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Abstract

This paper presents new evidence on the effects of retirement benefits on labor force participation decisions. The analysis is based on a mandated rule for employer-provided retirement benefits in Austria that creates discontinuities in the incentives for workers to delay retirement. We present graphical evidence on labor supply responses and effective financial incentives and develop nonparametric methods to estimate extensive margin labor supply elasticities. Overall, multiple results highlight modest impacts of financial incentives on retirement decisions.

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1 Introduction

Labor supply of older workers has moved to the center of public attention as expenditures from government sponsored social security programs have become an increasing financial burden in many countries. A central task for economic models and policy design relates to understanding how financial incentives from social security benefits affect individuals' retirement decisions. In this paper, we address the following question: how much are individuals willing to delay their retirement in response to anticipated increases in retirement benefits?

Our framework is based on a nationally mandated rule for employer-provided retirement benefits in Austria and exploits variation created by discontinuities in the intertemporal choice set of individuals. The nationally mandated rule is simple and salient: workers receive a lump-sum cash benefit (i.e. a severance payment) from their employer at entry into retirement. The amount of the severance pay depends on tenure at retirement in a step-wise function. Individuals are first eligible upon completing a tenure of 10 years, and further increases in benefits occur at thresholds of 15, 20, and 25 years of tenure. The key policy incentive is for workers to delay retirement to collect larger severance payments.

A graphical investigation of retirement responses to the severance pay system provides clear evidence that the incentives work as expected. Plots of the distribution of retirement entries by tenure show spikes in the retirement frequencies exactly at each tenure threshold and dips in retirement frequencies just before the thresholds.

The recent literature on labor supply elasticities has emphasized the importance of frictions that can attenuate observed labor supply responses to financial incentives (Chetty et al. 2011, Kleven and Waseem 2013). Therefore we also investigate the exact financial incentives from the severance payments. Using data on actual severance payments we find that some employers top up legislated severance payments with voluntary side-payments. These side-payments reduce the average financial incentives at the tenure thresholds, and in some cases, they smooth out the legislated discontinuities. Based on the severance pay data, we are able to identify a sample of individuals who appear to face financial incentives to delay their retirements.

By relating delays in retirement to the financial incentives we then formulate a reduced form extensive margin labor supply elasticity. We estimate the numerator of the elasticity, capturing changes in retirement probabilities at the tenure thresholds, using bunching techniques (Saez 2010, Chetty et al. 2011). The denominator of the elasticity, capturing the change in income at the tenure threshold, is also estimated from the discontinuity in severance payments. Based on these procedures we estimate an average elasticity of 0.6. This result highlights the importance of taking actual financial incentives into account, as elasticity estimates based on the legislated severance pay schedule would be three times smaller.

The relatively low estimated participation elasticities are confirmed by additional pieces of evidence indicating limited responses to the financial incentives from the severance payments. First, we show that individuals do not time their job starts to qualify for (larger) severance payments when retiring at the popular Early Retirement Age. Second, based on dips in retirement frequencies before the tenure thresholds we estimate that most individuals are not willing to delay their retirements by more than 1.5 years even in the face of severance pay increases as large as 25% of their annual salaries.

Our analysis contributes to the literature addressing the relationship between retirement and pension benefits.[1] This literature in general finds small responses to financial incentives, but convincing causal evidence is rare due to various selection and endogeneity problems. At older ages around retirement, workers are typically covered by multiple social insurance programs that either become effective at retirement or are available from certain ages, such as public and private pension systems, changes in health insurance, as well as more generous unemployment insurance or disability provisions. The interaction of incentives from different systems makes labor supply decisions of older workers very complex. In addition, they are a challenge for empirical research, because it is difficult to isolate the incentive effects of a specific policy tool.[2]

The empirical design of this paper has several advantages that largely overcome these difficulties. First, we exploit multiple discontinuities in employer-provided retirement benefits, which are largely independent from the rules of the public pension system. The multiple discontinuities provide transparent, credible identification of causal effects. Second, the private sector in Austria is universally covered by a mandatory, government provided pension and health insurance system, which also applies to retirees. Thus, the empirical analysis is not confounded by individuals becoming eligible for other social insurance programs at retirement or older ages. Third, the pension replacement rate in Austria is rather generous and there are virtually no transitions to employment after entry into retirement. Fourth,

[1] See Gruber and Wise (2004), Asch, Haider and Zissimopolous (2005), Coile and Gruber (2007), Coile and Gruber (2007), Liebman, Luttmer, Seif (2009), Mastrobuoni (2009), and Brown (2013).

[2] Alternative approaches use structural models to capture detailed incentives from social security and other insurance systems, e.g. Gustman and Steinmeier (1985), Rust and Phelan (1997), and French (2005).

we have access to rich register data from the pension and tax administration, which covers the entire labor market and earnings histories of the universe of workers retiring from the private sector.

Further, our paper relates to the literature on labor supply and contributes estimates of extensive margin intertemporal labor supply elasticities. Empirically, estimation of such extensive margin intertemporal elasticities has proven difficult because of a lack of credible research designs or limited data (Chetty et al. 2012). From the theoretical perspective, Attanasio (2012) argues that, in general, it is not realistic to have a single labor supply parameter to capture structural features of extensive margin elasticities, because of heterogeneity, time variation, and state dependence. We clarify that our the estimated labor supply elasticity is a reduced-form elasticity and does not correspond to a structural parameter in a specific theoretical framework. The estimated elasticities from this study are particularly valuable given the wide variety of populations retiring and the high degree of precision and credibility stemming from administrative, population-level data with minimal measurement error and a quasi-experimental research design with large changes in financial incentives across multiple tenure thresholds.

Our analysis further contributes to the literature on bunching estimation strategies, as we highlight the importance of estimating financial incentives along with the behavioral responses. Earlier bunching papers have formulated estimators of structural parameters exclusively based on the amount of excess mass at a notch or kink point in the budget set.[3] However, all these studies also find evidence of individuals making choices that appear suboptimal if they respond primarily to the legislated financial incentives. While the previous literature resorts to arbitrary concepts of frictions to explain these behaviors, we can go one step further and investigate evidence on financial incentives in the data.[4]

This paper is organized as follows. Section 2 discusses both the institutional background regarding the Austrian pension system and the administrative data from social security and income tax records. Section 3 presents nonparametric graphical analyses of retirement frequencies and severance payments by years of tenure at retirement. Section 4 defines

[3]For examples in the income tax literature, see Saez (2010), Kleven and Waseem (2013), Ramnath (2013), Almunia and Lopez-Rodriguez (2012), Marx (2012), and Seim (2012), and for an example in the retirement literature, see Brown (2013).

[4]It could also be important to condition on exact or effective financial incentives rather than just legislated financial incentives in contexts involving interactions between multiple benefit programs. For example, individuals could lose benefits from a notch in one program, but become eligible for benefits from another program. See Blundell and Hoynes (2004) for a discussion of interactions between multiple benefit programs.

the labor supply elasticity of interest, develops the estimation strategy, and presents the estimation results. Section 5 discusses the estimated elasticities and estimation techniques in the context of the related literatures and section 6 concludes.

2 Institutional Background & Data

2.1 Retirement Benefits in Austria

There are two forms of government-mandated retirement benefits in Austria: (1) government-provided pension benefits and (2) employer-provided severance payments. We start with the description of severance payments since these payments are the primary focus of the current study. The employer-provided severance payments are made to private sector employees who have accumulated sufficient years of tenure by the time of their retirement. Tenure is defined as uninterrupted employment time with a given employer and retirement is based on claiming a government-provided pension. The payments must be made within 4 weeks of claiming a pension according to the following schedule. If an employee has accumulated at least 10 years of tenure with her employer by the time of retirement, the employer must pay one third of the worker's last year's salary. This fraction increases from one third to one half, three quarters and one at 15, 20 and 25 years of tenure respectively. This schedule for the severance payments is illustrated in Figure 1. Given the fractions of annual salary specified in the severance pay schedule, the amounts of the severance payments are significant, but they are small relative to lifetime wealth. The payments are made in lump-sum and, since payments are based on an employee's salary, overtime compensation and other non-salary payments are not included when determining the amounts of the payments. Provisions to make these payments come from funds that employers are mandated to hold based on the total number of employees. Severance payments are also made to individuals who are involuntarily separated (i.e. laid off) from their firms if the individuals have accumulated sufficient years of tenure prior to the separation. The only voluntary separation that leads to a severance payment, however, is retirement. Employment protection rules hinder firms from strategically laying off workers to avoid severance payments and there is no evidence on an increased frequency of layoffs before the severance pay thresholds.[5] In general, older workers approaching retirement age enjoy the highest

[5]For more details regarding the severance payments at times of unemployment, see Card, Chetty and Weber (2007).

level of job protection in Austria.[6]

The Austrian income tax system, which is based on individual taxation, applies particular rules to tax income from severance payments. Specifically, mandated severance payments are exempt from social security contributions and subject to a tax rate of 6%. Income taxation of severance payments differs from the general income tax rules. Generally, gross monthly earnings net of social security contributions[7] are subject to the income tax with marginal tax rates in different tax brackets of 0%, 21%, 31% 41% and 50%.[8] [9]

Because the timing of the severance payments relates to pension claiming, eligibility for government-provided retirement pensions interacts with the severance payment system. Austria has a public pension system that automatically enrolls every person employed in the private sector. Fixed pension contributions are withheld from each individual's wage and annuitized benefits during retirement are then based on prior contributions (earnings histories). Replacement rates from the annual payments are roughly 75% of pre-retirement earnings and there are no actuarial adjustments for delaying retirement to a later age.

Individuals can retire by claiming Disability pensions, Early Retirement pensions and Old Age pensions. Eligibility for each of these pensions depends on an individual's age and gender, as well as having a sufficient number of contribution years. Beginning at age 55, private sector male and female employees can retire by claiming Disability pensions, where disability is based on reduced working capacity of 50% relative to someone of a similar educational background. At age 55, women also become eligible to claim Early Retirement pensions, but the Early Retirement Age is age 60 for men. Lastly, men and women become eligible for Old Age pensions at age 65 and 60 respectively.[10]

Figure 2 illustrates survival functions for exits from the labor force for the sample of private sector employees. The series are presented separately for men and women given the different eligibility ages. The survival functions show sharp declines at ages 55 and 60 highlighting a significant amount of entry into the pension system once individuals become eligible for the Early Retirement pensions. Additionally, the figure shows that, for both

[6]For more details on job protections for older workers, see Schnalzenberger and Winter-Ebmer (2009).

[7]Contributions for pension, health, unemployment, and accident insurance of 39% are split in half between employer and employee and the employee's share is withheld from gross annual earnings up to a contribution cap.

[8]These tax brackets are based on legislation in 2002.

[9]Additionally, Austrian employees are typically paid 13th and 14th monthly wage payments. These payments, up to an amount of one sixth of annual wage income, are also subject to a 6% tax rate.

[10]Benefits from disability and early retirement are entirely withdrawn if an individual earns more than about 300 Euros per month; therefore we see very few individuals returning to the labor force once they are retired.

men and women, most retirements occur between ages 55 and 60. Further, the graph shows that roughly 25% of the male sample retire by claiming disability pensions prior to age 60.

The early withdrawal of workers from the labor market in Austria can be largely explained by the generous public pension system. Pension replacement rates in Austria are high relative to those in the United States and other OECD countries (see Whitehouse and Queisser, 2007 for a comparison). Appendix Table 1 shows that gross and net replacement rates for the median earner in Austria are roughly 80% and 90% respectively.[11] The corresponding replacement rates in the United States are roughly 44% and 55% respectively; averaging across OECD countries, the gross and net replacement rates for median earners are roughly 61% and 72%. Given the generosity of the public pension system in Austria, private, voluntary pensions play a smaller role in Austria than in the United States and other OECD countries.

While pension rules were mostly stable beforehand, there have been multiple pension reforms in Austria in the last three decades. Reforms in the 1980s and 1990s generally aimed at reducing pension generosity and providing incentives for later retirement, and more recent reforms in the 2000s increased the Early Retirement Ages for men and women (Manoli Mullen and Wagner (2011), Manoli and Weber (2012)). Since these reforms create variation that is orthogonal to variation in tenure at age 54, we do not focus on the details of these reforms for our analysis. Additionally, in 2003, the severance payment system was reformed so that the tenure-based schedule was replaced with employer contributions to individual pension accounts equal to a fixed fraction of the annual salary. Since the new system was grandfathered in and only applied to new jobs starting in 2003 and later, this reform is not relevant for our empirical analysis.

2.2 Data on Retirements

Our empirical analysis is based on administrative registers from the Austrian Social Security Database (ASSD, see Zweimüller et al 2009), which is collected with the principle aim of verifying individual pension claims. The data provide longitudinal information for the universe of private sector workers in Austria throughout their working lives. Specifically, information on employment and earnings as well as other labor market states relevant for computing insurance years such as military service, unemployment, and maternity leave is collected. Detailed electronic records with employer identifiers are recorded in the period

[11] For the Web Appendix see `http://weber.vwl.uni-mannheim.de/fileadmin/user_upload/weber/sevpay_appendix.pdf`.

from 1972 onwards. For the years prior to 1972 retrospective information on insurance relevant states is available for all individuals who have retired by the end of the observation period. Combining the administrative data from 1972 onwards and the retrospective data prior to 1972 yields information on complete earnings and employment careers of retirees. Because firm identifiers are available only from 1972 onwards, uncensored tenure can be measured for jobs starting after January 1, 1972.

To investigate the effect of severance pay eligibility on retirement decisions we consider all individuals born between 1930 and 1945. For these individuals we observe sufficiently long uncensored tenure at retirement. We focus on workers who are still employed after their 54th birthday with a minimum private sector work experience of one year and follow them until entry into retirement or up to the age of 70. We make several restrictions to the original sample of about 700,000 workers, which are summarized in Appendix Table 2. Most importantly, we exclude individuals who worked as civil servants or whose last job was in construction, because they are subject to different pension and severance pay rules. As we are interested in tenure at retirement, we further exclude workers with left censored tenure at retirement and we only consider retirement entries which occur within 6 months of the worker's last job. Individuals with longer gaps between employment and retirement are only followed until the end of the last employment. To exploit the severance pay discontinuities, we focus on individuals with 6 to 28 years of tenure at retirement, which reduces the sample to $194,086$ retiring individuals. Given the selected birth cohorts and Austrian retirement ages, we observe individual retirements in the years 1985 - 2008, with about 95% of retirements occurring between 1986 and 2005 when the youngest cohort turns 60. In order to exploit information on severance payments from tax records, we focus specifically on the subsample of individuals, who retire in the years 1997 – 2005 and for whom we can match valid records of severance payments in the final year of employment. This leaves us with an estimation sample of $89,426$ individuals.

Summary statistics for this sample are presented in Table 1. The median retirement age is 59 years, which reflects that most individuals retire through disability (21%) or early retirement (57%). The average worker has 15 years of tenure at retirement and 34 years of total employment. Because we exclude workers from the construction industry – a large male-dominated sector in the Austrian economy – about 50% of our sample is female. The average severance payment at retirement amounts to roughly 60% of the average annual earnings before retirement. At retirement workers face a high implicit tax rate of about 80%, which is a combination of income taxes and social security contributions (30%) and foregone pension benefits (50%).

2.3 Data on Severance Payments

Data on severance payments come from income tax records that can be matched with the administrative social security registers via an individual identifier. The tax data correspond to reports that firms have to send to the tax office at the end of each calendar year. Specifically, the employer reports each worker's annual salary and withholdings of social security contributions and income tax which are directly transferred to the tax office. The employer reports are sufficiently detailed, such that workers who are employed in a single job for the entire year are not obliged to file individual tax returns. Workers with more than one job have to file tax returns to correct the income tax withholdings and workers not employed the whole year may file tax returns to apply for refunds. Note that we do not have data on the final tax returns, but only on the employer reports.

