Health and Retirement Study and find a large increase in the rate of exiting employment for those covered by employer-provided retiree health insurance. Similarly, using cross-sectional variation in retiree health insurance coverage for public sector workers in the HRS, Shoven and Slavov (2014) find an important role for access to retiree health insurance for retirements prior to Medicare eligibility. They find that transitions to part-time work and transitions out of the labor force entirely are facilitated by health insurance access. Bradley, et al. (2013) consider health insurance access within a household context using data on mid-career workers. They find that, following a breast cancer diagnosis, only women with access to health insurance through their spouse's employer reduce their own labor supply. In contrast, Levy, et al. (2018) do not find an impact of health insurance coverage available under the Affordable Care Act on retirement rates.

Fitzpatrick (2014) finds that retiree health insurance rollout allowed older teachers to retire earlier, highlighting the important interaction between pension-related financial incentives and health insurance access. Our findings are consistent with this work, suggesting that individuals concerned about health insurance access or medical expense costs are less responsive to pension-related financial incentives to retire at ages prior to Medicare eligibility.

3 Data and Methodology

3.1 North Carolina Public Sector Pensions

Teachers and state employees in North Carolina are covered by the Teachers' and State Employees' Retirement System (TSERS), while local government workers participate in the Local Governmental Employees' Retirement System (LGERS).[8] In order to qualify for normal or unreduced benefits, an employee must satisfy one of three criteria: reached age 65 with 5 years of membership service; reached age 60 with 25 years of service; or have completed 30 years of service at any age. Early retirement with reduced benefits is available to those who have reached age 50 and completed 20 years of creditable service and those who have reached age 60 and completed 5 years of service.[9]

The annual benefit is derived directly from the benefit formula specified by the retirement system:

$$\boldsymbol{B_{MAX} = Early * M * YOS * AFC}$$

B_{MAX} refers to the Maximum Benefit Option amount, which is a single life annuity for the retiree. *YOS* is the number of years of service at separation, and *AFC* is the average final compensation calculated using the highest four years of earnings. The pension multiplier, *M*, is 0.0182 for workers in TSERS and 0.0185 for workers in LGERS. *Early* is an early retirement reduction factor that is imposed for an individual claiming benefits prior to attaining the age and service

[8] The important characteristics of TSERS and LGERS are described in: https://www.nctreasurer.com/ret/Benefits%20Handbooks/TSERShandbook.pdf and https://www.nctreasurer.com/ret/Benefits%20Handbooks/LGERShandbook.pdf

[9] Workers qualify for unreduced benefits with either 30 years of service (any age), 25 years of service and ages 60+, or 5 years of service and age 65+. The early retirement benefit reduction factor is a function of both age at claiming and years of service. For most employees with at least 20 years of service between 50 and 59, the reduction factor decreases by 5 percent per year prior to 30 years of service and is not a function of age. For individuals age 53, however, there is a reduction of 3 percent between 21 years of service and 20 years of service. For persons aged 60 to 64 with fewer than 25 years of service, the reduction is 3 percent per year of age between age 60 and 65 and is not a function of years of service.

requirements for unreduced benefits. Benefits are adjusted for inflation on an ad-hoc basis, but there are no automatic cost of living adjustments (COLAs) built-in to the benefit formula. Individuals may earn retirement credit in both the TSERS and LGERS pension, either concurrently or sequentially. At retirement, these benefits may be consolidated under one retirement benefit by purchasing service from one system to the other.[10]

3.2 Administrative and Survey Data

The North Carolina Retirement Transition Study (NCRTS) data are derived from administrative records maintained by the North Carolina Retirement System Division.[11] We utilize two waves of administrative data: April 2016 and December 2017 to analyze the transition from active employment to potential termination or retirement. The sample is all active workers ages 50 to 64 as of April 2016 with five or more years of service as of April 2016. The sample is restricted to individuals in either the TSERS or LGERS retirement system (but not both).

We complement the administrative record data with an individual-level survey conducted in May and June 2016 prior to the decision to terminate employment (i.e., all survey respondents are actively employed at the time of the survey). The survey instrument includes a host of questions regarding household characteristics, health, finances, and retirement planning. The Data Appendix provides more detail on the sample construction and variable definitions. To measure health, we use responses to the survey question "How would you rate your health,

[10] An individual may not earn additional retirement benefits in a system where she is currently receiving a pension benefit. Individuals may work in one system while receiving benefits in the other system. Or, they may return to work in a non-covered (typically part-time) position. If a person returns to a covered position within the same pension system, the pension is suspended.

[11] These data are collected as a part of a larger project "Challenges to Retirement Readiness in the North Carolina Public Sector Workforce." Details about the project and data can be found here- https://sites.google.com/a/ncsu.edu/retirementstudy/

generally?"[12] Respondents could choose one from the following options: "excellent", "very good", "good", "fair" or "poor". We classify individuals as having poor health if they answered fair or poor.

Table 1 provides summary statistics of the sample.[13] Column (1) includes all survey respondents. Column (2) includes those reporting they are in poor health (poor or fair), while those in Column (3) reported either good, very good, or excellent health on the survey. We observe that while age and years of service are quite similar between the two groups, those who are healthier are more likely to be married and have higher salaries.

[Table 1]

3.3 Pension Eligibility

We construct variables denoting eligibility for early and normal retirement by using age and projected years of service. The projected years of service includes an additional amount of service that we impute out of sample from data on retirees actual additional service as a function of gender, years of service, age, salary level, and agency of employment cells. It is typical of most public sector workers to have additional service at retirement, including purchased service and unused sick leave. The average imputed additional service is 6 months, ranging from 2 months for individuals hired in their 50's and 9 months for those hired before age 30.[14]

Eligibility is measured at two points in time: April 2016 and December 2017. In the top portion of Table 1, we see that when measured in April 2016 about 51 percent of those actively

[12] Spousal's health is measured using responses to the question, "How would you rate the health of your spouse, generally?"

[13] Appendix Table A1 compares the characteristics of the sample with the full administrative records.

[14] Results are slightly attenuated but not qualitatively different when *not* including the projected additional service (available upon request). Note that we do not include health status in the imputation as we are only using information available in the administrative records. The imputation will not correct for the possibility that those in poor health exhaust their sick leave and therefore have less opportunity to convert unused sick leave to service credit at retirement.

working in April 2016 were already eligible to claim early (reduced) retirement benefits and 16 percent were already eligible to receive normal (unreduced) benefits. When comparing between those in poor and good health, we see that those in good health are about 4 percentage points more likely to be working past eligibility. Next, we consider both the eligibility status and work status as of the endpoint of our data, December 2017. These data are reported in the bottom half of Table 1 and in Figure 1. As of December 2017, 77.8 percent of our sample were still actively working with those in poor health being slightly less likely to be actively working at 75 percent versus 78 percent.

[Figure 1]

Next, we break the sample into 5 groups: not yet eligible; just newly eligible for early; eligible for early since prior to April 2016; just newly eligible for normal; and eligible for normal since prior to April 2016. Table 1 reports the fraction of the sample that falls into each group. Figure 1 presents the statistics on the percent actively working for each group with 95 percent confidence intervals indicated on each bar. Those in poor health are less likely to continue working than those in good health, except for the newly eligible for early group and the still eligible for normal retirement benefits group. The largest difference appears just as individuals cross to normal eligibility. This is somewhat surprising given that we anticipated retiring under early benefits might be due to poor health. As the confidence interval brackets indicate, none of these differences is statistically significant.

All individuals in the sample were actively working at the time of reporting health status. This implies that we are not able to observe individuals who were in poor health and already claimed benefits or exited employment prior to the survey. Further, many workers terminate employment prior to eligibility for benefits, known as deferred vested workers, and may claim

under reduced or unreduced benefits as they obtain key eligibility ages. The preliminary evidence shown here does not suggest a robust pattern of more or less responsiveness to financial incentives to work longer by own health status. We explore this further in a regression framework below.

3.3 Peak Value Pension Wealth

The reduced form eligibility measures only capture the effect of spikes in pension wealth accrual due to eligibility for reduced or unreduced benefits. To confirm the robustness of the findings, we model the financial incentives more directly by including a continuous measure of the difference in pension wealth when retiring in the current period relative to the highest potential level of pension wealth in present value terms.

