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The Effects of Increasing the Early Retirement Age on Employment of Older Workers

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The Effects of Increasing the Early Retirement Age on Employment of Older Workers

February 22, 2016

Abstract

This paper studies the effects of a series of reforms of the public pension system in Austria in 2000 and 2004. An important element of the reforms was the increase in the early retirement age (ERA), which was phased in linearly over several cohorts. The empirical analysis, based on detailed administrative data, distinguishes between pension entries, which are mechanically affected by the ERA, and job exits, which reflect individual labor supply decisions. The paper presents four main findings. (1) The cohort-wise increase in the early retirement age led to pronounced shifts in the spike of pension entries at the cohort specific early retirement ages. (2) Job exits shifted in an almost parallel fashion, which leaves little room for additional substitution with other social insurance programs. (3) An important mechanism leading to increased employment is that individuals keep their pre-retirement jobs longer. (4) To quantify the effects of the reform on average retirement ages, we use a regression kink design that exploits the increasing slope in the ERA by birth cohorts and relates it to a corresponding linear increase in the labor force exit and pension claiming ages. We estimate that a one year increase in the ERA leads to a 0.4 year increase in the exit age and a 0.5 year increase in the claiming age.

JEL-Classification: H55, J21, J26

Keywords: retirement, pension reform, regression kink design

1 Introduction

In many countries, there has been increasing pressure for social security reform due to demographic transitions and the generosity of government-provided retirement benefits. With this increasing pressure for reform, researchers and policy-makers are seeking to understand how potential changes to social security systems are likely to affect individuals' retirement decisions. The design of successful reforms crucially depends on understanding how incentives in social security regulations are perceived by individuals and how these incentives translate into decisions.

Security systems are typically framed around two age thresholds: the Early Retirement Age (ERA) and the Normal Retirement Age (NRA). The ERA is the youngest age at which individuals can become eligible to claim government provided retirement pensions. The NRA is the age around which legislation is framed and benefits are computed; retirements at ages prior to the NRA are deemed "early" retirements and there may be bonuses (increased benefits) for late retirements or penalties (reduced benefits) for early retirements. Empirical evidence across countries shows that generous early retirement regulations are associated with labor market exits at young ages and pronounced spikes in retirement hazards at crucial ages.

However, the mechanisms by which the ERA drives retirement decisions are not well understood, as there are types of incentives involved. First, the availability of benefits at the ERA which can induce individuals with liquidity constraints or self-control problems to exit the labor market. Second, the adjustment of benefits for retiring after the ERA is often not actuarially fair, which implies a large implicit tax on working beyond the ERA. For policy design it is valuable to know whether changes in the ERA or adjustments of benefits are more effective in motivating older individuals to remain in the labor force.

In this paper we study a series of pension reforms in Austria which implemented a step wise increase of the ERA over a range of birth cohorts. Our empirical analysis is based on administrative data from the Austrian Social Security Database, which record the universe of private sector employees in Austria. The data allows us to distinguish between two retirement-related outcomes: pension claims and job exits. This distinction is important for measuring labor supply, because pension claims should be mechanically related to changes in the ERA while job exits reflect labor supply decisions.

Graphical evidence shows that the reforms led to strong shifts in the spikes in job exits and pension claims according to the new ERA schedules. To quantify these effects we exploit the kinked schedule by which the reforms link quarterly birth cohorts and early retirement ages.

We implement a regression kink design that relates kinks in relationship between the average job exit and pension claim ages and birth cohorts to slope changes in the policy rule. The estimation results confirm the strong labor supply responses to the ERA. We estimate that a one year increase in the ERA leads to a 0.4 year increase in the exit age and a 0.5 year increase in the claiming age. The parallel shifts in job exit and pension claiming ages indicate that there is little room for substitution with other benefit programs such as unemployment insurance or sick leave.