In the tax reports the worker's gross annual earnings are split up into social security contributions, tax deductions, income subject to income tax, and income subject to the lower fixed tax rate of 6%. In particular, there is a separate category for severance payments, which only applies in the final year of the job. This category includes three different income components: (i) tenure-based severance pay according to the severance pay law, (ii) refunds for not consumed vacation days, and (iii) voluntary severance payments. Voluntary severance pay that can be claimed in this income category is tied to work experience in previous jobs for which the worker did not receive severance pay. The total amount of income that can be reported in the severance category is capped by 1.25 times the salary of the last 12 months, which equals 1.07 times the annual salary, because there are 14 monthly wage payments. There are no discontinuities in rules for vacation refunds by tenure, so we assume that refunds of vacation days evolve smooth through the tenure thresholds. Nonetheless, employers can make use of voluntary severance payments to smooth out the discontinuities in the schedule.

We have access to tax record data for the years 1994 – 2005, which we merge to the retirement data. We use information on income from the income tax records to compute the *severance pay fraction* at retirement as the ratio of the severance pay in the year of retirement to the average annual salary over the three years prior to retirement.[12] We use the income information from the tax records to compute this severance pay fraction

[12] Earnings over the last years prior for retirement are relatively stable for most individuals. We have experimented with alternative measures of the salary, but this one seems to be the most stable.

since the income from the tax records is uncensored (i.e. values beyond the social security earnings limits are observed) and salary is more accurately measured than in the social security record data. Because we use income information from three years prior to retirement to compute the severance pay fraction at retirement, our final sample is restricted to individuals who retire in the years 1997 through 2005.

3 Nonparametric Graphical Analysis

3.1 Evidence on Retirements

3.1.1 Distribution of Tenure at Retirement

Figure 3 presents the distribution of tenure at retirement, plotting the frequency of retirements at monthly tenure levels.[13] Several features are immediately evident from this graph. First, the plot shows large discontinuous spikes in the number of retirements at each tenure threshold. Second, there are dips in the number of retirements just before the tenure thresholds. The pattern is regularly repeated at each tenure threshold but not apparent at any other point in the tenure distribution. Third, the plot indicates a seasonal pattern illustrated by small spikes in the number of retirements at each integer value of years of tenure at retirement. The seasonality can be explained by a relatively large fraction of job starts in January and corresponding retirement exits in December. Fourth, even though there are decreases prior to the thresholds, the frequency of retirements never goes to zero just prior to the thresholds. This means there appears to be a substantial number of individuals who are unresponsive to the severance pay system at retirement.

The retirement pattern of dips and spikes around the tenure thresholds in the graph suggests that individuals who would have retired just before the thresholds in the absence of the severance pay discontinuities end up delaying their retirements until they qualify for the (larger) severance payments. Thus in absence of the tenure-based severance pay schedule, the retirement frequencies should be flat across all thresholds. We check this hypothesis by plotting retirement frequencies for civil servants and construction workers – two groups that are not subject to a tenure-based severance pay rule. These plots, which are presented in Appendix Figures 1 and 2 respectively do not show any discontinuities at

[13]For a plot of the distribution of tenure at retirement for the full sample of retirements of individuals born between 1930 and 1945 see the NBER working paper version of this paper (Manoli and Weber, 2011). The patterns are remarkably similar.

the tenure thresholds.[14] This confirms our hypothesis that the pattern in Figure 3 is driven by the severance pay schedule and not by regularities in job-leaving behavior at specific tenure levels.

Individuals who retire right before a tenure threshold seem to act sub-optimally, because they forfeit a high return to a few more weeks of work. We consider four explanations for this phenomenon: measurement error, salience or information problems, frictions in the flexibility of retirement timing, side payments or voluntary severance payments. The first two explanations do not appear to be particularly relevant in the Austrian case. First, the administrative data is extremely precise; it is the primary data source for computing pension claims and measures employment spells at a daily level.[15] Second, since the severance pay schedule is in place for individuals over their entire careers, severance pay is likely to be salient. In particular, the severance pay system does not apply only at retirement; workers are eligible for tenure-based severance pay at layoffs at any point throughout their careers. The severance pay schedule for layoffs is identical to the retirement schedule, but with two extra steps at 3 and 5 years of tenure. We will explore the role of the other two explanations, frictions and side-payments from employers, in more detail below. In particular, we will investigate retirement patterns by health status, age at retirement, and gender. In addition, we will analyze data on actual severance payments from tax records to verify how closely severance payments follow the legislated schedule in Figure 1.

3.1.2 Accounting for Covariates

We exploit panel variation in the probability of retirement to examine whether or not other observable characteristics change around the tenure thresholds. In particular, we estimate the following regression

$$r_{it} = \sum_{s=0}^{85} \gamma_s d_s + X_{it}\beta + \epsilon_{it}$$

[14]Data on employment spells of civil servants are only available as of 1988 in the ASSD. Thus the restriction to non-left-censored spells drastically reduces the number of observations with high tenure levels at retirement. Due to the seasonal nature of the construction industry (which implies frequent job interruptions), construction workers with high levels of tenure at retirement are also relatively rare.

[15]We examine one potential ambiguity in the measurement of tenure when including or excluding vacation days that are left over at the end of the job spell. Appendix Figure 3 plots the probability that an individuals has vacation days at the end of the last employment spell by job tenure. The graph shows a smooth pattern across all tenure thresholds and confirms that measurement error cannot account for any of the retirements just prior to the thresholds.

where r_{it} is an indicator equal to 1 if individual i retires within time period t. The set of observations per individual covers all quarters from age 54 to retirement or age 70. The sample used for estimation includes all job exits, not only the individuals retiring within 6 months of their last job. This allows us to examine whether or not regularities in general job exits (as opposed to just retirements) after 5, 10, 15, 20, or 25 year intervals are responsible for the observed retirement patterns in Figure 3. For computational reasons, time is measured at a quarterly frequency instead of the monthly frequency presented in Figure 3.

The regressors in the estimated equation are a set of indicators d_s equal to 1 if the individual's quarterly tenure at time t equals s. Further, we include a large set of time-varying control variables X_{it} relating to age, gender, calendar years, citizenship, industry, region, seasonality, earnings histories, firm size, health and experience. All of the variables in the regression are demeaned so that the coefficients on the tenure dummies reflect the mean probabilities of retirement within each tenure level.

Figure 4 plots the coefficients on the quarterly tenure dummies from the estimated retirement regression. The graph shows a pattern of dips before and large spikes at the thresholds that is very similar to Figure 3. The yearly seasonality pattern is now removed by controls for quarter of the year. We also plot confidence intervals for the estimated coefficients. Because of the large sample size, these intervals are very tight. Overall, Figure 4 confirms that incentives in the severance pay system are driving the retirement pattern around the tenure thresholds rather than other observable characteristics or regularities in job-leaving behavior.

3.1.3 Job Starts

Next, we investigate whether individuals time the beginning of new jobs so that they can retire at the Early Retirement Ages (ERAs, respectively 55 and 60 for women and men) and also claim severance payments at the time of their retirements. To explore this idea, Figure 5 plots the number of individuals starting new jobs (vertical axis) against age measured at a quarterly frequency (horizontal axis).[16] If individuals are timing the beginning of their new jobs so that they can just complete 10, 15, or 20 years of tenure at the ERAs, then we would expect to see sharp increases in the number of individuals

[16]For this graph we define a sample of job starters that closely resembles the definition of the retirement sample. Specifically, we select job starts of individuals who do not enter retirement before age 55, are still employed at age 54, and have a minimum employment experience of one year before age 54.

starting new jobs at ages 50, 45, and 40. The evidence in Figure 5, panel *A* shows no discernible change in job starts at any age prior to the ERAs. This smoothness across age emphasizes that, while there is evidence that some individuals delay their retirements to qualify for (larger) severance payments at retirement, there is no evidence that individuals adjust their labor supply (or participation) at earlier ages in response to the anticipated severance payments.

Figure 5, panels *B* and *C* shed more light on the age at job start, by splitting up the sample into job starts resulting from job-to-job transitions versus job starts from unemployment. We do not see any pronounced increases at any ages in either graph. It is remarkable, however, that the relatively stable number of job starts before age 55 for the full sample, panel *A*, is the composition of a declining trend in new jobs from employment and a rising number of job starts from unemployment, especially for men. At age 40 the majority of new job starts are the result of job-to-job transitions, while at age 55 the majority is due to jobs started from unemployment. We can interpret the declining number of new jobs from employment as workers getting more reluctant to change jobs voluntarily as they age, potentially because severance pay at retirement limits their mobility. However, even if workers are aware of the long term consequences of changing jobs at older ages, they do not target new job starts to become eligible for severance pay exactly at the Early Retirement Ages.

3.1.4 Heterogeneity in Responsiveness

To better understand the observed retirement patterns we investigate how the responsiveness to the severance pay rule differs across the population. We are especially interested, whether we can identify groups of individuals who are less flexible in the choice of retirement entry which could account for the relatively large fraction of retirements prior to the severance pay thresholds.

We start by investigating heterogeneity related to health status measuring health based on the fraction of time between age 54 and retirement spent on sick leave. In particular, we define an individual as unhealthy if the fraction of time between age 54 and retirement spent on sick leave is above the median fraction of time for individuals with positive sick leave days (this median is 0.076).[17] Figure 6 presents the distribution of tenure at retirement

[17]Roughly 35% of individuals in our sample have no sick leave days over their entire careers and 68% have no sick leave between ages 54 and retirement. Health status is highly correlated with the likelihood of claiming disability pension; about 64% of individuals with some sick leave between age 54 and retirement

for unhealthy and healthy individuals, respectively. As expected, unhealthy individuals are not very flexible in the timing of their retirements. We basically see no response to the severance pay thresholds among retirees with health problems. Thus, some of the pre-threshold retirement is likely to be driven by negative health shocks and also more permanently poor health status.

Figure 7 examines heterogeneity related to gender and retirement age. Men and women are separately divided into age groups based the Early and Normal Retirement Ages. In particular, we distinguish retirements before age 60 and after age 60. To check whether the large group of individuals retiring exactly at age 60 base their decisions on different incentives, we consider them as separate age group. The top row of the figure plots the distributions of tenure at retirement within each age group for men, and the plots for women are in the bottom panel. Overall the retirement patterns are remarkably similar across age and gender groups, except for men retiring prior to age 60. They are not yet eligible for early retirement and have to qualify for disability to be eligible for benefits. As applications for disability take a while to be approved it is not surprising that men below age 60 appear to be unable to flexibly time their retirement. We further note that individuals retiring at age 60 show a similar responsiveness to severance pay incentives as the overall population. It is important to keep in mind that the patterns in this graph should be interpreted as heterogeneity across individuals with different retirement ages rather than heterogeneity due to aging since there is clearly selection into different retirement ages.

3.2 Evidence on Severance Payments

Having established the response to the severance pay rule in terms of retirement patterns, we now investigate evidence on the actual severance payments received by retiring workers in the final year of employment. Our aim is to verify whether observed payments conform with the tenure-based severance pay schedule in Figure 1. As the schedule is specified in terms of severance pay as a fraction of earnings, we focus on the ratio of severance pay relative to annual earnings, which we call the *severance pay fraction*.

Figure 8 shows histograms of the distribution of the severance pay fraction for selected values of tenure around the severance pay tenure thresholds. Specifically, we present the distribution for individuals with $(9, 10)$, $(14, 15)$, $(19, 20)$, and $(24, 25)$ years of tenure in panels $A-D$. The histograms highlight variation in severance payments that is at odds with

claim disability pensions as opposed to 15% of those with no sick leave between age 54 and retirement.

the severance pay schedule shown in Figure 1. This variation is due to voluntary severance payments and refunds for leftover vacation days which are also counted in the severance pay income category in the tax records. A second explanation for the variation is measurement error. In the tax data, the base salary for computing severance pay is potentially measured with error as the records do not include an employer identifier. However, the histograms also show clear spikes at the values of the legislated severance pay fractions. These spikes shift as the tenure level crosses the threshold. Looking at the panel corresponding to individuals with 9 years of tenure at retirement, we see a spike at zero severance pay but also a prominent mass point at a severance pay fraction of 25%, which corresponds to the legislated severance pay fraction for layoffs with tenure longer than 5 years. This indicates that some employers make side-payments to treat job exits at retirement similar as layoffs at a tenure below 10 years. Once the tenure level moves above the first threshold of 10 years in the second panel in Figure 8, the mass point shifts to 33%, which corresponds to the legislated severance pay fraction. In this graph, as well as in the graphs for higher tenure levels, there is still a fraction of individuals receiving zero severance pay, for which we do not have a good explanation. In addition there are individuals receiving higher severance payments than the legislated values, which can be due to voluntary severance pay and refunds for vacation days. The maximum severance pay fraction is slightly above one which corresponds to the tax rule. Overall, the histograms indicate that there are discontinuous jumps in severance pay fractions at the tenure thresholds, which might, however, be moderated by side-payments.

Our goal is to use the severance pay data to determine empirically how much the severance pay fractions change around the tenure thresholds. Because the histograms show clear evidence of many individuals receiving severance pay beyond the legislated fraction, this suggests that just considering change in the mean severance pay fractions around the tenure thresholds would obscure some of the relevant changes in incentives around the tenure thresholds. In particular, the histograms indicate that it is more revealing to look at percentiles of the severance pay fractions within each level of tenure at retirement, and then to consider changes within these percentiles across the different tenure levels. Figure 9 shows four panels plotting the 15th, 25th, 50th, and 75th percentiles of the severance pay fractions. Specifically, this plot is constructed by computing the percentiles of severance pay fractions within each group of individuals at a given level of tenure at retirement. At the lower percentiles we see sharp discontinuities in the severance pay fractions at the tenure thresholds. Thus, for individuals receiving relatively low severance payments, the severance pay schedule illustrated in Figure 1 appears more likely to be binding. At the median, shown in the third panel, the severance pay fractions are rising for retirements in the quarters to the left of the thresholds. This indicates some smoothing via voluntary severance payments. The graph for the top quarter of the distribution shows no jumps at the tenure thresholds at all. This indicates that employers paying high of severance payments smooth out the legislated schedule completely. Thus, Figure 9 suggests that the severance pay schedule is binding only for a subset of the population at retirement, while many individuals receive voluntary severance payments from their employers that smooth out the schedule. Due to the nature of the tax records, which are filed by employers at the end of the year, we assume that voluntary severance payments are negotiated by employer and employees well in advance of retirement. This would in turn imply that individuals expecting to receive voluntary severance pay respond less in terms of the timing of retirement around the tenure threshold.

To examine whether individuals with high severance pay are indeed less responsive, we split the sample around each tenure threshold into two groups of workers: (1) individuals for whom the legislated severance pay schedule binds since their severance pay fractions are close to the legislated schedule and (2) individuals for whom the legislated severance pay schedule does not bind since their severance pay fractions are off the legislated schedule. The exact definition for each threshold sample is listed in Table 2. In particular we define as the non-binding group (2) about 25% of each the samples around the 10, 15 and 20 year threshold who receive severance pay fractions that are much higher or much lower than the legislated ones. For the sample around the 25 year threshold we choose individuals receiving zero severance pay as the non-binding group.

Figure 10 examines whether retirement responses indeed differ by the amount of voluntary severance pay. We plot retirement frequencies around each tenure threshold for individuals with binding and non-binding severance pay. Comparing the retirement patterns for the two separate groups shows convincingly that individuals who are expecting voluntary severance payments from their employers are not responding to the discontinuities as the retirement frequencies in the samples of individuals with non-binding severance pay schedule are smooth through the tenure thresholds.

Using the sample of individuals around each tenure threshold for whom the legislated severance pay schedule binds, Figure 11 presents plots of the average severance pay fractions by tenure at retirement. The plots demonstrate noticeable discontinuous changes in the mean severance pay fractions for these individuals. Therefore, in the elasticity estimation discussed below, we focus on the samples around each tenure threshold for whom the severance pay schedule binds and relate the excess mass of retirements at the threshold to estimated discontinuities in the severance pay fractions at the tenure thresholds.