We consider the standard measure of distance from the peak value of pension wealth as in Coile and Gruber (2000; 2001).[15] Consider an individual who is currently working in year *t*. Let Y_s be earnings in year *s* if the individual is still working and $B_s(r)$ be retirement benefits in year *s* if the individual retires in year *r*. Let *r** be the future year that maximizes the expected value of retiring. $\pi(s|t)$ denotes the probability of living to age *s* conditional on being alive at age *t*. The peak value incentive (or peak value difference) measures the difference in expected pension wealth if someone retires at a future optimal age versus retiring today (at age *t*), appropriately discounted.[16]

[15] One-year accrual measures (e.g., Burkhauser, 1979; Quinn, 1977) fail to capture the fact that, by working in the current year, the individual purchases an option to work in a future year with a higher accrual. Stock and Wise (1990) introduced an option value model; Coile and Gruber (2001) adapt this approach to model the financial gain (instead of utility gain) to estimate the impact of potential Social Security wealth on retirement timing. Coile and Gruber (2007) illustrate how this method can be used to estimate the impact of Social Security wealth on retirement timing.

[16] We derive gender-specific survival probabilities, or $\pi(s|t)$ in equation (1) from the retirement plan's experience studies. We assume a discount rate of 7.25 percent, which is the discount rate that the retirement system uses in adjusting the price of the annuity options and in other calculations. The model includes assumed salary growth of 2 percent annually. Salary income is not included in the present value except through the growth in pension wealth. The present value at each age of retirement is calculated by multiplying the annual benefit by the gender-specific

$$(1) \qquad PV_t(r^*) = \sum_{s=r}^{S} \beta^{s-t} \pi(s|t)\, E_t\big(B_s(r^*)\big) - \sum_{s=t}^{S} \beta^{s-t} \pi(s|t)\, E_t\big(B_s(t)\big)$$

Individuals who are eligible to claim benefits can terminate employment and claim benefits immediately or continue to work until a future optimal age where the present discounted value of pension wealth is the highest, or peak value. If individuals continue to work, the peak value coincides with eligibility for unreduced benefits (normal eligibility). If they continue to work beyond normal eligibility, their annual pension benefit will rise but they will forego years of receiving a pension and, thus the present value of total benefits will decline. Thus, for individuals who are eligible to claim benefits we calculate the financial incentive to continue working as the difference between the present value of continuing to work and claiming at normal eligibility and the present value pension wealth from terminating and claiming at time *t*. For those who are eligible for normal retirement benefits at or before time *t*, peak value is simply the accrual from working another year, or difference in the present value (discounted to time *t*) of pension wealth from working an additional year and the present value of pension wealth from terminating and claiming at time *t*.[17] Appendix B provides an example for a hypothetical worker.

Table 2 presents the average peak value differences for our data. The first row is the average for the full sample, while the subsequent rows present averages for the samples by eligibility status. The group of individuals who are not yet eligible to claim a benefit face a

survival probability at each age discounted to present value terms using a 7.25 discount rate. Because there are no automatic COLA's, we do not directly model inflation but rather assume that the annual benefit amount remains constant and that any COLA's will match inflation.

[17] Because our sample includes only those ages 50 and older, all individuals who were not eligible to claim benefits by December 2017 had fewer than 20 years of service. We assume that if an individual decides to terminate employment at time period *t*, she will claim benefits when she first become eligible. Thus, the financial incentive to continue working is the difference (discounted to time *t*) between the present discounted value of pension wealth from continuing to work and claiming at normal eligibility and the present discounted value of pension wealth at age 60 (when first eligible).

similarly sized incentive to continue working as those who are only eligible for early benefits. This means that the pension-related financial incentive to retire when crossing the early eligibility threshold is small, while the value for those crossing to normal eligibility is large. Those eligible for normal benefits face a "negative incentive" meaning that the pension incentive should cause them to be less likely to continue working.

[Table 2]

In Table 1, we saw that the sample of individuals in poor versus good health were similar along demographic characteristics. Thus, it is not surprising that the peak value differences are quite similar between these two groups. These calculations use gender and age-specific life expectancy and a standard personal discount rate of 7.25%. If poor health is correlated with lower predicted life expectancy or higher personal discount rates, then the actual financial incentive faced by the individual may be smaller than that imposed by the standard peak value calculation assumptions. We return to this in Section 4.2 below.

4. Results

4.1 Baseline Results

To understand whether poor health alters individuals' responsiveness to financial incentives, we estimate a simplified form of a hazard model. Estimates are average marginal effects from a logit model where the dependent variable is being observed actively working as of December 2017. Recall the sample consists of individuals who were actively working as of April 2016 and ages 52-64 with at least 5 years of service. We model whether these individuals continue actively working versus terminating employment. Note that exit from employment could be to directly claiming a benefit (early or normal), entering disability, terminating

employment and deferring claiming to a later date, or suspending employment with the intention to return to employment at a future date.

The regression model takes the following form:

(2) $$\Pr(Active_i = 1) = \beta_0 + \beta_1 * Elig\_Early_i + \beta_2 * Elig\_Normal_i + \beta_3 * PastNormalElig_i + \gamma_1 * Poor\_Health_i + \gamma_2 * Spouse\_Poor\_Health_i * Married_i + \gamma_3 Married_i + \gamma_4 * Female_i + \sum_{\{a=53:64\}} \delta_a * Age_{ai} + X_i\Gamma$$

The dependent variable is a binary indicator for continued active employment as of December 2017. This is regressed on three indicator variables: *Elig_Early* represents eligibility for early (i.e., reduced) retirement benefits only, while *Elig_Normal* represents eligibility for full (i.e., unreduced) retirement benefits. Because individuals may work past eligibility for normal benefits, we include a third term: being eligible for normal benefits since prior to April 2016 is indicated by *PastNormalElig*. This allows us to distinguish between crossing the threshold for normal retirement versus individuals who have demonstrated a strong attachment to the workforce and are likely to continue working. We include controls for being in poor health and for one's spouse (if married) being in poor health, in addition to gender and marital status. The time-scale in the model is age dummies, with age 52 being the reference category. The model also includes demographics measured at the beginning of the period including: years of service, salary, race/ethnicity indicators, number of children (1-2 children; 3+ children; no response to question; reference category is no children), and whether the individual holds a bachelor's degree. Finally, we include indicators for being in the TSERS system separately for whether the agency of employment is a public school system or a state government agency.

Table 3 presents the main estimates of the probability of continued work. Column (1) presents the estimates from Equation (2) for the full sample, while Columns (2) and (3) presents

estimates for those in poor health and those in good health, respectively. A fully interacted model is presented in Table 4, described below. The estimates in Table 3, Column (1) show that being eligible for early retirement is associated with a 10.4 percentage point lower probability of continued work relative to not being eligible for benefits. In Table 1, we saw that only 77.8 percent of the sample continued working. So, the point estimate implies a roughly 13 percent lower probability of continued work. As expected, we see a large decline in the probability of continued work for those eligible for normal retirement at 32.4 percentage points (approximately 42% of the sample mean). An indicator for working past normal eligibility is not significantly related to continued work. Thus, in the pooled data, we confirm that financial incentives do impact retirement timing, on average.

[Table 3]

Surprisingly, in Table 3, we do not observe any statistically significant direct effect of own or spouse's health on the probability of continued work. We also do not observe a significant relationship between working longer and marital status, gender, tenure, education, number of children, or salary. Age is measured in April 2016, and workers make their termination decisions over the course of the following 18 months. Terminations are more likely to occur at ages 60-62, conditional on eligibility for benefits, which roughly corresponds to individuals being first eligible for Social Security benefits. We do not see a statistically significant difference in the probability of continued work for individuals who are ages 63 and 64, many of whom will obtain Medicare eligibility age by December 2017. We return to the role of health insurance below.