The results from the empirical analysis contribute quasi-experimental evidence to a large literature on retirement decisions that has often lacked quasi-experimental variation. Earlier models of retirement decisions explained retirements at the ERA and NRA through preferences or exogenous age effects (see Burtless 1986 and Gustman and Steinmeier XX) or liquidity constraints and the availability of health insurance (see Rust and Phelan 1997). A more recent model from French (2005) emphasizes that, even in the presence of borrowing constraints that prevent borrowing against future social security benefits, individuals in the United States appear able to accumulate sufficient assets prior to age 62 so that increases in the ERA from age 62 to 63 would have little impact on retirement decisions. These earlier results have lacked quasi-experimental research designs because of a lack of policy variation, and hence they have been forced to rely on out-of-sample predictions or simulations to changes in the ERA (see also Panis et al 2002 and Gruber and Wise 2004). Our results based on responses to recent policy changes in Austria stand in contrast to these earlier intuitions. Specifically, we find that older employees delay their retirements and remain in their job longer when the ERA increases. These results are consistent with a significant body of research (see Gruber and Wise 1999, 2004 and Coile and Gruber 2002) that has emphasized implicit tax rates on work at older ages. These tax rates increase dramatically at the ERA, and especially in the case of benefit systems like Austria's that are actuarially unfair for most individuals, they create significant financial incentives to retire exactly at the ERA.

While our analysis is based on variation in the ERA, other papers have studied responses to changes in the NRA. Because benefit systems are often set up so that social security benefits are computed benefits based on the NRA, these studies have primarily focused on labor supply responses to changes in financial incentives rather than responses to changes in eligibility as in the case of the ERA variation. Mastrobuoni (2009) presents evidence of labor supply responses to changes in the NRA in the United States, and using similar variation, Duggan, Singleton and

Song (2007) highlight substitution to disability insurance in response to reduced social security benefits due to increases in the NRA.

Most closely related to the present analysis, Staubli and Zweimüller (2013) study the effects of the Austrian reform on employment and program substitution using the same policy variation. While there is some difference in methodology (a difference-in-difference analysis in the case of Staubli and Zweimüller versus a regression kink analysis in our case), a key difference between the analyses is based on the differences in the analysis samples and the labor supply margins that are studied. The Staubli-Zweimüller analysis focuses on all men and women with less than full labor market experience since these individuals should have been directly affected by the increases in the ERA (as described in more detail in the Institutional Background, men and women with full experience were exempt from the increases in the ERA). Thus, many of the individuals in the Staubli-Zweimüller analysis sample may already have been out of the labor force prior to the ERA. Our analysis focuses solely on individuals who were employed at older ages prior to the ERA so that we can study if these individuals delayed their retirements and remained employed longer in response to increases in the ERA. Furthermore, our analysis sample includes individuals who were exempt from the increases in the ERA so that we can directly examine spillovers in the form of labor supply responses by these exempt individuals who were also employed at older ages.

This paper is organized as follows. In the next section, we discuss the institutional background and data. In Sections 3 and 4, we present the main empirical analysis of the effects of the pension reforms on pension claims and job exits.

2 Institutional Background

2.1 The Austrian Pension System Before 2000

Austria has a universal government provided pension system that automatically enrolls every worker who is employed in the private sector. This system is operated as a traditional pay-as-you-go system. Social security contributions along with unemployment and health insurance contributions are withheld from the the worker's salary up to a contribution cap. Throughout the working life an individual accumulates *insurance years* either in the form of *contribution years* by actively contributing to the system when employed, or in the form of *additional qualifying years* that accrue due to unemployment, military service, parental leave, or sickness leave. At the end of the working life a worker receives pension benefits from the system.

Eligibility for pension benefits depends on age at retirement and a minimum number of insurance years. The normal retirement age (NRA) at which individuals with at least 15 insurance years become eligible for the *old age pension* is 65 for men and 60 for women. The system also allows access to pension benefits through an *early retirement* pathway. The early retirement age (ERA) is 60 for men and 55 for women. Early retirement pensions can either be accessed if an individual has 35 or more insurance years or if she is long-term unemployed with at least 15 insurance years. In addition, an individual can access benefits through the *disability pension*. Access depends on a severe health impairment that lasts for at least 6 months. Medical criteria for disability access are relaxed with age and significantly loosened starting age 57.¹ For this reason disability plays an important role in early retirement.