Selection into the group with binding severance pay schedule

The exclusion of individuals for whom the legislated severance pay schedule is not binding from the estimation procedure relies on the assumption that employers do not offer side-payments selectively to workers who are close to the tenure threshold. For example offering side payments to individuals close to the tenure cutoff whom the employer wants to retire early, but not offering side-payments to workers whom they want to stay beyond the tenure threshold would violate this assumption.

To investigate whether observable characteristics correlate with receiving voluntary severance pay beyond the legislated severance pay fractions or no severance pay at all, we estimate two linear regression models, which regress indicator variables for voluntary severance payments or zero severance pay on the full range of observable characteristics. See Table 2 for the exact definition of the dependent variables in each threshold sample. Regression results are shown in Appendix Tables 3*a* and 3*b*. Results in Appendix Table 3*a* confirm that the probability to receive voluntary severance pay is related to the institutional regulations. Specifically, individuals with long contribution years and high earnings, who are more likely to have switched from previous jobs without receiving severance pay face a higher probability to to receive voluntary payments at retirement. Other parameter estimates in the regression are also significant, but quantitatively they have small impact on the dependent variable. The second regression for zero severance pay receipt, in Appendix Table 3*b*, has a very small R-squared and indicates that receiving no severance pay is not well explained by observables.

To justify the restriction of our estimation sample to the group of individuals for whom the severance pay schedule is binding, we further check wether individual characteristics correlated with voluntary severance pay vary around the tenure thresholds. Figure 12 plots the predicted probabilities of receiving voluntary severance pay and of receiving no severance pay by monthly tenure levels separately for women and men. We see that probability of receiving voluntary severance pay is upward sloping in tenure levels, but there appear no discontinuities close to the tenure thresholds. Similarly, the probability of receiving no severance pay is decreasing in the level of tenure, but again the graphs are smooth through the tenure thresholds. This confirms that the restriction to individuals with binding severance pay schedules is not a major source of selection.

4 Quantitative Analysis

4.1 Labor Supply Elasticity

The graphical analysis in the last section provides clear evidence that (1) there are discontinuities in the severance pay fractions at the tenure thresholds and (2) workers delay their retirements to reach the tenure thresholds and collect larger severance payments. We now introduce a concept of a reduced-form participation elasticity that relates these two pieces of evidence to each other and quantifies how retirement decisions respond to financial incentives.

The elasticity concept is based on a thought experiment that compares the situation with the severance payment system to a counterfactual situation with no severance pay system. Under the counterfactual, there are no discontinuous changes in income at any tenure level and therefore retirements would be smooth in tenure.[18] With this counterfactual for the severance payments in mind, the main idea of the participation elasticity is to quantify the changes in retirements at a tenure threshold relative to the changes in income at that tenure threshold. Based on this intuition, the reduced-form participation elasticity is given by

$$\varepsilon = \frac{\Delta p/p}{-\Delta(1-\tau)/(1-\tau)} \tag{1}$$

where p and $(1-\tau)$ respectively denote the probability of participation and the net-of-tax rate at the tenure threshold, while Δp and $\Delta(1-\tau)$ denote the changes in either variable relative to the counterfactual without any increase in severance pay at the tenure thresholds.

We measure the change in participation using bunching methods based on the graphical retirements patterns. The measure of the net income change at the tenure threshold relative to the counterfactual takes into account that severance pay and labor earnings are taxed at

[18] In the definition of the participation elasticity we abstract from general equilibrium effects of the severance pay system on wage setting, hiring, and firing strategies of firms. We base the empirical analysis on a partial equilibrium framework where the counterfactual is defined as eliminating the severance pay discontinuity without any increase in other compensation. In a general equilibrium setting, equilibrium wages could change in the counterfactual without the severance pay discontinuity. However, Hofer, Schuh and Walch (2011) evaluate the reform of the Austrian severance payment system in 2003 and find only minimal implications on job mobility or wages.

different rates. In particular, severance payments are defined as a fraction of gross annual earnings and taxed at a fixed rate of 6%, while labor earnings are effectively taxed at an implicit tax rate that considers income taxes and foregone pension benefits. Therefore we express the change in financial incentive in terms of the net-of-tax rate. In the next section we provide a detailed explanation of the estimation of the numerator and denominator of the elasticity.

The concept of the reduced-form participation elasticity can be motivated within a dynamic framework that has been used extensively in the literature on retirement decisions. In particular, we refer to dynamic models by Stock and Wise (1990) and Berkovec and Stern (1991), as well as on the reduced form models by Coile and Gruber (2007) and Gruber and Wise (1999, 2004). In this framework a forward looking individual decides each period whether to continue working or to exit the labor market permanently and retire, based on an evaluation of the current and future benefits of continued work relative to the benefits of retirement. If tenure-based severance pay is introduced into this setting, the individual faces a sharp increase in the incentive to retire once she reaches a tenure threshold, since the benefits from retiring have jumped to a higher level. In Appendix *A* we present a dynamic model of retirement decisions that generates a pattern of retirement frequencies with dips prior to the tenure thresholds and spikes at the thresholds similar to the one we empirically observe in Figure 3.

An alternative concept of the participation elasticity can be derived from a static model of lifetime labor supply (see Brown 2013). The model captures the financial incentives from the severance pay schedule in a lifetime budget constraint that exhibits notches at the policy discontinuities. The static model predicts bunching of retirements right at the tenure thresholds and gaps in retirements before the thresholds. Upon the specification of a parametric utility function, the elasticity is a structural parameter that can be recovered from the response of an individual who is indifferent between retiring early and delaying retirement to the point when she becomes eligible for severance pay. We present the detailed alternative elasticity estimates based on the static labor supply model in Appendix *B*, along with a discussion of the differences between elasticity concepts based on the static and dynamic models respectively.

For the Austrian application, the reduced-form elasticity concept based on a dynamic framework seems more suitable. An important argument is that the elasticity in the static model is not scale invariant; it can be arbitrarily re-scaled depending on how labor supply is measured. For example, measuring labor supply over the full life-cycle, in terms of years of age, yields estimates of a smaller scale than if labor supply is measured in terms of years of tenure of years since age 54. In contrast, the scale of the reduced form participation elasticity is specified conceptually since the participation elasticity is measured in terms of changes in the probability of work and it takes into account changes in the financial incentives. Moreover, unless an ad hoc friction or noise is added to the model, the static model does not explicitly account for pre-threshold retirements as it predicts a gap with zero retirements before the threshold.

4.2 Estimation Procedures

Here we outline the estimation procedures for computing both the numerator and the denominator in equation (1) for one particular tenure threshold. The procedure is then applied to the estimation sample around each of the tenure thresholds in the severance pay schedule. Below we denote by s the monthly tenure level, centered around the threshold and divided by 12, such that $s = 0$ corresponds to the threshold level of tenure and $s = 1$ corresponds to one year of tenure above the threshold.

Changes in Retirement Probabilities $\Delta p/p$

The basis for estimating the change in retirement probabilities $\Delta p/p$ at the tenure threshold are the observed retirement patterns at monthly frequencies shown in Figure 10. We start with the observed frequencies n_s to estimate seasonally adjusted and counterfactual retirement frequencies, which we denote by n_s^a and $\hat{n}_s$ respectively. The estimation proceeds along the following steps. First, we estimate seasonally adjusted frequencies by fitting 5th order tenure polynomials on each side of the tenure threshold and dummy variables for integer values of tenure to the observed monthly frequencies of retirement.[19] Second, we use the seasonally adjusted retirement frequencies and estimate counterfactual retirement frequencies $\hat{n}_s$ to create the counterfactual scenario without any increases in severance pay. In this step, we fit a continuous 4th order polynomial over the full range of tenure levels and add dummy variables for the months around the tenure threshold. We

[19] The exact regression specification to estimate the seasonally adjusted frequencies using the observed retirement frequencies n_s at tenure s is given by

$$n_s \quad = \quad g_1(s) * 1(s < 0) + g_2(s) * 1(s > 0) + \beta * 1(s = 0) + \gamma * 1(s = -2|s = 2) + \varepsilon_s.$$

where $g_1(.)$ and $g_2(.)$ are 5th order polynomial functions in s. We then compute as $n_s^a = \hat{g}_1(s) + \hat{g}_2(s) + (\hat{\beta} - \hat{\gamma}) * 1(s = 0)$. We further re-scale these predicted seasonally adjusted frequencies so that the total number of retirements is equal to the total number of observed retirements.

then set the dummies equal to zero and predict values from this polynomial to construct counterfactual frequencies.[20] Figure 13 illustrates the estimation procedure by plotting the actual retirement frequencies n_s along with seasonally adjusted retirement frequencies n_s^a and the counterfactual frequencies $\hat{n}_s$ by tenure, separately for each threshold.

The counterfactual number of retirements in the 12 months after the tenure threshold is then given by the sum of $\hat{n}_s$ over the corresponding months. To compute the change in the annual retirement probability, we relate the excess number of retirements $n_s^a - \hat{n}_s$ over the 12 months to the counterfactual by

$$\frac{\Delta p}{p} = \frac{\sum_{k=0}^{11}[n_{k/12}^a - \hat{n}_{k/12}]}{\sum_{k=0}^{11}[\hat{n}_{k/12}]}. \tag{2}$$

Standard errors for this term are estimated by bootstrapping. Specifically, we start by drawing a bootstrap sample equal to the original sample size by randomly drawing individuals with replacement from the original sample. We then construct the observed frequencies and estimate the seasonally adjusted and counterfactual frequencies and the compute $\Delta p/p$. The standard error for $\Delta p/p$ is then computed by computing the standard deviation over all of the bootstrapped estimates for $\Delta p/p$.

The identifying assumption underlying our estimation procedure is that in the absence of the severance payments, individuals retiring at the tenure thresholds would behave like individuals retiring further away or between the tenure thresholds. The identifying assumption would be violated if, for example, individuals who retire at the tenure thresholds would have a higher probability of retiring at the Early Retirement Ages than individuals who retire away from the tenure thresholds. Based on our empirical evidence, individuals retiring at the tenure thresholds are similar to individuals retiring away from the tenure thresholds on a rich set of observable dimensions (see section 3.1.2). Therefore, we con-

[20]The exact regression specification to estimate the counterfactual frequencies $\hat{n}_s$ using the seasonally adjusted retirement frequencies n_s^a at tenure s is given by

$$n_s^a = h(s) + \sum_{k=-12}^{12} \alpha_k * 1(s = k/12) + \eta_s$$

where $h(.)$ is a 4th order polynomial function in tenure s. We then compute $\hat{n}_s = \hat{h}(s)$ and re-scale these predicted counterfactuals so that the total number of counterfactual retirements is equal to the total number of observed retirements. For detailed sensitivity analysis of this estimation procedure with respect to the polynomial degree or the window length of dummies around the threshold, please see the NBER working paper version of this paper (Manoli and Weber, 2011). There we document that the results are not sensitive to the choice of either parameter.

clude that it is unlikely that there would be differences in unobservable characteristics that would lead to such differences in retirement decisions in the absence of the severance pay thresholds. Under this identifying assumption, we are able to consider a counterfactual setting around each tenure threshold in which there are no increases in severance pay.

Changes in Net-of-Tax Rates $\Delta(1-\tau)/(1-\tau)$

For the denominator of the elasticity, we measure the change in net-of-tax rates due to the severance payments using the increase in severance pay relative to the after-tax income. Specifically, the change in the net-of-tax rate around a given tenure threshold can be written as $-\frac{\Delta(1-\tau)}{(1-\tau)} = \frac{SP}{(1-\tau)y}$ where SP is the amount of the net increase in severance pay at the tenure threshold, y is annual earnings and $\tau = 0.80$ is the implicit tax rate on earnings taking into account all taxes and benefits.[21] Since the amount of severance pay can be expressed as a fraction of annual earnings, the change in net-of-tax rates at the tenure threshold can be further simplified to

$$-\frac{\Delta(1-\tau)}{(1-\tau)} = \frac{(1-\tau^{sev})\delta_{SP}}{(1-\tau)} \qquad (3)$$

where $\tau^{sev} = 0.06$ is the low tax rate applied to severance pay income and δ_{SP} denotes the changes in the severance pay fractions at the tenure threshold.

We consider two strategies to obtain values for the change in severance pay fractions at the tenure threshold. First, we follow the description in section 2.1 and set δ_{SP} based on the changes in the severance pay fractions at the tenure thresholds as defined in the legislated severance pay schedule in Figure 1. This would give us the correct elasticity if there is full compliance with the severance pay law and if there are no voluntary severance payments. However, the analysis of the data on severance payments in section 3.2 indicates

[21]The implicit tax rate on gross annual earnings is defined such that after-tax income is equated to gross earnings net of all taxes and retirement benefits, i.e. τ such that

$$(1-\tau)y = y - inctax - sscontr - b + \Delta B.$$

Here y denotes annual gross earnings, $inctax$ denotes income taxes, $sscontr$ denotes social security contributions or payroll taxes, b denotes annual pension benefits, and ΔB denotes the increase in social security wealth (the expected present discounted value of social security benefits) coming from delaying retirement by one year.

Appendix C explains in detail how we compute the implicit tax rate τ for our sample. Empirically, the average over individual net-of-tax rates shows little variation over the different tenure levels. Thus we set the implicit tax rate equal to 0.80 throughout the estimation procedures.

evidence for non-compliance. Therefore, as a second alternative strategy, we estimate δ_{SP} based on the mean changes in the actual severance pay fractions at the tenure thresholds.

For this estimation we again use the samples of individuals around each tenure threshold for whom the severance pay schedule binds and estimate δ_{SP} separately for each threshold. We use observations on severance pay fractions at the individual level as the dependent variable, denoted by $sevfrac_i$, and fit linear trends in tenure on either side of the threshold and allow for a discontinuous jump at the threshold. The regression specification is given by

$$sevfrac_i = \gamma_0 + \gamma_1 s + \delta_{SP} D + \gamma_2 s * D + v_i,$$

Where D is an indicator variable for $s > 0$. The estimated coefficient $\hat{\delta}_{SP}$ from this regression provides an estimate for the effective change in the severance pay fraction that can differ from the legislated jump due to side payments, ignorance or other factors.[22] The estimated linear trends and the jump in the average severance pay fraction at the threshold are plotted for each threshold sample in Figure 11.

To compute the estimate of the change in the net-of-tax rate, we plug the estimated coefficient into equation (3). Similar to the standard errors for the changes in the retirement probabilities, the standard errors for the changes in the net-of-tax rates are computed by bootstrapping. In particular, we randomly draw bootstrap samples and estimate δ_{SP} at each tenure threshold. The standard errors for δ_{SP} and $\frac{\Delta(1-\tau)}{(1-\tau)}$ are computed by computing the standard deviations of the corresponding terms across all of the bootstrapped samples.

Estimating ε

The estimate of the labor supply elasticity can now be derived from combining the numerators and denominators according to equation (1). The standard errors for the estimated elasticities are computed by taking the standard deviation of the 1000 estimates that result from the bootstrap procedures used to compute the standard errors for the numerators and denominators.

[22] When estimating this regression specification we omit observations with tenure at retirement within $+/-$ 1 quarter of the threshold. This is because the number of observations changes around the threshold, and we aim to estimate the change in the severance pay fraction based on individuals further away from (but still close to) the thresholds.

4.3 Estimation Results

Changes in Retirement Probabilities at the Tenure Thresholds

We start by examining the changes in retirement probabilities based on the excess mass of retirements at each tenure threshold. Table 3 presents results for the full sample of individuals retiring between 1997 and 2005 and for several subsamples. As shown in row (1) for the full sample, the retirement frequencies in the first 12 months after the tenure threshold increase between 8% and 28% relative to the counterfactual; with an average increase of 18% across all thresholds. Excluding unhealthy individuals from the samples, in row (2), hardly affects estimated changes in the retirement probabilities at the thresholds. However, we can see marked differences in the changes in retirement probabilities by gender in rows (3) and (4). Relative to the counterfactual, the excess mass of retirements is higher for women than for men at all thresholds. On average relative retirement probabilities increase by 14% form men and by 22% for women. Next we compare changes in retirement probabilities by gender and retirement age across three different age groups in rows (5) to (10). The higher responsiveness to severance payments among women than men persists across all age groups and at most tenure thresholds. The gender difference is largest in the group of individuals retiring before age 60, where men are only eligible for disability pensions and thus less flexible in their retirement decisions.