Table 3, Columns (2) and (3) present estimates for the group of individuals in poor health versus good health, respectively. We observe no statistically significant relationship between

pension eligibility and continued work for those in poor health, except that those who reported being in poor health while actively working past normal eligibility are less likely to terminate employment.[18] Those who are in good health, shown in Column (3) have the anticipated signed coefficients. Early retirement benefit eligibility leads to a 12 percentage point drop in the probability of continued employment, while normal eligibility leads to a 34 percentage point drop. Interestingly, comparing the estimated coefficients on age between those in poor health and good health, workers in poor health between age 60-62 (and even 59 year olds in poor health) are much more likely to stop working, as well as those age 64. This indicates that non-pension related financial incentives, such as Social Security or Medicare, may be a more important factor for those in poor health. It also gives us more confidence that Type II error cannot fully explain our findings.

Next, Table 4, Column (1) presents our preferred specification. This model includes interaction terms between the financial incentives and self-reported health status and improves efficiency by only interacting health status with the pension eligibility indicators. Here we observe that becoming eligible for normal retirement does significantly predict termination for those in poor health with a point estimate of -0.247. Normal eligibility for those in good health is associated with a higher 33.1 percentage point lower rate of continued employment. However, as shown at the bottom of the table under Post Estimation results, when comparing these two point estimates, they are not statistically significantly different from each other. For early retirement, those in poor health do not have a significantly different probability of continued work relative to those not yet eligible, but the difference between those in poor health and good health is itself not statistically significant. Those who were already eligible for normal

[18] Our sample of individuals who are actively employed but in poor health is only 212 individuals, so the estimates in Column (2) may suffer from Type II error.

retirement benefits in April 2016 and actively working while reporting being in poor health are more likely to continue working. The difference in working past normal eligibility between those in good and poor health is statistically significant.

Taken together, the results in Column (1) of Table 4 suggests that although those in good health may be slightly more responsive to financial incentives, the differences are small and not statistically significant. We find no evidence that those in poor health are more likely to be retiring under early retirement. Moreover, the results fail to show that health status plays a significant role in mediating the relationship between financial incentives and working longer.

[Table 4]

Next, we consider three other ways of viewing own health. First, In Table 4, Column (2), we proxy for health status by using responses to a question on life expectancy: *Until what age do you expect to live?*[19] We classify individuals as having low life expectancy if they choose categories less than 75, 75-79, not sure, or do not respond to the question. Other categories are 80-84, 85-89, and 90 or older.[20] The estimates suggest no difference in responsiveness to financial incentives based on projected lifespan. This is somewhat surprising but may reflect two countervailing issues. Those with lower life expectancy have less to gain from postponing pension claiming, so may be more likely to respond to early eligibility. But, those in poor health might be less responsive to pension-related financial incentives perhaps due to financial need or access to health insurance.

Table 4, Columns (3) and (4), ask more directly about projected health costs rather than health status. First, survey respondents were asked which factors are important in their decision

[19] For a discussion of the validity of subjective survival probabilities, see Hurd and McGarry (1995) and (2002).

[20] Note that results are very similar classifying 80-84 as low (not shown).

about when to retire. Those selecting "Need for health insurance provided to active workers" and/or "Access to retiree health insurance" in response to this question are classified as viewing health insurance as important. Those not selecting either option are coded as feeling that 'health insurance is not important.' Here, we see large and statistically significant differences in the responsiveness to financial incentives to retire. For those who feel health insurance is important, pension eligibility is significantly less important relative to their peers who do not feel health insurance access is important.

Similarly, we asked survey respondents whether they expect to have enough money to take care of any medical expenses during retirement. Those classified as "Agree" selected "Agree" from the list while all others are classified as "Not Agree." In Table 4, Column (4), those who indicated some concern over health expenses are significantly less responsive to the financial incentives to retire relative to those who report they will have enough money to take care of medical expenses. These results that it is not poor health per se, but rather health insurance and exposure to medical expense risk that mediates relationship between pension-related financial incentives and retirement.

4.2 Forward Looking Measures

To more formally capture the financial incentives for continued employment, we next turn to the peak value difference measures described above. In the models, the peak value is scaled to tens of thousands of dollars. We estimate the following regression model:

$$(3)\ \Pr(Active_i = 1) = \beta_0 + \beta_1 * PeakDiff_i + \gamma_1 * Poor\_Health + \gamma_2 * Spouse\_Poor\_Health_i * Married_i + \gamma_3 Married_i + \gamma_4 * Female_i + \sum_{\{a=53:64\}} \delta_a * Age_{ai} + X_i\Gamma$$

The specification is identical to Equation (2) except that we replace the eligibility indicators with

the peak difference measure.

Table 5 presents these estimates. Column (1) includes the peak value for all workers. Column (2) separates this value by eligibility status. We see that for each additional $10,000 in potential pension wealth, an individual is 1 percentage points more likely to continue working (roughly 1.3 percent of the sample mean). Thus, we again find strong evidence that individuals do respond to the financial incentive to continue working, on average. When separating out by eligibility status in Column (2), we see that the financial incentive does matter for those eligible for early retirement where those who are calculated to have a larger financial incentive to continue working are significantly more likely to continue working. The point estimates are quite similar between those eligible for early benefits and those not yet eligible, suggesting that the effect of an additional ten thousand dollars of potential pension wealth is similar whether eligible for retirement benefits or not. As we saw above, the financial incentive operates in the opposite direction for those working past normal retirement eligibility. These individuals have both larger financial penalties in terms of pension wealth for continued work and demonstrate stronger persistence in the labor market.

[Table 5]

Our estimated peak value may be smaller than we might find using alternative assumptions, so that our responsiveness measure could be understated. For example, the peak value incentive only includes the pension incentive and does not incorporate additional Social Security wealth from continued employment. We also assume a discount rate that is relatively high compared with other studies. Still, our results are of the same order of magnitude as prior studies using these forward-looking measures. Coile and Gruber (2000) include both Social Security and pension wealth and find that a $10,000 increase in peak value difference lowers

retirement by 5 percent of the sample average retirement rate. Asch et al. (2005) examine the impact of financial incentives on retirement behavior of federal civil service workers. Their results suggest that a $10,000 increase in peak value decreases the retirement rate by about 4 percent of the mean.

Columns (3) and (4) of Table 5 disaggregate the results by health status. As above, we find no evidence that those in poor health respond to the financial incentive to continue working. To test equality more formally, Column (5) presents estimates where the peak value difference measure is interacted with health status. Here we again see that the peak value measure is only statistically significant for those in good health. However, as reported at the bottom of the table, the difference between the estimated coefficient on peak value between those in poor health and good health is not statistically significant. Using this alternative measure of pension-related financial incentives, we again find only suggestive evidence that those in good health are more responsive to pension-related financial incentives to retire.

Due to discounting, longevity, or potentially lower salary growth, a person in poor health likely has a lower present value of the pension incentive than the average population value used in the peak value regression analysis. Similarly, the pension eligibility thresholds represent smaller "jumps" in present value pension wealth for those in poor health. Thus, an additional reason we predict that those who are in poor health may be less responsive is that the true dollar value incentive itself is smaller.[21] However, the results in Table 5 still fail to find an important mediating role for health status in the responsiveness to pension-related financial incentives to

[21] Since poor health is likely to affect how individuals value future income flows, the choice of discount rate might be an important factor in the current analysis. Many prior studies, both structural estimations and reduced form analyses, have used discount rates in the range of 2 to 3 percent. Here, we have used the North Carolina Retirement Systems Division's preferred discount rate of 7.25 percent, which is what is used in the actuarial valuation of pension funding. This choice might lead to a lower present value of benefits and a smaller estimate of the peak value incentive. It might also explain why our results are somewhat lower than those found in prior studies. Appendix B discusses this point in more detail and provides estimates of peak values under different assumptions.

retire.

4.3 Spouse's Health Status

Table 6 reports estimates interacting financial incentives with spouse's, rather than own, health status. Column (1) presents estimates on the full sample, while Columns (2) and (3) report female and male samples, respectively. The differences between the responsiveness to early and normal retirement eligibility by spousal health status are small and not statistically significant. Estimates are similar when looking separately by gender. Women are more responsive to early retirement eligibility than men, but the difference by spouse's health status is small. For men, there is some evidence that those whose spouse is in good health are more responsive to normal retirement eligibility, but the difference is not statistically significant. We fail to find evidence that spouses' health mediates the relationship between financial incentives and working longer.