Pension benefits are determined by an individual's revaluated average gross earnings over a baseline period of 15 years with highest earnings qualifying for social security contributions. This *assessment basis* is multiplied by the *pension coefficient*, which depends on age at retirement and the number of insurance years. The maximum pension coefficient is 0.8, which implies that the maximum pension benefit amounts to 80% of the average gross earnings over 15 years. Most of the Austrian pension reforms targeted the pension coefficient rather than the assessment basis. Up to 1993, the pension coefficient was not age dependent, it increased by 2 percentage points for each insurance year. A worker reached the maximum pension coefficient with 40 insurance years and was not able to increase the pension benefit by working longer. A reform in 1993 introduced penalties for retiring before the NRA by making the pension coefficient age dependent. The average penalty for one year of early retirement ranged between 2% and 4%. But the maximum pension coefficient of 0.8 still applied, such that individuals with more than 40 insurance years faced the smallest penalties for early retirement. The pension coefficient was slightly adjusted by a pension reform in 1996 that lowered the average penalty for early retirement. The 2000 and 2004 pension reforms introduced more severe penalties for early retirement raising the average penalty for each year of early retirement to about 8 - 9 % bringing the system closer to actuarial fairness.

Individuals receiving pension benefits pay contributions to health insurance and the pension is subject to income tax. The resulting net replacement rate is roughly 75% on average, which makes the pension the major source of income of retired individuals and private pensions play a minor role. Labor earnings of individuals receiving early retirement benefits are taxed at 100%,

¹Staubli (2011) studies the effects of 1997 reform in disability pension which raised the age from 55 to 57 for men.

if they exceed a low threshold (376 Euro per month in 2012). Employment protection, which tends to be high for older workers, is discontinued at the NRA and workers can be laid off by their employers at age 65 (60) without cause.

2.2 Pension Reforms in 2000 and 2004

Budgetary problems and projections indicating serious long-term problems with fiscal sustainability of the Austrian pension system led the government to implement a series of reforms between 2000 and 2004. The main aim of these reforms was to raise the low effective retirement age, increase labor force participation of older workers, and reduce the generosity of the benefit system. For a detailed overview of the reform steps and a discussion of the fiscal implications see Knell et al. (2006). Here we focus on components of the reform that are relevant for labor supply decisions, namely the increase in the ERA and changes in the pension benefit formula.

Increase in the Early Retirement Age

The pressure for reforms of the pension system was discussed in public throughout the late 1990's and several components of the reform package that was implemented in 2000 were already passed into law in late 1996. But the reform of the early retirement age and the exact schedule by which it was rolled out were mostly unexpected. The implementation of the increase in the ERA started immediately after the law passed parliament in August 2000 and the first cohort of affected workers were those who became eligible for early retirement under the old rule in October 2000.

The reform scheduled an increase in the early retirement age for men to 61.5 and for women to 56.5. It was implemented cohort-wise starting with men born in the fourth quarter of 1940 and with women born in the fourth quarter of 1945, whose ERA was raised to 60 (55) plus two months. The ERA for each subsequent quarterly cohort was raised by an additional 2 months. In August 2003 an extension of the ERA increase was passed, which continued the cohort-wise increase up to age 62 for men and 57 for women. For subsequent cohorts the increase in ERA slowed down to 1 month by quarterly cohort. We refer to this second part of the ERA increase as the 2004 reform. The overall schedule leads to an elimination of the early retirement option by 2017, when the ERA equals the NRA for both men and women. The green squares in Figure 1 show the reformed ERA schedule by cohort in Panels A and B for women and men, respectively. Horizontal red lines mark the initial cohorts affected by the increases from the 2000 and 2004 reforms.

This general schedule of increasing early retirement ages allows for two exemptions, which are also shown in Figure 1. As an element of a newly established retirement corridor around the NRA of 65, the *corridor pension*, was introduced in 2004, which allows men to access early retirement at age 62 if they have accumulated at least 37.5 insurance years.

To acknowledge "hard workers" who have contributed to the social security system throughout their careers an exemption for individuals with *long contribution years* was introduced. It applied to men with at least 45 contribution years and women with at least 40 contribution years, who could still access early retirement at age 60 or 55. Note that this exemption applies to individuals who enter the labor market at age 15 and remain employed throughout, interrupted only by a limited number of years on military service or parental leave.² Initially in 2000 this exemption was only planned for few birth cohorts. But it was subsequently extended and stayed in place until 2011.