The estimates in the last row (11) in Table 3 focuses on the sample of individuals who have a binding severance pay schedule and for whom we can also estimate the change in financial incentives. This sample will be the basis of the remaining estimation results. Corresponding to the graphical results in Figure 10, the changes in retirement probabilities at the tenure thresholds are slightly larger for individuals with binding severance pay schedule, with an average increase of the probability of retiring at the threshold of 24%. This is intuitive, since individuals with larger jumps in severance payments at the tenure thresholds have higher incentives to retire at the tenure thresholds.

Estimated Labor Supply Elasticities

Table 4 presents the estimation results for the labor supply elasticity according to equation (1). For the estimate of the numerator, we repeat row (11) from Table 3. The denominator is based on the financial incentives according to the legislated changes in severance pay fractions (Panel A) and the estimated changes in severance pay fractions

(Panel B). The legislated schedule mandates the largest change in the severance pay fraction at the 10 year tenure threshold, and a average change in the severance pay fraction of 0.25 across all thresholds. The estimated changes, presented in Panel B, with an average of 0.08, are about one third smaller than the legislated ones and we measure the largest change at the 20 year threshold. The denominator of the elasticity formula combines the changes in severance pay fractions with the tax rates on labor earnings and severance pay, and the elasticity estimate is computed as the ratio.

Using the legislated changes in severance pay fractions the average elasticity is 0.23, whereas the average elasticity using the estimated changes in severance pay fractions is roughly three times larger with 0.63. Focusing on the differences between the thresholds across the two panels, the results in Panel B suggest that the elasticities are more uniform across the tenure thresholds than in panel A. Once the differences in effective changes in financial incentives across the tenure thresholds are accounted for, the responsiveness to the financial incentives from the severance payments appears relatively uniform across the tenure thresholds.

Next, we present estimated labor supply elasticities by gender and retirement age in Table 5. Focusing on the average estimates across the tenure thresholds the estimates of the changes in retirement probabilities for the sample with binding severance pay schedules confirm the results from Table 3: women are more responsive to the severance pay incentives than men. But at the same time the estimated changes in severance pay fractions are larger for women than for men. Therefore the resulting elasticity estimates are relatively equal across gender. The average labor supply elasticity based on estimated changes in severance pay fraction is 0.60 for men and 0.63 for women. If we focus on individuals retiring at age 60, for whom the gender difference in changes in retirement frequencies is less pronounced, the elasticity estimate for men is 0.50 and slightly higher than the elasticity for women with 0.30. But due to smaller sample sizes the difference is not significant. Neither can we reject the hypothesis that the labor supply elasticities are equal across gender and age. Once the effective financial incentives are accounted for, the responsiveness to the effective financial incentives from the severance payments appear to be relatively uniform across men and women and across different retirement ages.

Length of Delay in Retirement Entry

An alternative measure of the impact of the financial incentives in the Austrian severance pay system on retirement decisions is the length of delay in retirement entry. How long do individuals delay their retirements to become eligible for severance payments? Based on the graphical pre-threshold retirement patterns, we present two methods to estimate the length of delay and show the results in Panels A and B of Table 6.

The first estimation method is based on a comparison of the excess mass of retirements in the first 12 months after each threshold to the reduced mass in a specific number of months before the threshold. Across the columns in Table 6, we fix a number of months prior to the thresholds and estimate the pre-threshold reduced mass in the same way that we estimate excess mass at the tenure thresholds. The numbers presented in Panel A are the estimated ratios of the excess mass to the reduced mass at the different tenure thresholds. According to this method, and we determine the length of delay by the minimum number of pre-threshold months that achieves equality of the reduced and excess mass or a ratio of one. The estimation results in Panel A of Table 6 indicate that virtually all of the excess retirements at the thresholds can be accounted for by the pre-threshold dips starting at 6 to 15 months before the thresholds. Thus, most individuals appear to delaying their retirements by less than 1.25 years for the financial incentives from the severance payments.

The second method of estimating the length of delay is based on the percentage differences between the seasonally adjusted frequencies and the counterfactual frequencies at different numbers of months prior to the tenure thresholds. Here the length of delay is defined as the smallest number of months for which this gap is equal to zero. The results in Panel B of Table 6 indicate that at 1.25 years (15 months) prior to the tenure thresholds, the differences between the seasonally adjusted and counterfactual frequencies are mostly statistically insignificant. Thus, consistent with the results in Panel A, individuals appear to be willing to delay their retirements by 1.25 years or less to receive the higher severance payments. Overall, the relatively short length of delay given the relatively large financial incentives indicates a low labor supply responsiveness.

5 Discussion

5.1 Policy Relevance

A primary contribution of our empirical analysis is providing precise, well-identified estimates of an extensive margin intertemporal labor supply elasticity. We estimate how strongly individuals respond in their participation decisions to anticipated, discontinuous changes in benefits. This elasticity is relevant for the literatures on labor supply in labor economics, public finance, and macroeconomics. In particular, the estimated extensive margin elasticities for older individuals are relevant for the literature on retirement and social security reforms. Previous quasi-experimental studies have documented that retirement decisions appear relatively unresponsive to financial incentives from retirement benefits (see for example Coile and Gruber 2007, Liebman, Luttmer, Seif 2009, Asch, Haider and Zissimopolous 2005, Mastrobuoni 2009, and Brown 2013). Our results confirm the previous findings and contribute to the literature by providing better identification, a higher degree of precision, as well as insights into mechanisms behind the low responsiveness. While most of the previous quasi-experimental studies rely on variation across age, earnings histories, or cohorts, which may be subject to bias from differences in unobservables, we are able to exploit variation across tenure, within multiple ages, earnings histories and cohorts, and we can exploit variation across multiple tenure thresholds. Further, our large sample size and minimal measurement error allows for a high degree of precision in our estimates.[23]

To demonstrate the policy relevance of the labor supply elasticity estimates in the context of social security reforms, we simulate responses to a simple policy example designed to provide an incentive for individuals to delay their retirement past the popular retirement age of 60. Specifically, we consider a hypothetical policy in which the government introduces a one-time, lump-sum bonus of 5000 Euros paid to individuals who retire at age 61 or older.[24] Under the assumption that tenure-based benefits are similar to age-based benefits, we can apply the estimated elasticities and simulate responses to this policy. Note that we abstract from wealth effects as we argue that the severance payments are small relative to lifetime income. Thus, the estimated elasticities reflect substitution effects related to the willingness to delay retirement in response to higher benefits.

Figure 14 illustrates the retirement frequencies by age under the baseline and hypothetical policy regimes and with the different elasticity values.[25] This relsut highlights that,

[23]See Chetty et al (2012) for a survey of previous estimates in the literature.

[24]The hypothetical policy change is not constructed to be a revenue-neutral reform. If foregone pension benefits from the delayed retirements were equal to the total bonus payments, then the hypothetical reform could be revenue-neutral.

[25]Under the hypothetical policy, $\frac{\Delta(1-\tau)}{(1-\tau)} = 1.00$. We then use the estimated participation elasticities to translate this change in the net-of-tax rate into a change in the probability of retirement at age 61. We examine responses using the elasticities $\hat{e}_1 = 0.25$ and and $\hat{e}_2 = 0.65$ from Table 2. Based on $\hat{e}_1 = 0.25$, the hypothetical policy change implies a 25% ($= \hat{e} * \frac{\Delta(1-\tau)}{(1-\tau)} = 0.25 * 1.00$) increase in the probability of retirement at age 61. The retirement frequencies observed in the data indicate a baseline probability of retirement at age 61 equal to 0.0954 as $8,533$ individuals out of the sample of $89,426$ individuals retire at 61. In response to the hypothetical policy change, this probability increases by 25% to about 0.1193, implying that the new retirement bonus would cause an additional $2,133$ ($= (0.1193 - 0.0954) * 89,426$)

even in the presence of high-powered financial incentives from the retirement bonus, the spike in retirements at age 60 would persist since responsiveness to the financial incentives is relatively low.

There are a few caveats to keep in mind when interpreting outcomes of this simple policy simulation. First, as pointed out by Chetty et al. (2012), responses to such a hypothetical policy will depend on the density of individuals who are at the margin of retiring (versus continuing to work). In the empirical analysis of the responses to the severance pay rule, the density appears relatively uniform across the whole range of tenure levels. However, the density of individuals on the margin of retirement may not be smooth across ages, because there are large spikes in the retirement frequencies at ages 55 and 60. If there are many (few) individuals who are nearly indifferent between retiring at age 60 or 61, then the responses to the policy could be more (less) than what is predicted.

As a further caveat, we emphasize that the participation elasticities are estimated in the context of the Austrian pension system. As discussed earlier, the Austrian pension system is relatively generous compared to systems in the United States and other OECD countries. Because of this generosity, individuals may have low marginal utilities of consumption from additional severance pay income. It is plausible that one could estimate larger participation elasticities in settings with relatively less generous pensions systems since individuals may have higher marginal utilities of consumption in those settings.

5.2 Relationship to the Literature on Bunching Estimation Techniques

There is now a growing literature that exploits bunching induced by nonlinearities in the budget constraint to identify behavioral responses to price changes. A common type of nonlinearity, arising for example in tax schedules, creates kinks in the budget set. Empirical studies investigating kinks typically document evidence for bunching around the kink points. However, in contrast to the sharp bunching exactly at a kink point that would be predicted by theory in a frictionless environment, empirical evidence finds an excess

individuals to retire at 61. Based on the graphical evidence, we assume that the additional retirements at 61 results from individuals delaying their retirements from age 60. Based on the larger elasticity $\hat{e}_2 = 0.65$ estimated with the effective changes in financial incentives at the tenure thresholds, the estimates from the severance payments indicate that an additional $5,546$ individuals would retire at 61.

With the assumption that all of the excess retirements at age 61 come from retirements at age 60, the spike at age 60 only decreases by roughly 7% ($= \frac{-2{,}133}{31{,}168}$) with an elasticity $\hat{e}_1 = 0.25$ and by roughly 18% ($= \frac{-5{,}546}{31{,}168}$) with an elasticity $\hat{e}_2 = 0.65$.

mass of individuals locating around the kink point (Saez 2010, Chetty et al. 2011). The pattern is in general attributed to individuals who cannot target the kink point perfectly due to adjustment costs, constraints in the choice set, or uncertainty.

A second type of studies in this literature focuses on discontinuous jumps or notches in the budget constraint, which create stronger distortions and should therefore induce larger behavioral responses. The typical behavioral pattern found in these studies is a sharp change in behavior at the notch, resulting from bunching before the price increase and holes in the distribution after the price change (Brown 2013, Ramnath 2013, Kleven and Waseem 2013, Almunia and Lopez-Rodriguez 2012, Marx 2012, and Seim 2012). These patterns correspond very well to our findings on behavioral responses of retirement entry to severance pay discontinuities. We find dips in the distribution of tenure at retirement just before the threshold is reached and excess retirements at the threshold. A further common feature of studies based on notches in the budget constraint is that none of them finds gaps with zero density. This seems counterintuitive, since locating right after the price increase indicates a suboptimal choice, which in some settings can even be shown to be strictly dominated by alternatives (Kleven and Waseem 2013). Again, the typical explanation for suboptimal choices are frictions or adjustment costs.[26]

The estimation of structural behavioral parameters hinges crucially on assumptions about the extent of optimization frictions, however. Reported elasticity estimates based on observed bunching absent frictions tend to be an order of magnitude smaller than estimates that take frictions into account (Chetty et al. 2012, Kleven and Waseem 2013). The novelty of our setup is that we are able to analyze changes in financial incentives at the budget discontinuities directly in the data. This makes our results less dependent on strong and arbitrary assumptions. By excluding individuals with high employer side-payments, we can restrict the estimation to individuals who are more likely to face the legislated severance pay schedule. In addition we can estimate the average jump in the severance pay fraction at the threshold directly as a *first stage* instead of having to rely purely on the information about legislated jumps. Comparing our elasticity estimates based on legislated and estimated financial incentives strongly confirms the previous findings that estimates based on bunching can severely understate the parameters of interest.

[26]Given the well-defined region of strictly dominated choices in their application, Kleven and Waseem (2013) provide an estimate of the attenuation of behavioral responses due to optimization frictions.

6 Conclusion

This paper presents new empirical evidence on the effects of retirement benefits on labor force participation decisions. To summarize, the empirical analysis is based on administrative data on the universe of private sector employees in Austria and variation from policy discontinuities in mandated, employer-provided retirement benefits. We present clear graphical evidence on changes in the effective financial incentives and on labor supply responses to the policy discontinuities. Based on this evidence, we develop nonparametric procedures to estimate labor supply elasticities quantifying the observed responses.

The empirical analysis highlights multiple moments in the data demonstrating relatively limited responses to large financial incentives for retirement. First, the analysis yields low estimates of extensive margin labor supply elasticities. Based on the effective financial incentives from the policy discontinuities, we estimate an average elasticity of roughly 0.6. Second, we show that individuals are willing to delay their retirements by at most 1.25 or 1.5 years in response to severance pay increases that are larger than 25% of the annual salaries. Third, we find no evidence of changes in job starts to qualify for (larger) severance payments at retirement. These empirical moments all indicate a relatively low responsiveness of retirement decisions to financial incentives.

The results also allow for additional methodological and policy-relevant conclusions. First, the results indicate that it is important to account for effective financial incentives rather than relying solely on legislated financial incentives. If one were to rely only on the legislated financial incentives from the severance payments, the estimated elasticities would be roughly 0.2 since the legislated financial incentives overstate the effective financial incentives from the severance payments by a factor of three. Furthermore, after accounting for differences in effective financial incentives, the estimated elasticities are similar for men and women and across retirement ages.

Second, the relatively low elasticity highlights that many retirement decisions are likely to be affected by factors beyond only financial incentives from retirement benefits. Thus, a reform that involves mandatory changes in the pension system, such as raising the Early Retirement Age may be more effective at changing retirement decisions than a reform only based on financial incentives. The success of pension reforms seems to depend on affecting social norms regarding retirement, which may be easier achieved with other elements beyond pure financial incentives from retirement benefits.

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Table 1: Summary Statistics, N = 89,426

	Mean	Median	Std. Dev.
Retirement Age	59.10	60.00	2.59
Tenure (years)	15.66	15.25	6.10
Annual Earnings (Euro)	29,327	28,098	12,949
Severance Pay (Euro)	18,510	12,427	21,661
Implicit Tax Rate	0.81	0.80	0.21
Years of Employment	34.27	35.58	8.67
Years of Unemployment	0.33	0.00	0.74
Years of Sick Leave	0.17	0.01	0.33
Firm Size	1,876	129	4,823
Indicator Variables			
Female	0.51		
Claiming Disability Pensions	0.21		
Claiming Early Retirement Pensions	0.57		
Claiming Old Age Pensions	0.22		
Agriculture & Mining	0.03		
Manufacturing	0.24		
Sales	0.19		
Tourism	0.02		
Transportation	0.05		
Services	0.48		

Notes: All earnings variables are expressed in 2008 euros.

Table 2: Definition of the Threshold Estimation Samples

	10 Year Threshold	15 Year Threshold	20 Year Threshold	25 Year Threshold
Tenure (years)	6 -13	12 - 18	17 - 23	22 - 28
Binding severance pay	sevpay-fraction < 0.45	sevpay-fraction < 0.65	sevpay-fraction > 0.4 sevpay-fraction < 0.9	sevpay-fraction > 0.05
No Sevarance Pay	n.a.	sevpay-fraction < 0.05	sevpay-fraction < 0.05	sevpay-fraction < 0.05
Voluntary Severance Pay	sevpay-fraction > 0.45	sevpay-fraction > 0.65	n.a.	n.a.

Notes: sevpay-fraction denotes the ratio of severance payment over the average annual earnings in the last 3 years before retirement.