[Table 6]

5. Health Insurance and Retirement

The results presented in Table 4 suggest that expected health costs and health insurance access did temper responsiveness to pension-related financial incentives to retire at specific ages. Here, we explore that more formally. The survey asks whether the respondent expects to qualify for retiree health benefits, not including Medicare, from several sources. Those who respond "No, I do not expect to qualify for retiree health benefits", "I don't know whether I will qualify for retiree health benefits", or do not respond to the question are classified as not having own retiree health insurance (RHI). The proportion of individuals not having access to RHI is similar by health status. Approximately 7.5 percent of individuals have no RHI among both groups--those in good health and those in poor health. The first column of Table 7 presents results for this

group. For those without health insurance in retirement, health status does mediate the responsiveness to pension-related financial incentives. Those in good health are statistically significantly more likely to terminate employment relative to those in poor health once eligible for normal retirement benefits. Although the pattern is similar for early retirement, that difference is not statistically significant. Interestingly, we see that women in this group are more likely to continue working relative to men, suggesting a net effect of access to retiree health insurance for women but not men. Table 7, Column (2) estimates a parallel specification for the group of workers that does have access to retiree health benefits. Those in good health are still more responsive to financial incentives, but the difference in small and not statistically significant.

[Table 7]

Given that access to health insurance matters for individuals, we next revisit the results for spousal health status disaggregating by whether the spouse has health insurance. Again, this sample is restricted only to married individuals. First, we consider those individuals who report their spouse is covered by "Employer-provided health insurance from my current employer" or "Retiree health insurance from my current employer." Table 8, Column (1) presents results for this group. Here we see a large role for spouse's health status. The effect is only statistically significantly different at eligibility for early benefits. If the spouse is in good health, the worker is more responsive to the pension eligibility thresholds relative to those workers whose spouse is in poor health. This suggests that access to health insurance for active workers is an important mediator. Workers concerned about health insurance access or health costs find the pension-related financial incentives are less important in determining retirement timing.

[Table 8]

On the other hand, the majority of married workers' spouses are covered by health insurance not through the respondents' current employer. Here the spouse might be covered by own employer-provided active or retiree health insurance, Medicaid, or "Other health insurance." The spouse might be relying on the worker for earnings or for caregiving, but not for health insurance. The estimates suggest a striking pattern. For this group, those whose spouse is in poor health and are not eligible for benefits are 206 percentage points more likely to continue working, while an equally sized negative effect occurs at early and (slightly larger) at normal eligibility. Among this group, workers whose spouse is in poor health are waiting until pension eligibility and then exiting employment. The financial incentive to continue working is important, but the desire to exit employment also appears important. Workers whose spouse is in good health are more likely to exit employment at normal retirement eligibility, but not at early retirement eligibility. The differences in retirement patterns here are prominent and statistically significant. This indicates that, conditional on the spouse having an independent source of health insurance, spouse's health *does* mediate the responsiveness to financial incentives with those whose spouse is in poor health being much more responsive.

The third group of married workers did not report any health insurance coverage for their spouse (N = 210). Because of the question wording, it is likely that many of these individuals do have some health insurance but simply skipped that questionnaire item. Thus, it is difficult to interpret the findings for this group. In Table 8, Column (3), the findings are opposite to that above. Prior to eligibility, having a spouse in poor health is associated with a 252 percentage point lower probability of continued work. There is no change at early or normal eligibility for those whose spouse is in poor health. There is a 223 and 225 percentage point drop at early and normal eligibility, respectively, for those whose spouse is in good health.

6. Discussion and Conclusion

This study highlights the important interactive effects of health status and health insurance when modeling how health impacts retirement timing. Prior work, mostly conducted in the private sector, finds that poor health and health shocks do precipitate retirement. This study asks whether in a public sector pension plan, poor health can explain patterns of claiming early (reduced) retirement benefits. We find that, on average, workers are responsive to the pension-related financial incentives to retire at certain age and years of service combinations. However, we fail to find robust evidence that poor health mediates the responsiveness of pension-related financial incentives to retire, on average. Rather, we find that concern over health care costs in retirement is the primary mediating factor. Those who are concerned over how to pay for medical expenses in retirement are less responsive to the pension-related financial incentives to retire.

When looking at health insurance access in retirement, those who are covered by retiree health insurance do time retirement around pension-eligibility thresholds, while those not covered do not respond to these incentives. Similarly, while there is no mediating role for spouse's health, on average, this masks important heterogeneity by whether the spouse is covered by the worker's employer-provided health insurance. Workers whose spouse is covered by their employer-provided health insurance are more likely to discontinue working when eligible for early retirement if their spouse is in good health but not bad health. At the same time, those whose spouse has their own health insurance are significantly more likely to terminate employment when first eligible for retirement benefits. This suggests an important financial consideration for those covering their spouse and a potential caregiving role for those

whose spouse has other health insurance. This heterogeneity is masked when looking on average.

Public sector workers comprise about 14 percent of the workforce nationwide, yet less is known about the retirement patterns of these workers compared to those in the private sector.[22] The population of public sector workers nearing retirement is younger and healthier than typical older workers, and pension benefits compromise a large portion of public workers' retirement wealth. In contrast with work in other sectors, our findings suggest that, in the public sector, health status does not play as central a role in the timing of retirement on average. However, the findings also suggest a large role for access to health insurance in retirement. For the portion of our sample covered by retiree health insurance, pension-related financial incentives do predict retirement timing, while those not covered by retiree health insurance are not responsive. Retiree health insurance may be a more important factor for public sector workers who typically are eligible for pension benefits at ages younger than the Medicare eligibility age of 65. These findings suggest that changes to retiree health insurance plans, or changes in the eligibility age of Medicare, will dampen the potential of pension-related financial incentives to influence the timing of workers' retirements at key pension eligibility ages.

While we fail to find a mediating role for own or spousal health status on average, the results indicate an important role for health insurance and health care costs in retirement. Individuals concerned about health insurance access and/or health care costs are less likely to be responsive to the pension-related financial incentives to retire. In North Carolina, all teachers and state employees hired prior to January 1, 2021 and covered under TSERS who have accumulated sufficient years of service are covered by retiree health insurance through the State

[22] See: https://www.bls.gov/emp/tables/employment-by-major-industry-sector.htm, [accessed July 2019].

Health Plan (SHP). Many local government employers are also a part of SHP, but most do not extend that coverage into retirement. While many local government employees have access to some form of retiree health benefits, the eligibility rules vary. Workers hired after January 1, 2021 will no longer have access to retiree health insurance through the SHP (Bonner 2017). While this change may also affect hiring and the composition of the workforce, it will be many years until the implications for retirement timing are felt. Our results suggest that workers will be less responsive to pension-related financial incentives to retire at given age and years of service combinations when not covered by retiree health insurance.

Public sector employers nationwide are grappling with large unfunded liabilities from retiree health insurance obligations (Clark and Morrill 2010). The North Carolina State Treasurers' Office estimated that State retiree health benefits costs $892 million per year, according to recent coverage in the local newspaper (Bonner 2017). In response, many public employers, including North Carolina's State Health Plan, are discontinuing coverage for newly hired workers. This study suggests that the ways in which retiree health insurance coverage affect workers' behavior may not be fully appreciated in the arguments against continuing these benefits. We find that the incentives embedded in the primary DB pension plan for individuals to retire at key years of service and age combinations are not as effective at inducing retirements among those without health insurance access. This is consistent with the findings in Fitzpatrick (2014), which shows that the introduction of retiree health insurance increased workers' responsiveness to pension incentives. As public sector employers dismantle these plans, workers may choose to continue working until they (and/or their spouse) are eligible for Medicare. This may be beneficial to financial sustainability of retirement plans, but may undermine the intended retirement income security benefits provided by the pension design.