Table 3: Change in Retirement Probabilities

	10 Year Threshold	15 Year Threshold	20 Year Threshold	25 Year Threshold	Average
1. Full Sample	0.0843	0.1717	0.2846	0.1889	0.1824
	(0.0175)	(0.0210)	(0.0245)	(0.0244)	(0.0119)
N	32379	28166	25455	19932	
2. Full Sample Excluding Unhealthy	0.0585	0.1601	0.2609	0.1917	0.1678
	(0.0212)	(0.0248)	(0.0263)	(0.0275)	(0.0136)
N	22719	20639	20219	16802	
3. Men	0.0516	0.1023	0.2294	0.1752	0.1396
	(0.0258)	(0.0294)	(0.0351)	(0.0304)	(0.0165)
N	16224	13511	12048	11111	
4. Women	0.1161	0.2341	0.3337	0.2065	0.2226
	(0.0246)	(0.0303)	(0.0358)	(0.0390)	(0.0177)
N	16155	14655	13407	8821	
5. Men, Retirement Age < 60	0.0444	0.1270	0.1795	0.0622	0.1033
	(0.0490)	(0.0665)	(0.0623)	(0.0480)	(0.0314)
N	4883	3693	3489	3004	
6. Men, Retirement Age == 60	0.0177	0.0606	0.1761	0.1397	0.0985
	(0.0407)	(0.0441)	(0.0523)	(0.0438)	(0.0259)
N	6642	5820	5205	5092	
7. Men, Retirement Age > 60	0.1074	0.1449	0.3627	0.3798	0.2487
	(0.0484)	(0.0554)	(0.0762)	(0.0841)	(0.0372)
N	4699	3998	3354	3015	
8. Women, Retirement Age < 60	0.1472	0.2076	0.3635	0.2409	0.2398
	(0.0330)	(0.0360)	(0.0437)	(0.0474)	(0.0222)
N	9355	8653	8831	6062	
9. Women, Retirement Age == 60	0.0269	0.1443	0.2625	0.1100	0.1359
	(0.0436)	(0.0579)	(0.0711)	(0.0835)	(0.0352)
N	4794	4253	3182	1773	
10. Women, Retirement Age > 60	0.1769	0.5909	0.3183	0.1528	0.3097
	(0.0689)	(0.1193)	(0.0986)	(0.1043)	(0.0558)
N	2006	1749	1394	986	
11. Sample with Binding Sev Pay Schedule	0.1414	0.2424	0.3777	0.2123	0.2434
	(0.0228)	(0.0270)	(0.0346)	(0.0267)	(0.0153)
N	21729	19724	15588	18461	

Notes: Numbers in parentheses are bootstrapped standard errors based on 1000 replications. The definitions for the samples areoun each tenure threshold and the samples with a bindin sev pay schedule (row 11) are given in Table 2. For row 2, health status is measured based on the fraction of time between age 54 and retirement that is spent on sick leave. An individual is classified as unhealthy if his health status is below the median level. The median health status is computed within the sample of individuals with positive sick leave; this median health status is 0.038.

Table 4: Estimation Results

Panel A: Legislated Δ Sev Pay Fraction

	10 Year Threshold N=21,729	15 Year Threshold N=19,724	20 Year Threshold N=15,588	25 Year Threshold N=18,461	Average
Change in Retirement Probabilities	0.1414	0.2424	0.3777	0.2123	0.2434
	(0.0224)	(0.0273)	(0.0330)	(0.0251)	(0.0146)
Δ Sev Pay Fraction	0.3333	0.1667	0.2500	0.2500	0.2500
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Change in Net-of-Tax Rate	1.5667	0.7833	1.1750	1.1750	1.1750
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Elasticity	0.0902	0.3094	0.3214	0.1807	0.2254
	(0.0143)	(0.0349)	(0.0281)	(0.0214)	(0.0138)

Panel B: Estimated Δ Sev Pay Fraction

	10 Year Threshold N=21,729	15 Year Threshold N=19,724	20 Year Threshold N=15,588	25 Year Threshold N=18,461	Average
Change in Retirement Probabilities	0.1414	0.2424	0.3777	0.2123	0.2434
	(0.0233)	(0.0277)	(0.0350)	(0.0251)	(0.0157)
Δ Sev Pay Fraction	0.0620	0.1056	0.1202	0.0514	0.0848
	(0.0046)	(0.0058)	(0.0049)	(0.0070)	(0.0028)
Change in Net-of-Tax Rate	0.2916	0.4963	0.5651	0.2415	0.3986
	(0.0215)	(0.0275)	(0.0229)	(0.0331)	(0.0131)
Elasticity	0.4848	0.4883	0.6684	0.8790	0.6301
	(0.0892)	(0.0622)	(0.0683)	(0.1668)	(0.0559)

Notes: Numbers in parentheses are bootstrapped standard errors based on 1000 replications. For each tenure threshold, estimation results are based on the sample of observations that have a binding sev pay schedule. Table 2 provides the exact sample definitions. The Change in the Net-of-Tax Rate is mechanically computed using Δ Sev Pay Fraction: Change in Net-of-Tax Rate = (1-0.06)*(Δ Sev Pay Fraction)/(1-0.80).

Table 5: Estimation Results by Gender & Retirement Age, Averages Across Thresholds

	Men	Women	Men Retirement Age == 60	Women Retirement Age == 60
Change in Retirement Probabilities	0.2102	0.2704	0.1841	0.1416
	(0.0227)	(0.0203)	(0.0360)	(0.0397)
Δ Sev Pay Fraction	0.0742	0.0929	0.0796	0.1039
	(0.0043)	(0.0039)	(0.0058)	(0.0078)
Elasticity	0.6014	0.6495	0.4941	0.2985
	(0.0877)	(0.0795)	(0.1274)	(0.1724)

Notes: Numbers in parentheses are bootstrapped standard errors based on 1000 replications. For each tenure threshold, estimation results are based on the sample of observations that have a binding sev pay schedule. Table 2 provides the exact sample definitions. The Change in the Net-of-Tax Rate is mechanically computed using Δ Sev Pay Fraction: Change in Net-of-Tax Rate = (1-0.06)*(Δ Sev Pay Fraction)/(1-0.80).

Table 6: Pre-Threshold Retirement Patterns

Panel A: Ratio of Excess Mass to Reduced Mass

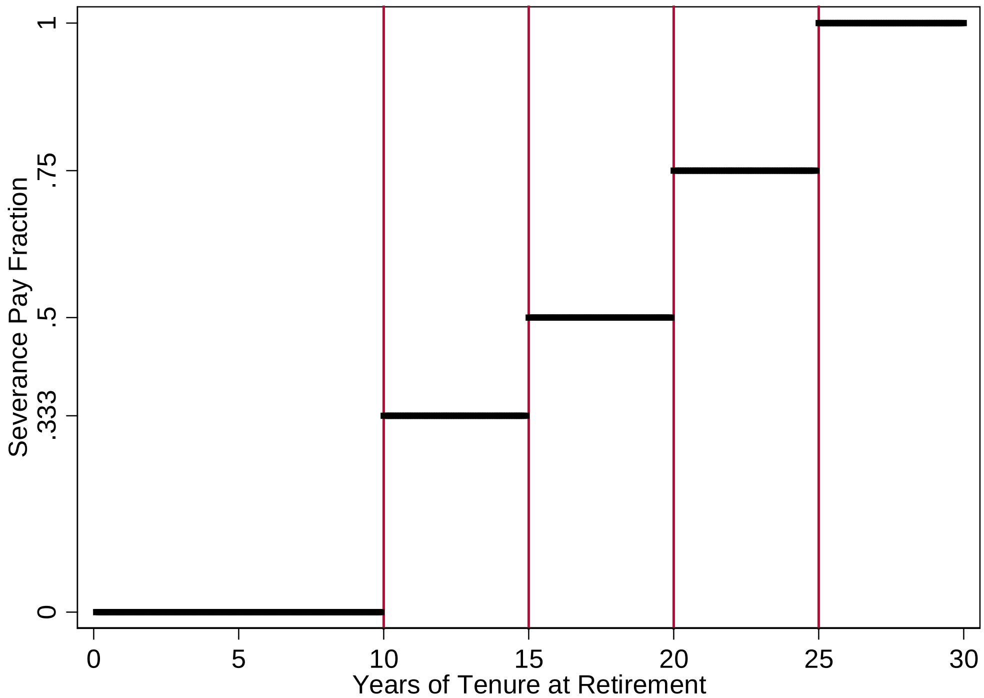
	Months Prior to Threshold				
	6	9	12	15	18
10 Year Threshold	0.6056	0.4778	0.4352	0.4316	0.4511
	(0.1487)	(0.1168)	(0.1048)	(0.1009)	(0.1010)
15 Year Threshold	1.0604	0.8269	0.7465	0.7337	0.7569
	(0.1683)	(0.1326)	(0.1186)	(0.1126)	(0.1091)
20 Year Threshold	1.6573	1.2713	1.1273	1.0867	1.0939
	(0.2039)	(0.1563)	(0.1360)	(0.1246)	(0.1158)
25 Year Threshold	1.0512	0.8652	0.8149	0.8230	0.8605
	(0.1672)	(0.1387)	(0.1284)	(0.1235)	(0.1185)
Average Over Thresholds	1.0936	0.8603	0.7810	0.7688	0.7906
	(0.0927)	(0.0738)	(0.0662)	(0.0627)	(0.0603)

Panel B: Percentage Differences between Seasonally Adjusted and Counterfactual Frequencies

	Months Prior to Threshold				
	6	9	12	15	18
10 Year Threshold	-0.2611	-0.1402	-0.0498	0.0113	0.0458
	(0.0285)	(0.0187)	(0.0108)	(0.0098)	(0.0113)
15 Year Threshold	-0.3338	-0.1791	-0.0672	0.0034	0.0386
	(0.0362)	(0.0235)	(0.0126)	(0.0101)	(0.0121)
20 Year Threshold	-0.3799	-0.2132	-0.0951	-0.0192	0.0173
	(0.0388)	(0.0248)	(0.0139)	(0.0110)	(0.0125)
25 Year Threshold	-0.2778	-0.1199	-0.0268	0.0246	0.0425
	(0.0317)	(0.0193)	(0.0112)	(0.0112)	(0.0137)
Average Over Thresholds	-0.3132	-0.1631	-0.0597	0.0050	0.0360
	(0.0178)	(0.0113)	(0.0062)	(0.0054)	(0.0066)

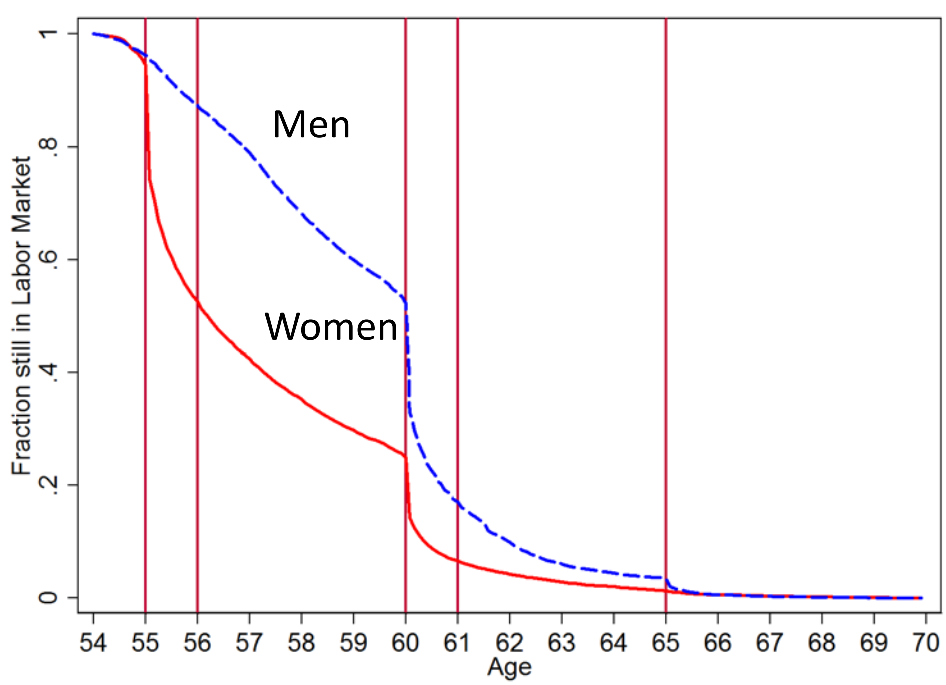
Notes: Numbers in parentheses are bootstrapped standard errors based on 1000 replications. For each tenure threshold, estimation results are based on the sample of observations that have a binding sev pay schedule. Table 2 provides the exact sample definitions.

Fig. 1. Payment Amounts based on Tenure at Retirement



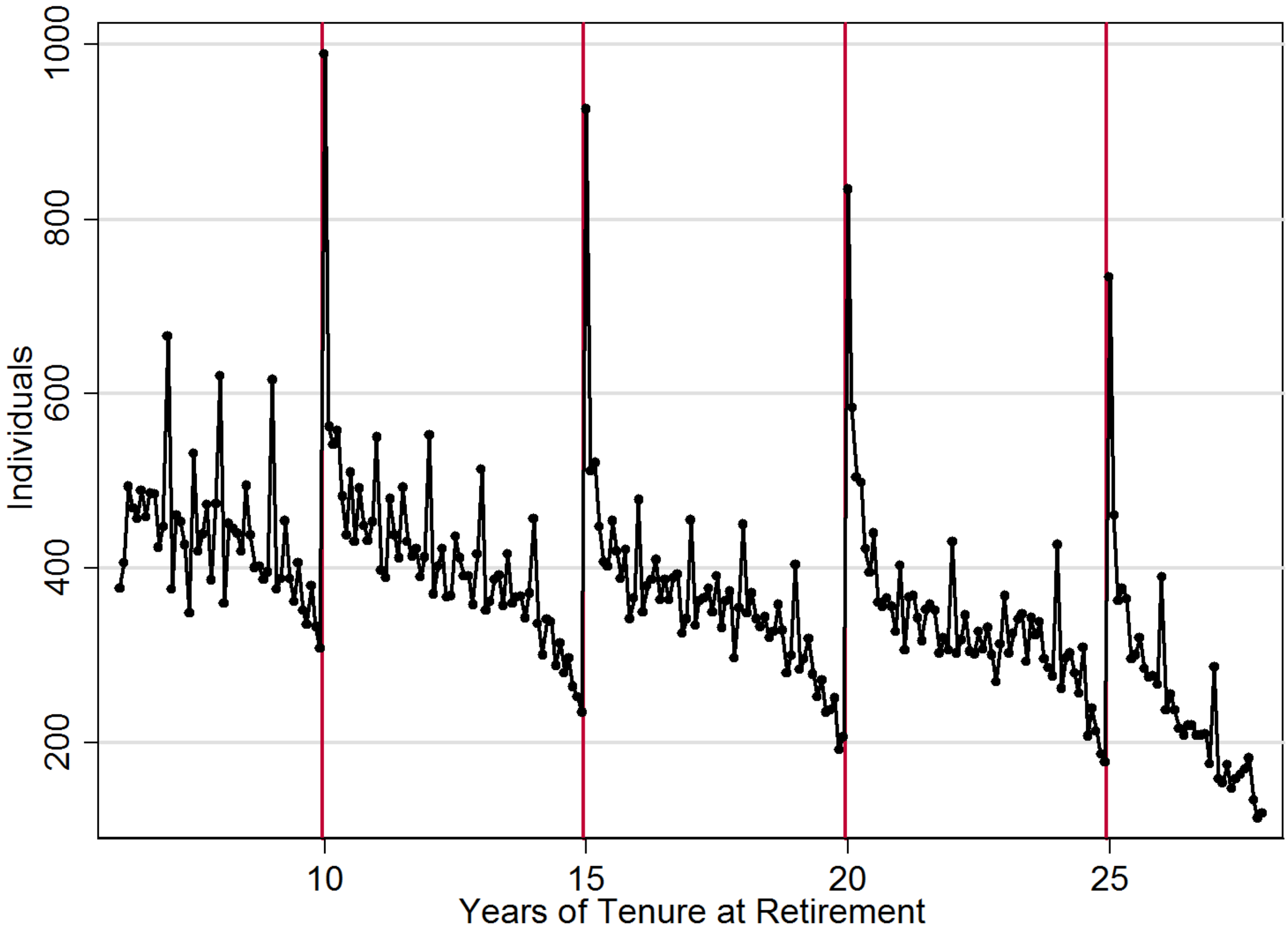
Notes: The employer-provided severance payments are made to private sector employees who have accumulated sufficient years of tenure by the time of their retirement. Tenure is defined as uninterrupted employment time with a given employer and retirement is based on claiming a government-provided pension. The payments must be made within 4 weeks of claiming a pension according to the following schedule.