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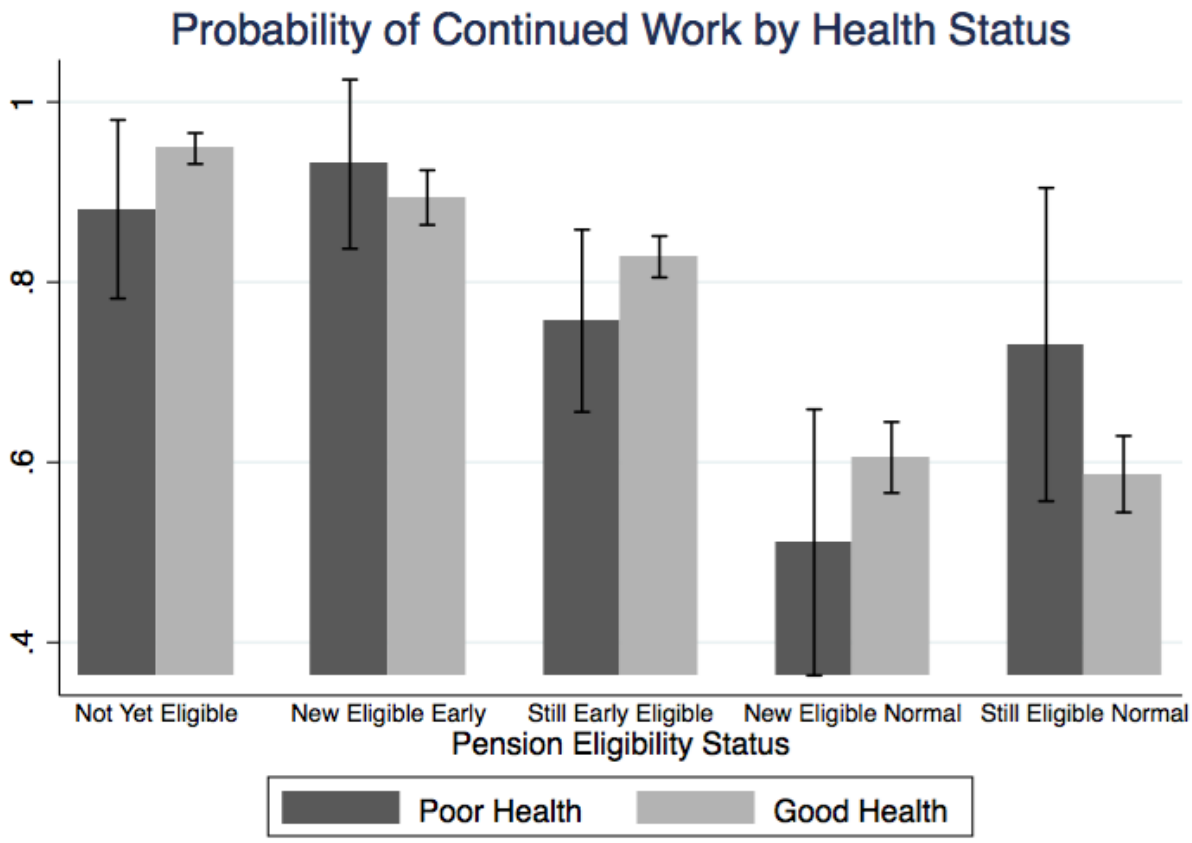
Figure 1: Probability of Continued Employment by Pension Eligibility



Notes: Data are derived from the NCRTS sample of active workers in April 2016 ages 50 to 65. Eligibility for pension benefits is determined from administrative records, as described in the text. Early eligibility corresponds to being eligible for reduced benefits, while normal eligibility means eligible for full and unreduced benefits. See Appendix for more information.

Table 1: Summary Statistics

	(1) Full	(2) Poor Health	(3) Good Health
Observations	3,394	212	3,182
Measured April 2016			
Poor Health	0.062	1.000	0.000
Poor Spouse Health x Married	0.090	0.292	0.076
Married	0.702	0.590	0.709
Female	0.727	0.708	0.728
Age	57.603	57.632	57.601
Years of Service	18.992	18.590	19.019
1-2 Kids	0.611	0.580	0.613
3+ Kids	0.209	0.165	0.212
Black	0.151	0.137	0.152
Hispanic	0.018	0.033	0.017
Other Race	0.037	0.066	0.035
College Degree	0.647	0.557	0.653
Public School Employee	0.347	0.363	0.346
State Gov't Employee	0.418	0.401	0.419
Salary (10K)	5.830	5.178	5.873
Already eligible early	0.514	0.542	0.512
Already eligible normal	0.160	0.123	0.163
Measured December 2017			
Actively Working	0.778	0.750	0.780
Not Eligible	0.201	0.198	0.201
Newly Eligible Early	0.125	0.137	0.124
Still Eligible Early	0.326	0.330	0.326
Newly Eligible Normal	0.188	0.212	0.186
Still Eligible Normal	0.160	0.123	0.163

Notes: Data are derived from the NCRTS sample of active workers in April 2016 ages 50 to 65. Eligibility for pension benefits is determined from administrative records, as described in the text. Early eligibility corresponds to being eligible for reduced benefits, while normal eligibility means eligible for full and unreduced benefits. See Appendix for more information.

Table 2: Summary Statistics of Peak Value Differences

	Full Sample	Poor Health	Good Health
	(1)	(2)	(3)
Full Sample N	3,394	212	3,182
Average Peak Difference	$28,002	$30,466	$27,838
Panel A: Not Eligible N	681	42	639
Average Peak Difference	$50,837	$47,972	$51,025
Panel B: Eligible Early N	1,531	99	1,432
Average Peak Difference	$48,192	$50,696	$48,019
Panel C: Eligible Normal N	1,182	71	1,111
Average Peak Difference	-$11,305	-$8,097	-$11,510

Notes: Data are derived from the NCRTS sample of active workers in April 2016 ages 50 to 65. Present value calculation assumptions are described in Appendix B. Panel A uses the system's 7.25% discount rate, while Panel B applies a lower 3% discount rate.

Table 3: Probability of Continued Work by Pension Eligibility Rules and Own Health

	(1) Full		(2) Poor Health		(3) Good Health	
Eligible Early	-0.104**	(0.030)	0.083	(0.117)	-0.118**	(0.032)
Eligible Normal	-0.324**	(0.037)	-0.037	(0.159)	-0.340**	(0.038)
Elig Past Norm	0.037	(0.023)	0.234*	(0.116)	0.026	(0.024)
Poor Health	-0.027	(0.028)				
Poor Sp Hlth x Married	-0.013	(0.023)	0.043	(0.075)	-0.021	(0.025)
Married	-0.016	(0.016)	-0.089	(0.080)	-0.014	(0.016)
Female	-0.005	(0.016)	-0.083	(0.069)	-0.003	(0.016)
Age 53	0.042	(0.039)	-0.100	(0.200)	0.059	(0.040)
Age 54	0.047	(0.040)	-0.174	(0.197)	0.069+	(0.041)
Age 55	0.021	(0.038)	-0.052	(0.183)	0.029	(0.039)
Age 56	-0.003	(0.037)	-0.201	(0.188)	0.017	(0.038)
Age 57	0.010	(0.038)	-0.269	(0.208)	0.028	(0.039)
Age 58	0.049	(0.038)	-0.194	(0.205)	0.065+	(0.039)
Age 59	-0.014	(0.037)	-0.343+	(0.198)	0.006	(0.038)
Age 60	-0.107**	(0.037)	-0.353+	(0.206)	-0.087*	(0.038)
Age 61	-0.111**	(0.038)	-0.399+	(0.208)	-0.088*	(0.039)
Age 62	-0.132**	(0.039)	-0.554**	(0.194)	-0.104**	(0.040)
Age 63	0.014	(0.045)	-0.336	(0.243)	0.039	(0.046)
Age 64	-0.016	(0.042)	-0.489*	(0.231)	0.010	(0.043)
Years of Service	-0.001	(0.002)	-0.009	(0.007)	-0.001	(0.002)
Black	0.069**	(0.021)	0.017	(0.083)	0.069**	(0.022)
Hispanic	-0.082+	(0.047)	-0.031	(0.155)	-0.087+	(0.049)
College Degree	0.002	(0.016)	-0.053	(0.064)	0.007	(0.017)
1-2 Kids	0.004	(0.019)	0.039	(0.072)	0.002	(0.020)
3+ Kids	0.016	(0.023)	0.095	(0.102)	0.012	(0.024)
Public School Employee	-0.095**	(0.019)	-0.074	(0.077)	-0.098**	(0.019)
State Gov't Employee	-0.021	(0.018)	-0.083	(0.081)	-0.018	(0.019)
Salary (10K)	0.002	(0.003)	-0.005	(0.017)	0.001	(0.004)
Observations	3394		212		3182	
Mean of Dep Var	0.778		0.750		0.780	

Notes: Data are from the NCRTS active workers in April 2016 ages 50-64. The dependent variable is actively working as of December 2017. Estimates are average marginal effects from a logit model estimation with robust standard errors in parentheses. Covariates are measured as of April 2016. The specification includes indicators for missing response to number of children and other race. ** p<0.01, *p<0.05, $^{+}$ p<0.1

Table 4: Alternative Measures of Health

Self-Reported Health Status (1)		**Self-Assessed Life Expectancy (2)**		**Health Insurance Importance (3)**		**Expect to Have Enough Money to Cover Health Costs in Retirement (4)**	
Early x Poor	-0.019	Early x Low	-0.112**	Early x Important	-0.090**	Early x Not Agree	-0.079*
	(0.081)		(0.033)		(0.031)		(0.031)
Early x Good	-0.112**	Early x High	-0.100**	Early x Not Important	-0.132**	Early x Agree	-0.133**
	(0.032)		(0.031)		(0.034)		(0.033)
Normal x Poor	-0.247**	Normal x Low	-0.331**	Normal x Important	-0.298**	Normal x Not Agree	-0.280**
	(0.088)		(0.041)		(0.038)		(0.038)
Normal x Good	-0.331**	Normal x High	-0.322**	Norm x Not Important	-0.366**	Normal x Agree	-0.374**
	(0.038)		(0.038)		(0.039)		(0.038)
Past Norm x Poor	0.173*	Past Normal x Low	0.049	Past Normal x	0.018	Pass Norm x Not Agree	0.017
	(0.083)		(0.035)	Important	(0.027)		(0.028)
Past Norm x Good	0.029	Past Normal x High	0.031	Past Normal x Not	0.062+	Past Normal x Agree	0.063*
	(0.024)		(0.027)	Important	(0.033)		(0.031)
Poor Health	-0.130+	Poor Health	-0.026	Poor Health	-0.028	Poor Health	-0.034
	(0.076)		(0.028)		(0.028)		(0.028)
Poor Sp Hlth Married	-0.014	Poor Sp Hlth Married	-0.013	Poor Sp Hlth Married	-0.012	Poor Sp Hlth Married	-0.020
	(0.023)		(0.023)		(0.023)		(0.023)
Married	-0.015	Married	-0.016	Married	-0.017	Married	-0.009
	(0.016)		(0.016)		(0.016)		(0.016)
Female	-0.006	Female	-0.005	Female	-0.007	Female	-0.006
	(0.016)		(0.016)		(0.016)		(0.016)
Post Estimation, P-value of Difference:							
Poor Health = Good Health		Low = High LE		Important = Not Important		Have Money = Not Have Money	
Eligible Early:	0.277	Eligible Early:	0.590	Eligible Early:	**0.052**$^{+}$	Eligible Early:	**0.011***
Eligible Normal:	0.354	Eligible Normal:	0.747	Eligible Normal:	**0.006****	Eligible Normal:	**0.000****
Past Normal:	**0.087**$^{+}$	Past Normal:	0.634	Past Normal:	0.250	Past Normal:	0.205

Notes: Data are from the NCRTS active workers in April 2016 ages 50-64. The dependent variable is actively working as of December 2017. Estimates are average marginal effects from a logit model estimation with robust standard errors in parentheses. The specifications include all covariates listed in Table 3. ** p<0.01, *p<0.05, $^{+}$ p<0.1

Table 5: Forward-looking measures of distance to peak value pension wealth (7.25%)

	(1) Peak Diff.	(2) Peak Diff.	(3) Poor Health	(4) Good Health	(5) Interactions
Peak Value Incentive	0.010**		0.001	0.011**	
	(0.004)		(0.010)	(0.004)	
Peak x Not Yet Eligible		0.019*			
		(0.009)			
Peak x Eligible Early		0.019**			
		(0.006)			
Peak x Eligible Normal		-0.039			
		(0.024)			
Peak x Past Normal		-0.000			
		(0.023)			
Peak x Poor Health					0.006
					(0.008)
Peak x Good Health					0.011**
					(0.004)
Poor Health	-0.028	-0.026			-0.020
	(0.028)	(0.028)			(0.031)
Married*Poor spouse health	-0.018	-0.017	0.036	-0.025	-0.018
	(0.023)	(0.023)	(0.076)	(0.025)	(0.023)
Married	-0.018	-0.019	-0.094	-0.015	-0.018
	(0.016)	(0.016)	(0.080)	(0.017)	(0.016)
Female	-0.012	-0.009	-0.079	-0.011	-0.012
	(0.017)	(0.016)	(0.072)	(0.017)	(0.017)
Observations	3394	3394	212	3182	3394
Mean of Dep Var	0.778	0.778	0.750	0.780	0.778
Post Estimation					
P-value: Peak x Poor Health = Peak x Good Health					0.561
Observations	3394	3394	212	3182	3394

Notes: Peak value differences are specified in ten thousands of dollars. The dependent variable is actively working as of December 2017. Estimates are average marginal effects from a logit model estimation with robust standard errors in parentheses. The specifications include all covariates listed in Table 3. ** p<0.01, *p<0.05, $^{+}$ p<0.1

Table 6: Responsiveness by Spouse's Health Status among Married Workers

	(1) Full	(2) Female	(3) Male
Elig Early x Poor Spouse Health	-0.093	-0.121	0.027
	(0.100)	(0.122)	(0.181)
Elig Early x Good Spouse Health	-0.121**	-0.158**	-0.034
	(0.038)	(0.048)	(0.065)
Elig Normal x Poor Spouse Health	-0.317**	-0.322*	-0.259
	(0.105)	(0.128)	(0.190)
Elig Normal x Good Spouse Health	-0.344**	-0.361**	-0.288**
	(0.045)	(0.059)	(0.071)
Past Normal x Poor Spouse Health	0.095	0.049	0.209+
	(0.062)	(0.073)	(0.117)
Past Normal x Good Spouse Health	0.032	0.020	0.061
	(0.029)	(0.035)	(0.049)
Poor Health	-0.030	-0.016	-0.073
	(0.038)	(0.049)	(0.061)
Poor Spouse Health	-0.054	-0.068	-0.056
	(0.098)	(0.119)	(0.175)
Observations	2382	1630	752
Mean of Dep Var	0.771	0.764	0.787
Post Estimation: P-value difference Spouse Poor Health = Spouse Good Health			
Eligible Early:	0.792	0.766	0.746
Eligible Normal:	0.797	0.759	0.876
Past Normal Eligibility:	0.320	0.697	0.214

Notes: Data are from the NCRTS active workers in April 2016 ages 50-64. The dependent variable is actively working as of December 2017. Estimates are average marginal effects from a logit model estimation with robust standard errors in parentheses. The specifications include all covariates listed in Table 3. ** $p<0.01$, *$p<0.05$, $^{+}$ $p<0.1$

Table 7: Retiree Health Insurance

	No RHI	Has RHI
	(1)	(2)
Eligible Early x Poor Health	0.006	-0.039
	(0.129)	(0.103)
Eligible Early x Good Health	-0.119+	-0.115**
	(0.061)	(0.038)
Eligible Normal x Poor Health	0.012	-0.331**
	(0.152)	(0.113)
Eligible Normal x Good Health	-0.240**	-0.349**
	(0.083)	(0.044)
Past Normal x Poor Health	-0.106	0.270*
	(0.141)	(0.109)
Past Normal x Good Health	0.011	0.033
	(0.059)	(0.026)
Poor Health	-0.151	-0.108
	(0.116)	(0.097)
Poor Sp Health x Married	-0.007	-0.021
	(0.050)	(0.026)
Married	0.019	-0.024
	(0.036)	(0.018)
Female	0.071*	-0.024
	(0.034)	(0.018)
Observations	656	2738
Mean of Dep Var	0.803	0.772
Post Estimation: P-value difference		
Poor Health = Good Health		
Elig Early:	0.355	0.480
Elig Norm:	0.093	0.877
Past Norm:	0.412	0.031