Fig. 2. Exits from Labor Force into Retirement



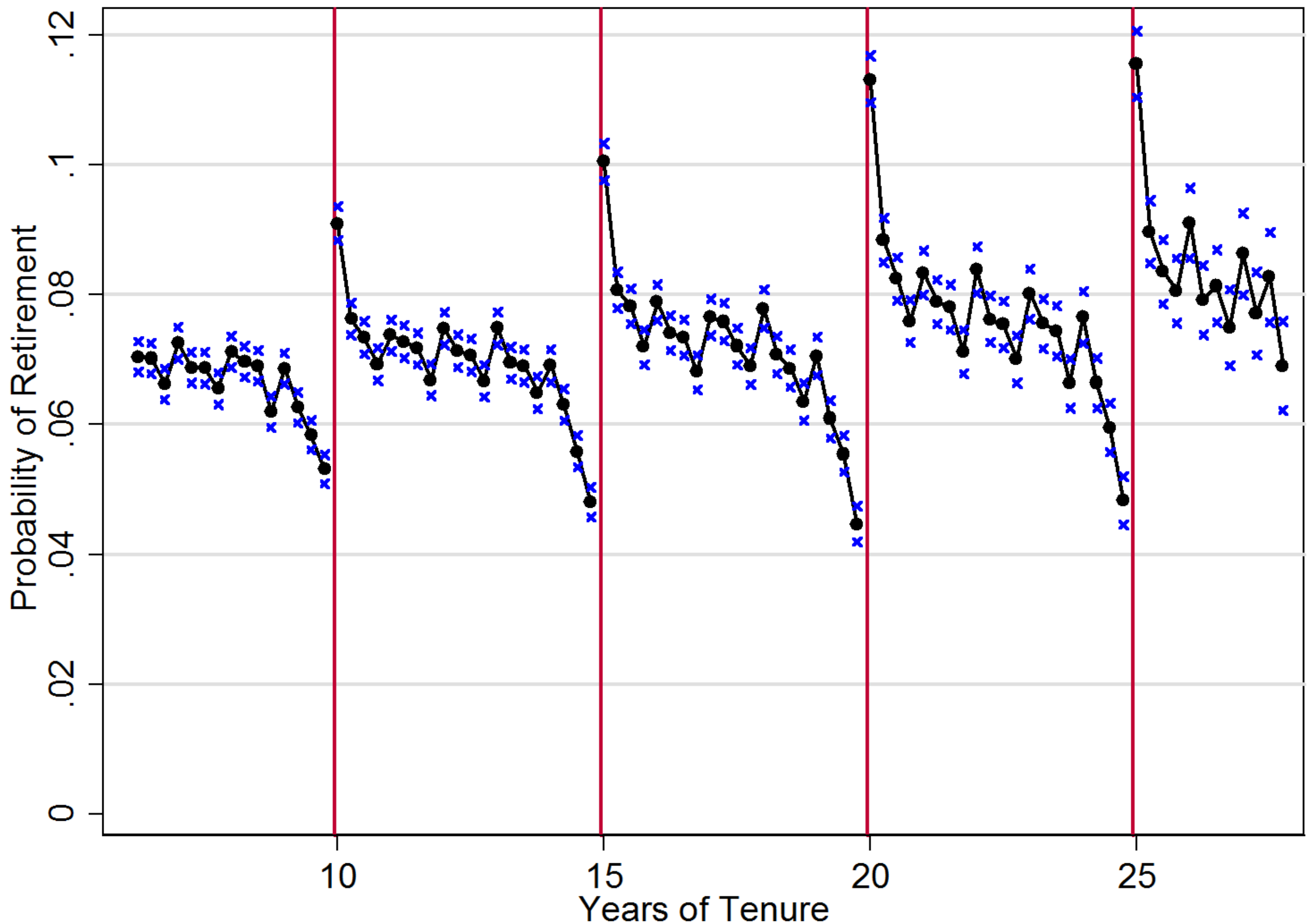
Notes: The survival functions are computed at a monthly frequency using birthdates and last observed job ending dates. The solid red line is the survival function for women; the Early Retirement Age and Normal Retirement Age for women are respectively 55 and 60. The dashed blue line is the survival curve for men; the Early Retirement Age and Normal Retirement Age for men are respectively 60 and 65. Prior to age 60, men can retire through disability pensions.

Fig. 3. Distribution of Tenure at Retirement



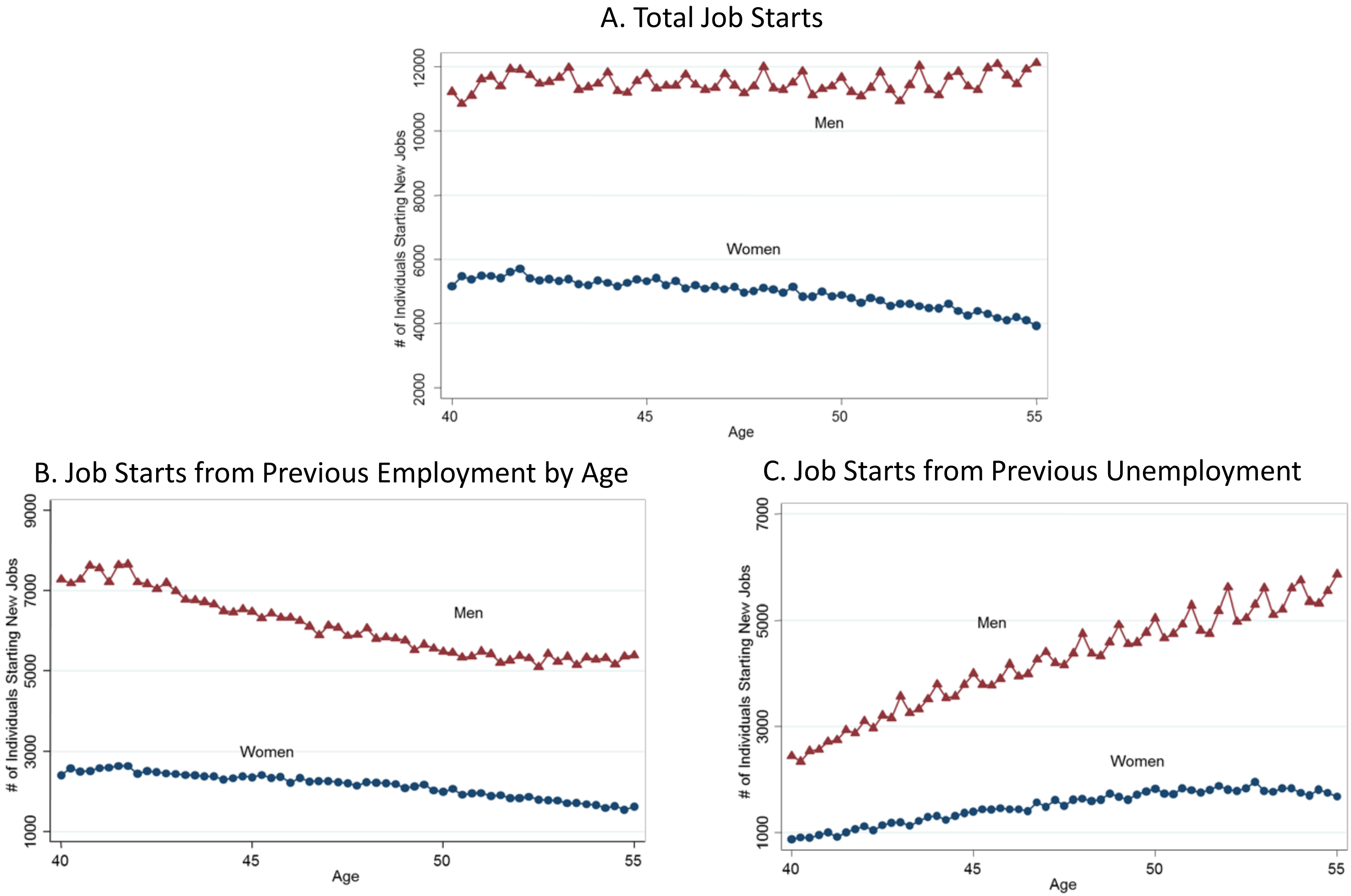
Notes: This figure plots the distribution of tenure at retirement at a monthly frequency. Each point captures the number of people that retire with tenure greater than the lower number of months, but less than the higher number of months. Tenure at retirement is computed using observed job starting and job ending dates. Since firm-level tenure is only recorded beginning in January 1972, we restrict the sample to individuals with uncensored tenure at retirement (i.e. job starting after January 1972). The matched sample is the sample of individuals from the full sample who are matched to the tax data.

Fig. 4. Controlling for Covariates



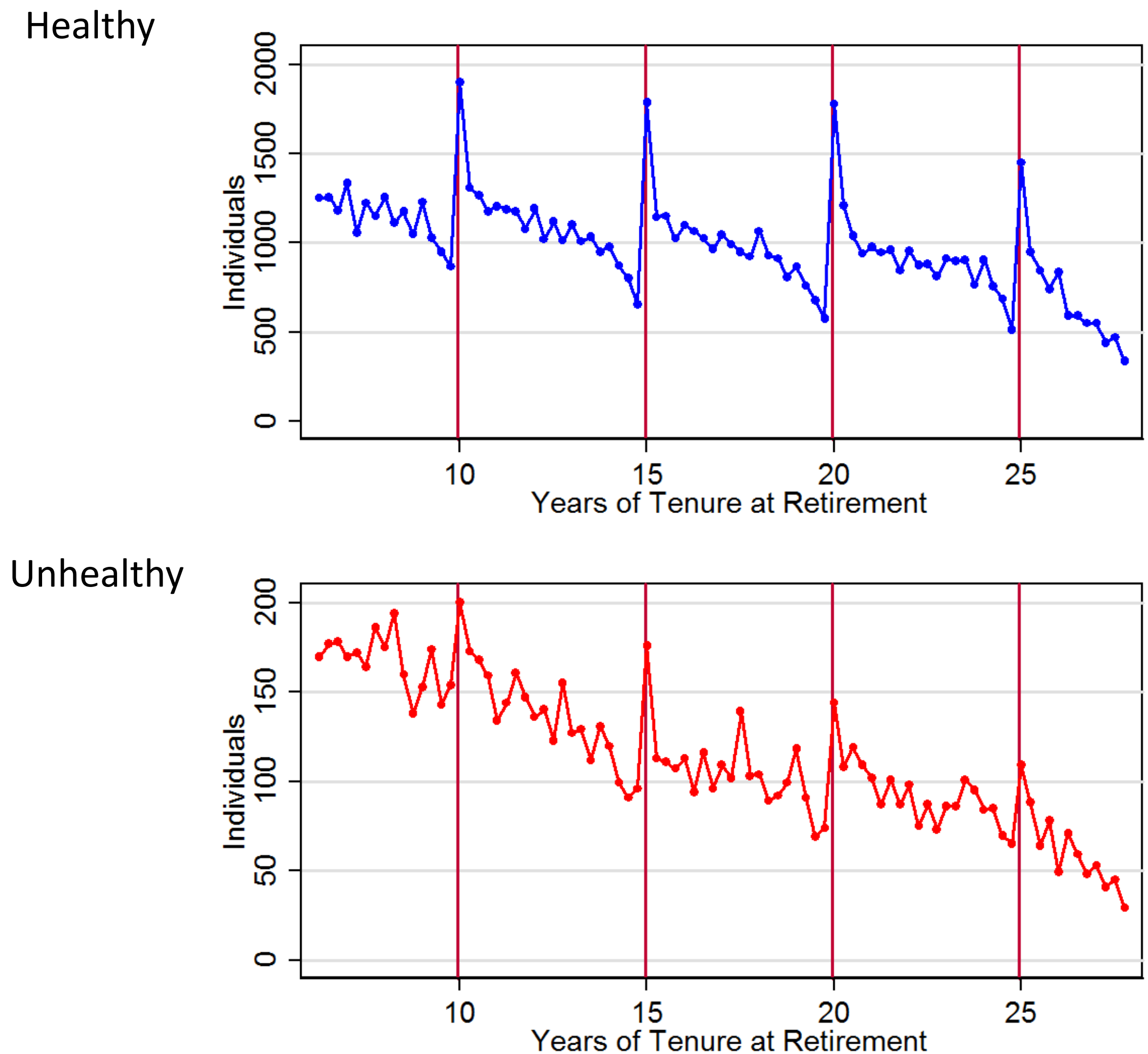
Notes: We regress a quarterly retirement indicator on quarterly tenure dummies and controls for age, gender, calendar years, citizenship, blue collar job status, industry, region, current calendar quarter, job starting month, earnings histories, firm size, health and years of experience. The black circles are the estimated coefficients on the tenure dummies. The blue x's above and below each circle represent +/- 2 standard errors around each point estimate.

Fig. 5. Job Starts by Age



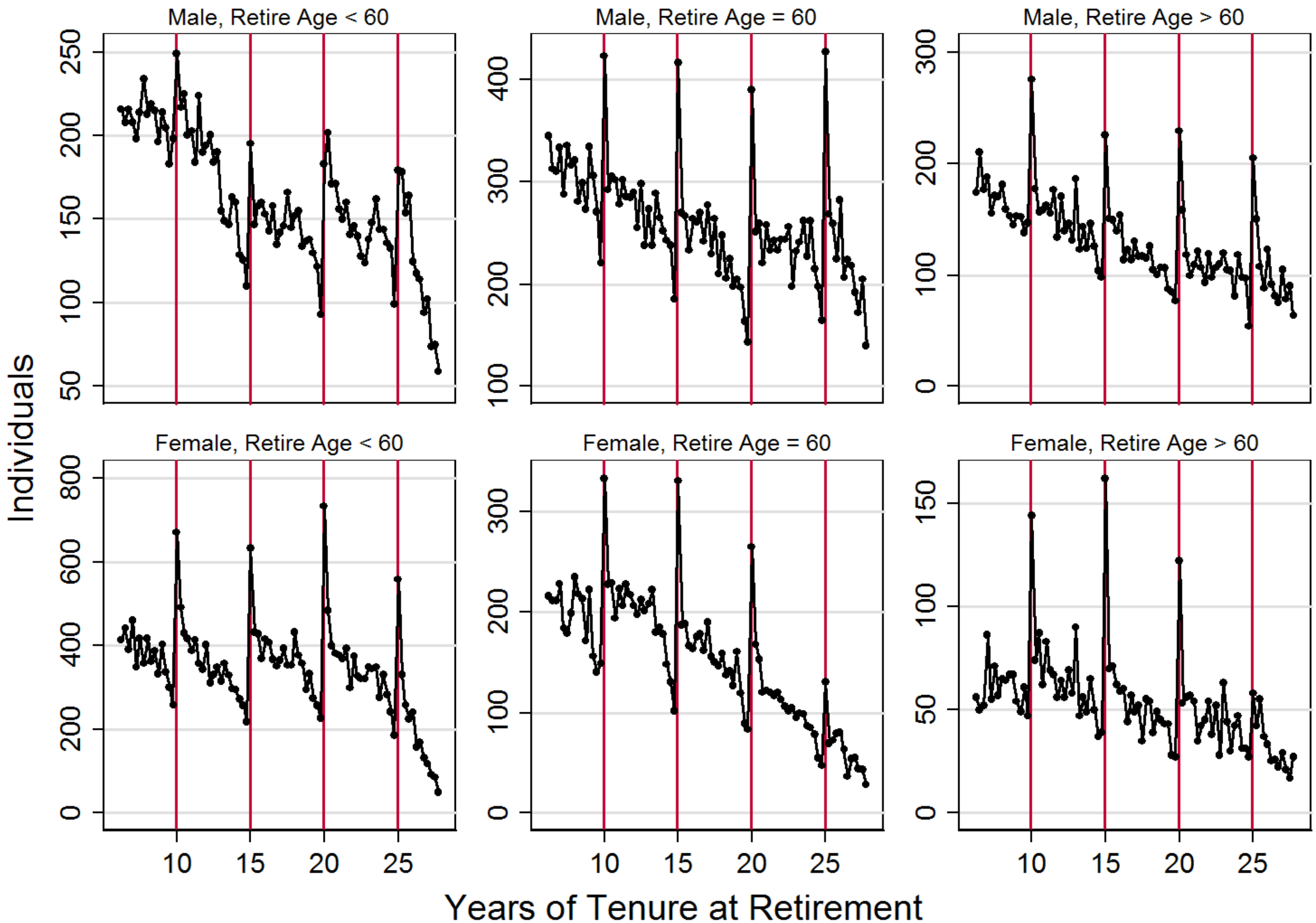
Notes: Panel A plots the total numbers of men and women starting new jobs at each age. The sample consists of all men and women, including those with uncensored tenure at retirement. Age is measured at a quarterly frequency. The blue triangles capture the number of men starting new jobs and the red circles captures the number of women starting new jobs. Panel B plots the total numbers of men and women starting new jobs at each age. The sample consists of all men and women, including those with uncensored tenure at retirement. Age is measured at a quarterly frequency. The blue triangles capture the number of men starting new jobs and the red circles captures the number of women starting new jobs. Panel C plots the numbers of previously employed men and women starting new jobs at each age. The sample consists of all men and women who were employed at different establishments prior to their new job start, including those with uncensored tenure at retirement. Age is measured at a quarterly frequency. The blue triangles capture the number of men starting new jobs and the red circles captures the number of women starting new jobs.