Notes: Data are from the NCRTS active workers in April 2016 ages 50-64. The dependent variable is actively working as of December 2017. Estimates are average marginal effects from a logit model estimation with robust standard errors in parentheses. The specifications include all covariates in Table 3. ** p<0.01, *p<0.05, $^{+}$ p<0.1

Table 8: Spouse's Health Insurance among Married Workers

	(1) Sp on My EHI	(2) Sp has Own HI	(3) Sp has no HI
Elig Early x Poor Sp Health	0.126	-2.159**	0.116
	(0.138)	(0.106)	(0.149)
Elig Early x Good Sp Health	-0.185**	-0.070	-2.228**
	(0.060)	(0.049)	(0.382)
Elig Norm x Poor Sp Health	-0.266*	-2.389**	0.220
	(0.135)	(0.111)	(0.180)
Elig Norm x Good Sp Health	-0.395**	-0.314**	-2.252**
	(0.071)	(0.060)	(0.415)
Past Norm x Poor Sp Health	0.110	0.138	.
	(0.089)	(0.086)	
Past Norm x Good Sp Health	-0.030	0.060	0.107
	(0.044)	(0.039)	(0.110)
Poor Health	-0.004	-0.015	-0.168
	(0.062)	(0.051)	(0.104)
Poor spouse health	-0.194	2.061**	-2.517**
	(0.118)	(0.104)	(0.392)
Female	-0.029	-0.034	0.129*
	(0.030)	(0.024)	(0.060)
Observations	807	1361	210
Mean of Dep Var	0.804	0.759	0.738
Post Estimation: P-value difference Spouse Poor Health = Spouse Good Health			
Elig Early:	0.030	0.000	0.000
Elig Norm:	0.344	0.000	0.000
Past Norm:	0.142	0.368	.

Notes: Data are from the NCRTS active workers in April 2016 ages 50-64. The dependent variable is actively working as of December 2017. Estimates are average marginal effects from a logit model estimation with robust standard errors in parentheses. The specifications include all covariates in Table 3. ** p<0.01, *p<0.05, $^{+}$ p<0.1

Appendix A: Data Appendix

The data used in this paper were gathered as part of a larger project, "Challenges to Retirement Readiness in the North Carolina Public Sector Workforce," funded by the Sloan Foundation Grant Numbers 2013-10-20 and G-2016-7054. For more information about the full project, please see the website: http://go.ncsu.edu/publicsectorretirement. PI's on this project are Robert Clark, Robert Hammond, and Melinda Morrill.

For this paper, the sample is restricted to active workers who were between ages 50 and 64 as of April 2016 and who were members of TSERS or LGERS, but not both. In addition, we exclude individuals who were hired prior to age 22 and who had less than 5 years of service in April 2016. To create our final analysis sample, we merge the administrative records with responses to a survey of active employees fielded in April 2016. Table A1 presents summary statistics for the full administrative records and the analysis sample. The sample has a higher proportion of females and state government employees as compared with the full administrative records. The average years of service in the administrative records is lower--16.7 years as compared with 18.9 in the sample. This difference reflects in the proportion of individuals eligible for early and normal retirement between the two groups. While approximately 45 percent of all active employees are eligible for early retirement as of April 2016, 51 percent of the employees in our sample are eligible for early retirement. Similarly, 10 percent and 16 percent individuals are eligible for normal retirement in the full administrative records and the analysis sample respectively.

A.1 Administrative data variables

Years of service

Membership service should approximate the actual tenure of the employee minus transferred and withdrawn service. However, to be eligible for retirement benefits, individuals may also have purchased non-contributory (e.g., sick leave and vacation time) service. These latter types of service are included in our calculation of eligibility for retirement benefits. Because most non-contributory service is only reported upon retirement, we imputed purchased non-contributory service by age at hire, gender, salary and agency of employment categories. The average imputed

purchased service is 6 months, ranging from 2 months for individuals hired in their 50's and 9 months for those hired before age 30.

Early Eligible

Age 50 and 20 years of service as of December 2017 **OR**

Age 60 and 5 years of service as of December 2017

Normal Eligible

Age 65 and 5 years of service as of December 2017 **OR**

Age 60 and 25 years of service as of December 2017 **OR**

Any age and 30 years of service as of December 2017

Survey variables

The full survey instrument is available here:
https://sites.google.com/site/publicsectorretirement/files/Survey3-Actives.pdf

Key questionnaire items are presented here in the order they appear in the survey.

Health Insurance Importance:
Q: Which of the following are important factors in your decision about when to retire? (Check all that apply.)
Those selecting o Need for health insurance provided to active workers o Access to retiree health insurance

Expect to Have Enough Money to Cover Health Costs in Retirement:
Q: Please indicate whether you agree or disagree with each of the following statements.
(Disagree; Neither Agree nor Disagree; Agree; Not Applicable/Don't know)
I expect to have enough money to take care of any medical expenses during my retirement.

Self-Reported Health Status:
Q: How would you rate your health, generally? o Excellent o Very Good o Good o Fair o Poor

Spouse's Health Status:
Q: [If spouse/partner]How would you rate the health of your spouse/partner, generally?
o Excellent o Very Good o Good o Fair o Poor

Life Expectancy:
Q: Until what age do you expect to live? o Less than 75 o 75 to 79 o 80 to 84 o 85 to 89 o 90 or older o Not sure
Low: Missing; 75-79: less than 75: and not sure
High: 80-84; 85-89; 90+

Spouse Health Insurance

Q: Please indicate whether your spouse/partner is currently covered by any of these types of insurance: o Yes o No o Not sure

Spouse Own Health Insurance: Employer-provided health insurance from my spouse/partner's current employer; Retiree health insurance from my spouse/partner's previous employer; Retiree health insurance from my previous employer; Medicaid; Other health insurance
(*Note that previous employer is classified as "own" since it does not depend on respondent's current work status)*

Spouse On My Health Insurance: Employer-provided health insurance from my current employer; Retiree health insurance from my current employer; Spouse has no Health Insurance: None of these are selected

Own Retiree Health Insurance (RHI):

Q: Do you expect to qualify for any retiree health benefits not including Medicare? o Yes, I expect to qualify for retiree health benefits through my current employer. o Yes, I expect to qualify for retiree health benefits through my spouse/partner's employer. o Yes, I expect to qualify for retiree health benefits through a previous employer. o Yes, I expect to qualify for retiree health benefits through other means. o No, I do not expect to qualify for retiree health benefits. o I don't know whether I will qualify for retiree health benefits.
No Own RHI: No, don't know, or missing

Table A1. Summary statistics: full administrative records and analysis sample (Table 1)

	(1) Full Administrative Sample	(2) Analysis Sample
Measured April 2016:		
Age as of April 2016	57.223	57.603
Years of Service	16.714	18.992
Female	0.668	0.727
Public School Employee	0.426	0.347
State Gov't Employee	0.344	0.418
Salary (10K)	4.905	5.830
Already eligible early	0.445	0.514
Already eligible normal	0.101	0.160
Measured December 2017		
Actively Working	0.809	0.778
Not Eligible	0.302	0.201
Newly Eligible Early	0.151	0.125
Still Eligible Early	0.299	0.326
Newly Eligible Normal	0.147	0.188
Still Eligible Normal	0.101	0.160
Observations	89029	3394

Appendix Table A2. Probability of Continued Work for Administrative vs. Survey Samples (Table 3)

	(1) Full Admin	(2) Survey Sample
Eligible Early	-0.044**	-0.101**
	(0.005)	(0.031)
Eligible Normal	-0.202**	-0.322**
	(0.007)	(0.037)
Past Eligible Normal	0.006	0.032
	(0.006)	(0.026)
Age 53	-0.009	0.042
	(0.007)	(0.039)
Age 54	-0.007	0.049
	(0.007)	(0.039)
Age 55	-0.010	0.022
	(0.007)	(0.038)
Age 56	-0.011	-0.003
	(0.007)	(0.038)
Age 57	-0.017*	0.012
	(0.007)	(0.039)
Age 58	-0.010	0.049
	(0.007)	(0.038)
Age 59	-0.075**	-0.016
	(0.007)	(0.037)
Age 60	-0.102**	-0.107**
	(0.007)	(0.037)
Age 61	-0.164**	-0.114**
	(0.007)	(0.038)
Age 62	-0.147**	-0.133**
	(0.008)	(0.039)
Age 63	-0.038**	0.009
	(0.009)	(0.045)
Age 64	-0.107**	-0.021
	(0.009)	(0.043)
Female	-0.001	0.002
	(0.003)	(0.016)
Years of Service	-0.000	-0.004
	(0.001)	(0.005)
Public School Employee	-0.068**	-0.100**
	(0.010)	(0.018)
State Gov't Employee	-0.024**	-0.022
	(0.003)	(0.018)
Salary (10K)	0.005**	0.001
	(0.001)	(0.003)
Observations	89029	3394

Appendix B: Peak Value Calculations

Here, we illustrate the present values and distance to peak value measures for a hypothetical worker. The values are calculated assuming the worker was hired at age 38, which is the mean and median age at hire for our sample. We assume the worker is a member of the TSERS retirement plan, had a starting salary of $35,000, and experienced an earnings growth rate of 2%. This exercise uses female survival probabilities derived from the plans' experience studies and a discount rate of 7.25%. The bolded rows are the "peak difference" value of the pension benefit when discounted the corresponding potential termination age, which is the measure that will be used in the regression analysis below. Appendix Table B1 presents the values from our simulation of pension benefits for this hypothetical worker.

At each possible termination age, the hypothetical worker compares the present value of pension at the termination age and the peak value, or when present value of pension wealth discounted to the termination age is highest. For our context, the peak value calculations would differ by eligibility status of the worker. We model the decision-making of this hypothetical individual at three stages: (A) not yet eligible for benefits (age 55); (B) eligible for early retirement (age 58); and (C) working past eligibility for normal benefits (age 68).

Panel A illustrates the calculation for individuals who are not yet eligible for benefits. These individuals face the option to continue working or to terminate employment and then collect benefits. We assume that the individual will collect benefits as soon as eligible. If the hypothetical worker continues working until eligible for normal benefits, she would first become eligible for full benefits when she reaches 25 years of service at age 63. We measure the present value of that pension wealth at age 63 to be $281,463 using the assumptions from above. Then, this value is discounted back to the time of decision-making at age 55, yielding a peak value of

$154,628 in pension wealth at age 55. On the other hand, if she stops working at age 55 with 17 years of service, she will first be eligible for a reduced benefit at age 60. The present value of that pension at age 60 is $145,608. This value is $108,932 in present value discounted to age 55. The difference taken at age 55 is $46,435. This is the value that would be used in the regression analysis to represent the distance from the optimal level of pension wealth. If the individual stops working in that year, she is foregoing the potential of an additional $46,435 in present value terms.

Panel B illustrates the calculation for an individual who is eligible for a reduced benefit. If she continues to work, she can receive that full retirement benefit at age 63 that is $192,777 in present value at age 58. If she stops working at age 58, when first eligible for reduced benefits, she can immediately claim a benefit that is worth $164,962 in present value terms at age 58. At the time of decision-making, the present value difference is $27,815 in lifetime pension wealth discounted back to age 58. This is a smaller incentive than that faced by the same worker when she was age 55.

Panel C illustrates the calculation for an individual who is past eligibility for normal benefits. Here, an individual is foregoing collecting the pension while continuing to accrue benefits. If she stops working at age 68, she can start immediately collecting her pension benefit now valuated at $338,433 in present value terms. If she continues working one more year, her present value pension wealth discounted to age 68 drops to $321,092. Thus, the peak difference is negative: $-17,341. This implies that for every additional year of work, the individual is losing pension wealth in present value terms. An individual may continue to work past eligibility for full benefits either to collect additional salary income, to ensure access to active worker health insurance, or because the individual receives a non-pecuniary benefit to working.

However, that individual is facing a financial incentive of lost pension wealth to discontinue working and begin collecting the pension benefit.[23]

To give a sense of the potential size of the present value difference between health and unhealthy individuals, we consider the changes in present value of pension wealth under alternate discount rate and life expectancy assumptions. Appendix Table B2 presents results from this simulation exercise. The first row replicates Panel B of Appendix Table B1. Here the hypothetical worker is eligible to claim reduced (early) benefits. Recall that the peak value incentive measure was $27,815 for this individual. Now, we see how this financial incentive value might change by altering some key assumptions. First, we consider a higher discount rate. This might be a spurious correlation or reverse causality whereby an individual with a high discount rate fails to invest in health. We recalculate the net present value (NPV) for our hypothetical worker using a 10% discount rate. The new incentive is only $6,437 which is 23% of the baseline value. Thus, we would expect that those with higher discount rates are substantially less likely to wait until eligible for full retirement benefits

Similarly, we consider the impact of a slightly lower life expectancy. To illustrate this, we calculate the peak value using the male (instead of female) experienced life expectancy rates. We find that the incentive is now $22,885, or 82% relative to the baseline. This is a dramatic decrease from only a slightly worse life expectancy. When we combine the two assumptions, lower life expectancy and higher personal discount rate, we observe that the peak value incentive is only $3,758 in present value lifetime wealth at age 58. This value is only 14% of the baseline peak value calculation.

[23] Current pension rules preclude an individual receiving a benefit from one retirement system and then returning to covered employment in that same system. In that case, the benefit would be immediately discontinued and the individual would not be present in our dataset. Individuals may retire from one system and begin a new employment spell in the other system or may return to work part-time in a non-covered position.

Appendix Table B1: Example Calculations for Peak Value

PANEL A: Not yet eligible to claim a benefit

Definition: PV work until normal eligibility – PV terminate at time *t* and claim when first eligible

Work Longer?	**PV Normal Eligibility**	**PV First Eligible**	**Peak Difference**
Terminate: Age 55 with 17 YOS	Work until 25 YOS and claim full benefit at 63 PV at 55 $154,628	Claim with 17 YOS at earliest eligibility age 60 PV at 55 $108,193	**Measured at age 55: $46,435**

PANEL B: Eligible for reduced benefit only

Definition: PV work until normal eligibility – PV terminate and claim at time *t*

Work Longer?	**PV Normal Eligibility**	**PV Early Eligibility**	**Peak Difference**
Terminate: Age 58 with 20 YOS	Work until 25 YOS and claim full benefit at 63 PV at 58 $192,777	Claim with 20 YOS at current age 58: PV at 58 $164,962	**Measured at age 58: $27,815**

PANEL C: Eligible for unreduced benefit

Definition: PV work one more year – PV terminate and claim at time *t*

Work Longer?	**PV retire time t**	**PV retire time t+1**	**Peak Difference**
Terminate: Age 68 with 30 YOS	PV at 68: $338,433	Work until and claim at 69 PV at 68: $321,092	**Measured at age 68: $-17,341**

Notes: The values are calculated assuming the worker was hired at age 38, is a member of the TSERS retirement plan, starting salary of $35,000, and earnings growth rate of 2%. We use gender-specific survival probabilities derived from the plans' experience studies (female) and a discount rate of 7.25%. The bolded rows are the "peak value" of the pension benefit when discounted to age the corresponding termination age.

Appendix Table B2: Hypothetical Worker Calculations with Alternative Modeling Assumptions

Baseline Method:	
Female survival rates; 7.25% discount rate	
NPV 58: $164,962	Peak Value Incentive: $27,815
NPV 63: $138,356	
Female survival rates; 3% discount rate	
NPV 58: $257,353	Incentive: $94,062
NPV 63: $351,415	Relative to baseline: 338% higher
Female survival rates; 10% discount rate	
NPV 58: $131,919	Incentive: $6,437
NPV 63: $138,356	Relative to baseline: 23%
Male survival rates; 7.25% discount rate	
NPV 58: $158,760	Incentive: $22,885
NPV 63: $181645	Relative to baseline: 82%
Male survival rates; 10% discount rate	
NPV 58: $128,422	Incentive: $3,758
NPV 63: $132,180	Relative to baseline: 14%