Fig. 6. Tenure at Retirement by Health Status



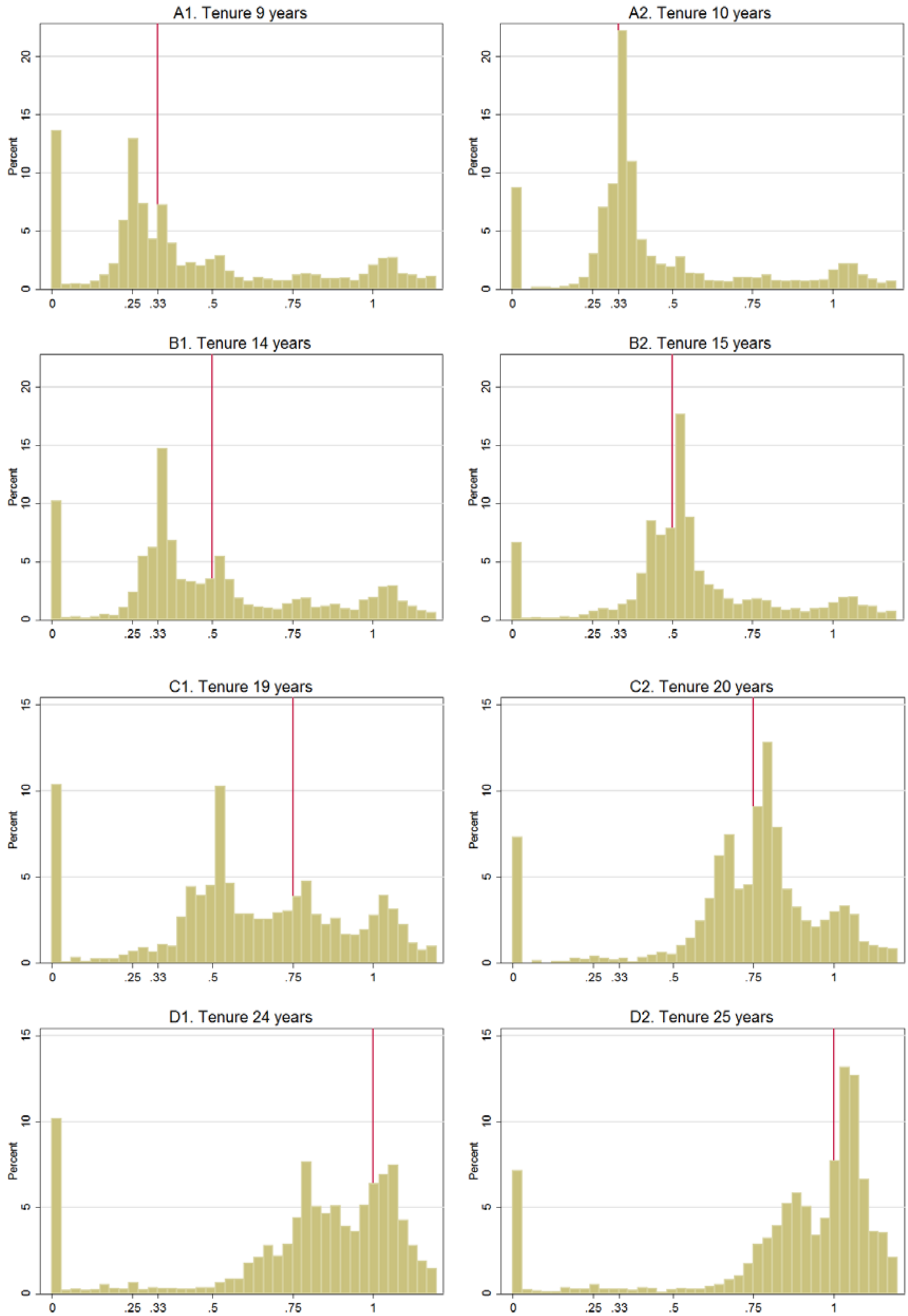
Notes: Health status is measured based on the fraction of time between age 54 and retirement that is spent on sick leave. An individual is classified as unhealthy if his health status is below the median level. The median health status is computed within the sample of individuals with positive sick leave; this median health status is 0.038.

Fig. 7. Tenure at Retirement by Gender & Retirement Age



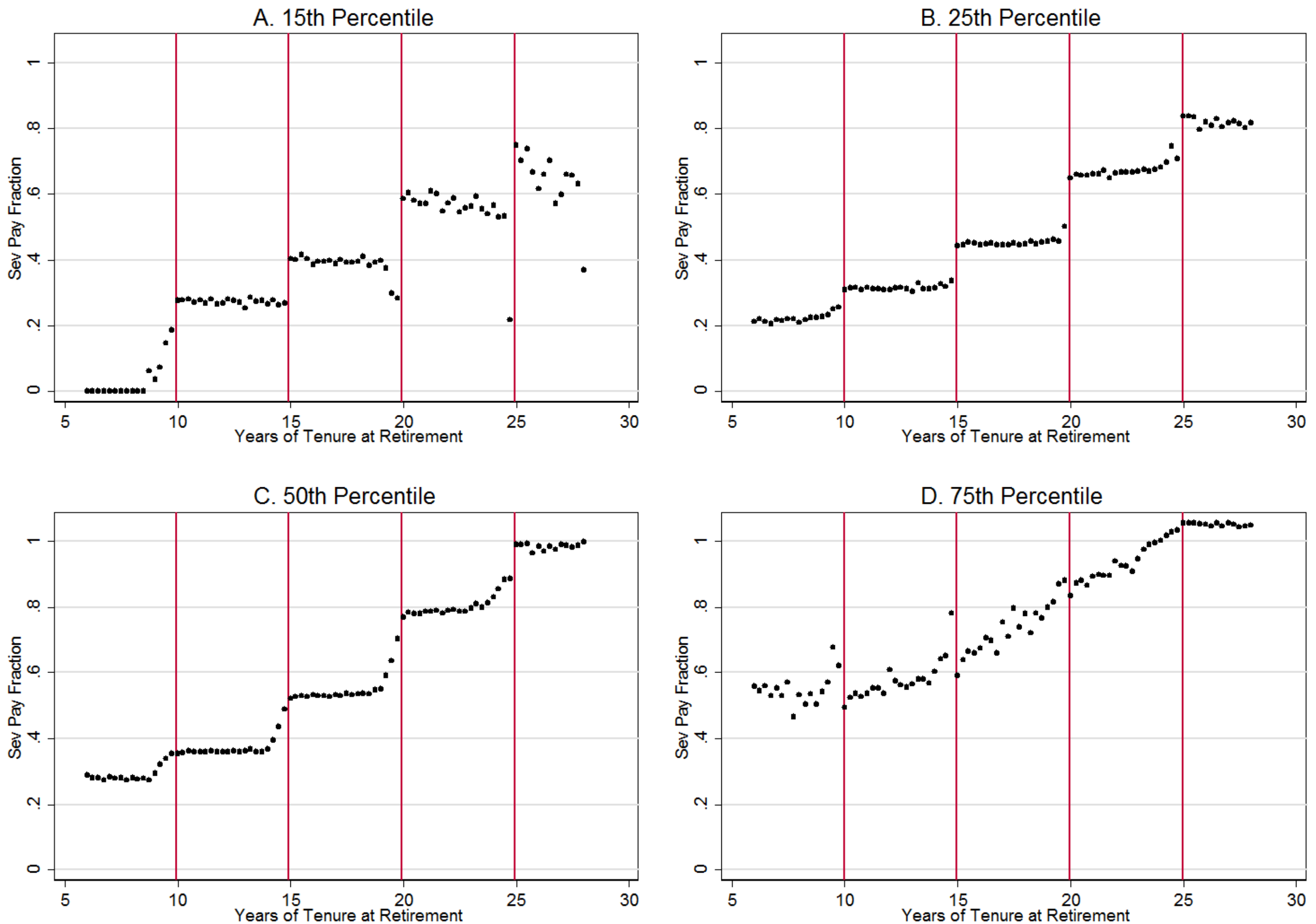
Notes: The age groups for men and women are chosen based on the survival curves illustrated in Figure 2. The Early Retirement Age and Normal Retirement Age for women are 55 and 60; the corresponding ages for men are 60 and 65 respectively. Prior to age 60, men can retire and claim disability pensions.

Fig. 8. Severance Pay Fractions at Different Tenure Levels



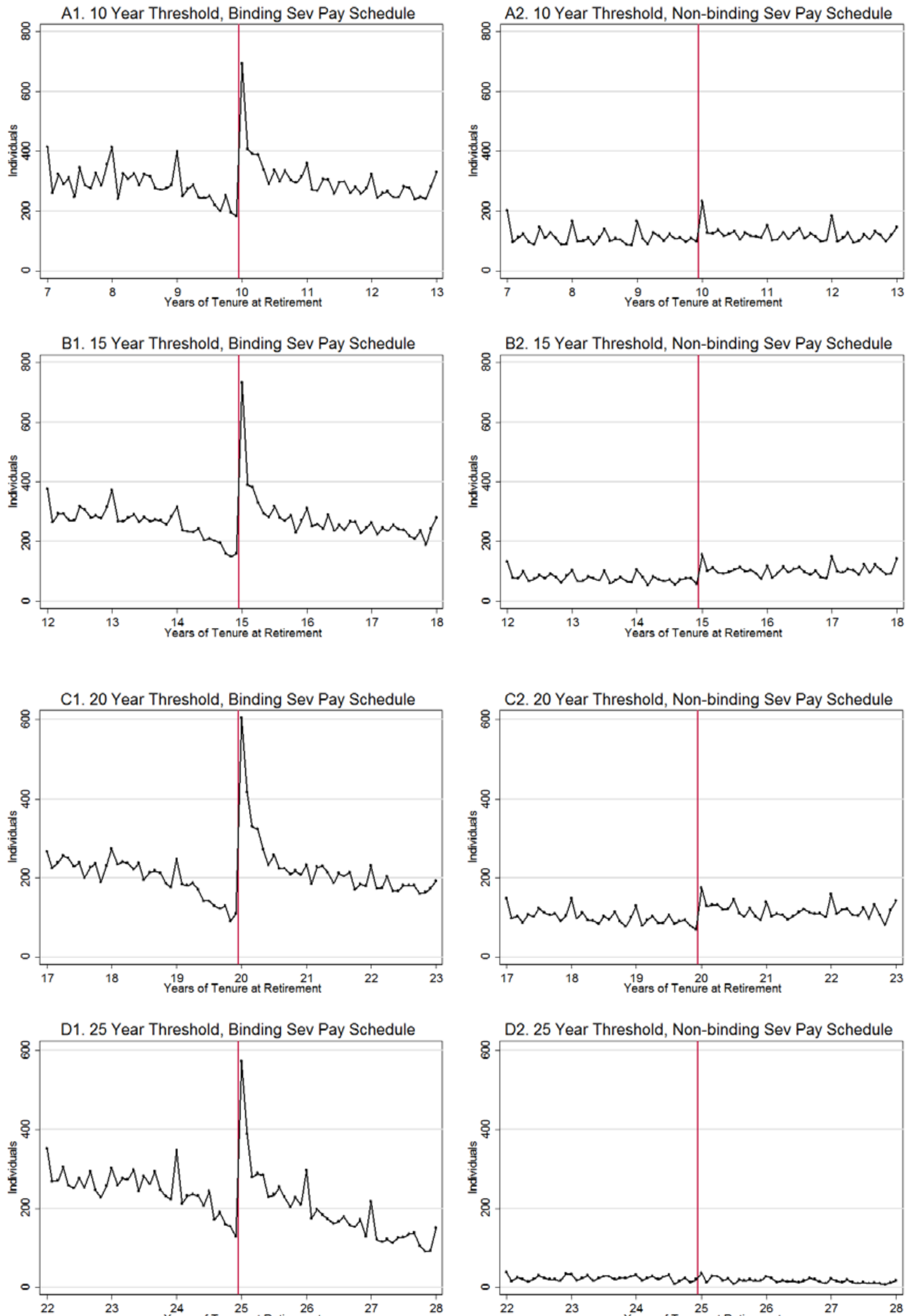
Notes: This figure presents the distribution of the severance pay fraction at a given level of tenure at retirement. The severance pay fraction is computed using data from income tax records. Specifically, the fraction is computed as the severance pay in the year of retirement divided by average income in the 3 years prior to retirement. Years of tenure at retirement are computed using job start and exit dates from social security records. The vertical red lines in each plot indicate the legislated severance pay fraction at retirement based on the given level of tenure at retirement.

Fig. 9. Percentiles of Severance Pay Fractions by Tenure at Retirement



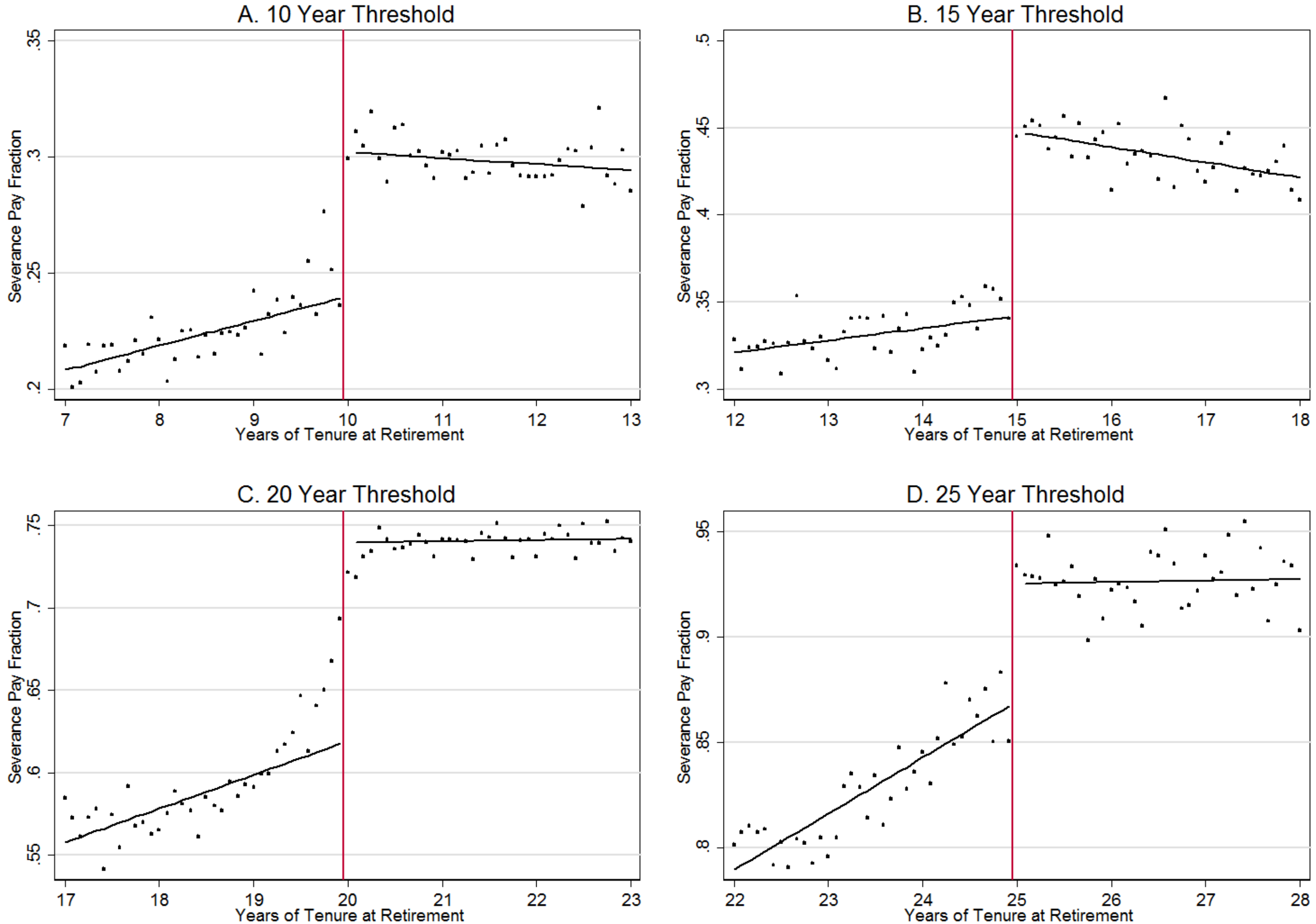
Notes: This figure plots percentiles of severance pay fractions by tenure at retirement, and tenure at retirement is measured at a quarterly frequency. To construct the figure, the percentiles of severance pay fractions are computed within each group of individuals at a given level of tenure at retirement. Each plot then illustrates the specified percentiles across the different tenure levels.

Fig. 10. Percentiles of Severance Pay Fractions by Tenure at Retirement



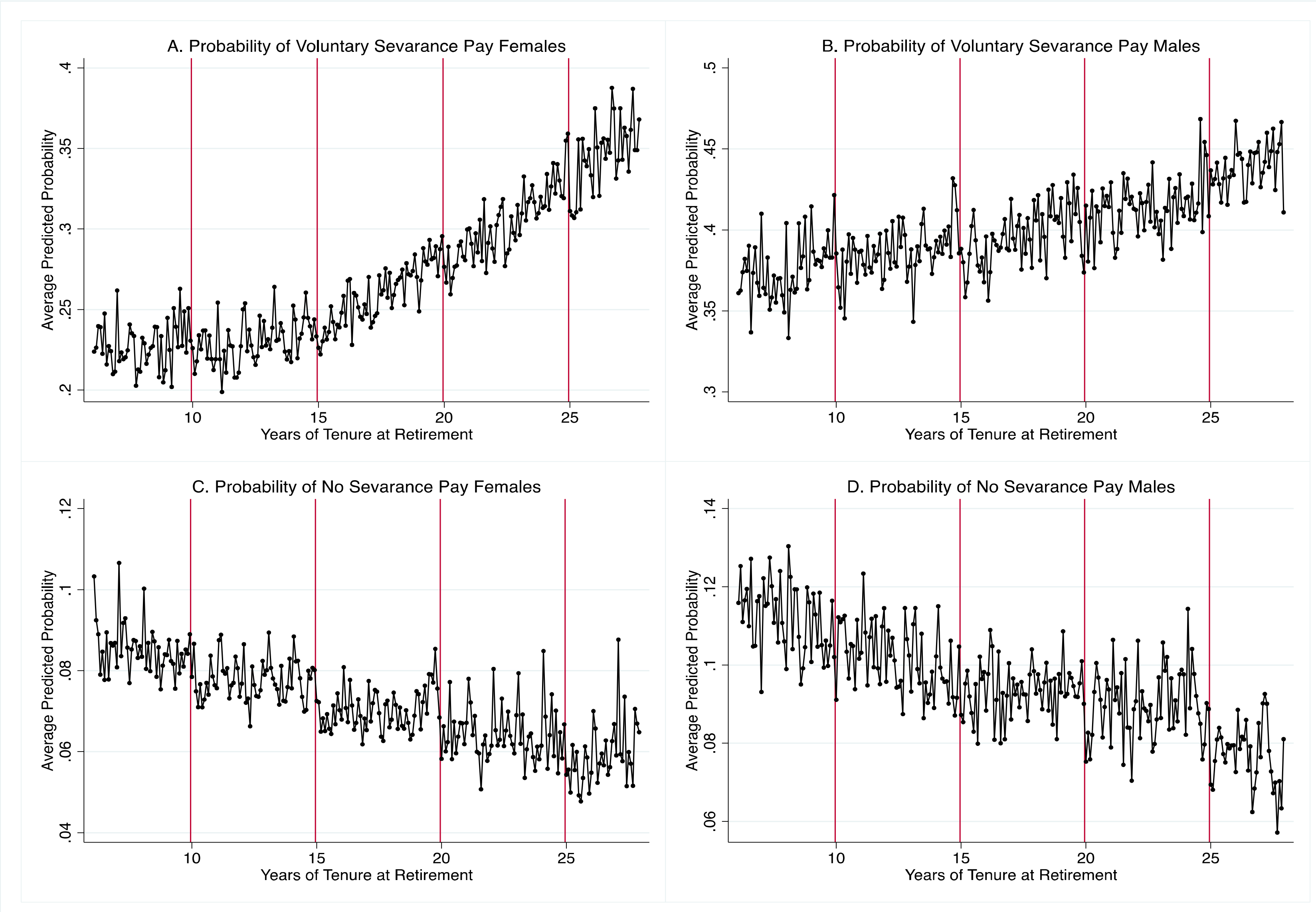
Notes: This figure plots the distribution of tenure at retirement across the different tenure thresholds. See Table 2 for the definitions of the samples around each tenure threshold with binding severance pay schedules and non-binding severance pay schedules.

Fig. 11. Percentiles of Severance Pay Fractions by Tenure at Retirement



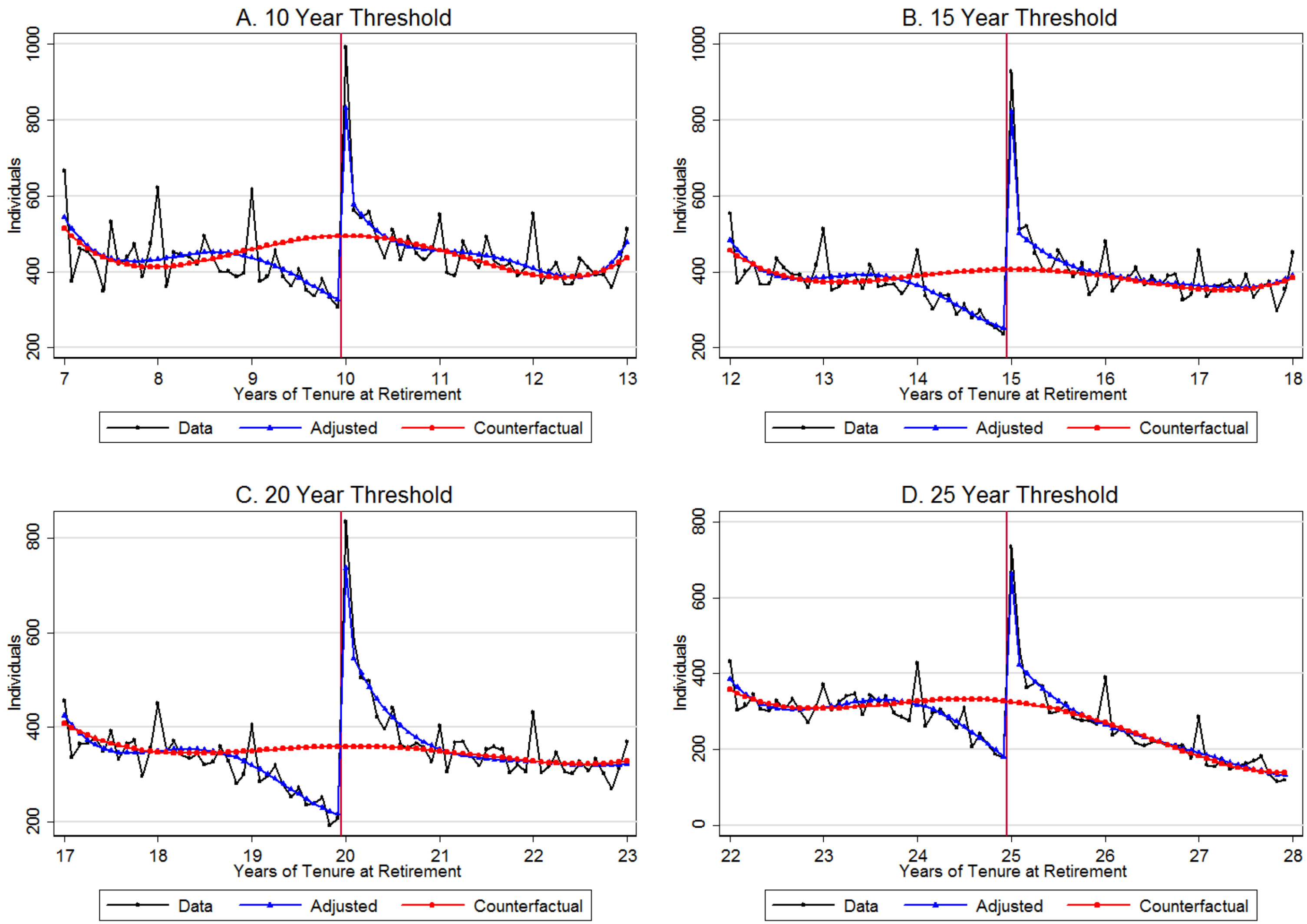
Notes: This figure plots the effective changes in severance pay fraction around each tenure threshold for the samples of individuals for whom the legislated severance pay schedule binds. Around each tenure threshold, the samples are also restricted to be within +/- three years of the tenure threshold. Around each threshold, we regress the individual-level severance pay fraction on linear trends in tenure on either side of the threshold and a discontinuity at the threshold. The estimated coefficient on the discontinuity at the threshold captures the effective change in the severance pay fractions at the given tenure threshold.

Fig. 12. Predicted Probabilities of Side Payments and Zero Severance Pay by Tenure at Retirement



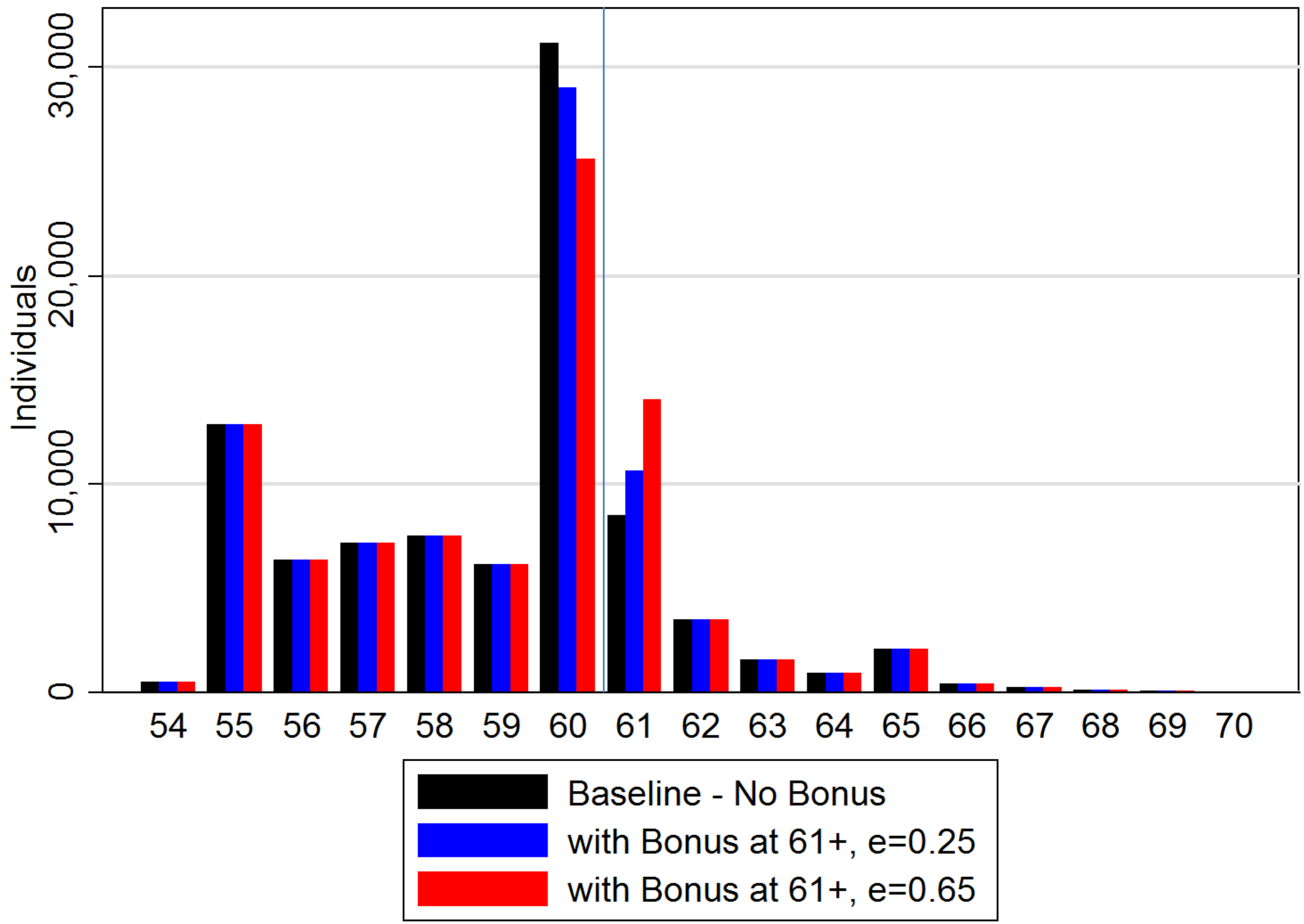
Notes: This figure plots the average predicted probabilities of receiving Side Payments or Zero Severance Payments by the monthly tenure level at retirement separately for Females and Males. The predictions are based on the regressions in Table 3a and Table 3b.

Fig. 13. Estimating the Changes in Retirements



Notes: This figure combines plots for the observed retirement frequencies (black squares), the seasonally adjusted retirement frequencies (blue triangles) and the counterfactual retirement frequencies (red circles).

Fig. 14. Labor Supply Responses to Retirement Bonus at 61 or Older



Notes: This figure plots retirement frequencies by age (horizontal axis). The blue bars present the frequencies observed in the data for the full sample. The blue and red bars present the frequencies under a hypothetical policy that provides a one-time, lump-sum retirement bonus of 5000 euros paid to individuals who retire at ages 61 or older. The blue bars present frequencies using and elasticity of 0.25 and the red bars present frequencies when using an elasticity of 0.65.