The access to early retirement for individuals who are long-term unemployed was closed in 2004. Consequently only individuals with at least 35 insurance years can draw early retirement pensions if they did not qualify for disability.

The reformed ERA schedule sets very clear incentives for individual decisions to claim benefits or exit the labor market. It is important, however, to distinguish between individuals who are potentially eligible for the exemption with long contribution years and individuals who do not fall under the exemption. We will call them individuals with *long contribution years* and individuals with *short contribution years* in the following (see section 3 for detailed definitions in our data). For individuals with short contribution years the reformed ERA schedule delays the option to claim pension benefits to later ages. Therefore they face strong incentives to delay exits and pension claims until the new ERA. With the reform, individuals with long contribution years can still claim pension benefits at an unchanged ERA, if they accumulate 45 or 40 contribution years, which essentially requires that they remain employed until age 60 (55). If these individuals exit before age 60, and thus fail to accumulate sufficient contribution years, they cannot claim early retirement benefits until they reach their cohort specific ERAs. Therefore they face a strong incentive to exit and claim at age 60 (55), but not earlier.

Individuals with health problems, who exit the labor market before the ERA, can apply for disability benefits. Eligibility for DI is linked to a reduced work capacity at least 50% in any occupation. Starting with age 57 the eligibility criterion applies only to the individual's last

²In Austria the majority of each cohort leave school at age 14 and enter the apprenticeship system or enter the labor market directly. In both cases they start contributing to the social security system. Labor force participation below age 20 is high in Austria compared to other countries.

occupation, which implies that at this age a wider group of individuals become eligible for DI. The pension reform in 1996 increased this age threshold from 55 to 57. The first cohort affected are individuals born in the last quarter of 1941, who turned 55 after September 1996.

Changes in Penalties for Early Retirement

The second component of the 2000 pension reform aimed at reducing benefit generosity and increasing penalties for early retirement. With January 2000 the formula defining the pension coefficient was simplified. Each insurance year counts for two percentage points of the pension coefficient. Individuals drawing pension benefits before the NRA face a penalty of 2 percentage points for each year of early retirement with a maximum penalty of 10 percentage points. A second cap states that the reduction can be at most 15% of the pension coefficient before penalty. With the increase in the ERA starting in October 2000, the penalty was adjusted to the step-wise schedule, such that the maximum penalty for retiring at the cohort-specific ERA remains at 10 percentage points. For example, for the cohort with ERA of 61 the penalty for each year of early retirement amounts to $10/4 = 2.5$ percentage points. However, the cap at 15% still applies, which is particularly relevant for individuals with high pension coefficients.

In 2004 the formula for the pension coefficient was changed again and a system with penalties and bonuses for retirements earlier or later than the NRA was introduced. The factor for each insurance year is reduced from 2 to 1.78 percentage points, such that 45 insurance years are now required to reach the maximum pension coefficient. Each year of early retirement before the NRA lowers this pension coefficient by 4.2 percent with a maximum penalty of 15%. In order to avoid too abrupt changes in the benefit formula an additional cap was introduced at a fixed fraction of the pension coefficient computed according to the pre 2004 formula. For individuals first becoming eligible for pension benefits in 2004 this fraction was 95% and it was decreased in the subsequent years. Interestingly, the discounted pension coefficient according to the pre-2004 formula is higher than the pension coefficient computed with the reformed 2004 formula for most individuals who first become eligible for early retirement benefits from 2006 onwards.

The pension coefficient for men retiring under the corridor pension at age 62 is computed by the pre-2004 formula and applies two sets of penalties. First, a penalty of 2 percentage points for each year of retiring before the NRA is deducted. Second, a penalty of 2.1% for each year of retirement before the cohort specific ERA is applied.

To visualize the change in financial incentives by birth cohort, Panels A and C in Figure 2 plot the percent increase in the pension coefficient from retiring at the cohort specific ERA versus

retiring one year after the ERA for women and men who do not qualify for the exemption due to long contribution years. The means by quarterly cohort in the figure are based on observations of individual insurance years in our analysis sample (see section 3 for details). Even though the rules for computing benefits are identical for women and men, women have on average accumulated fewer insurance years than men due to their lower ERAs. The figure shows that before 2000 penalties for early retirement were slightly higher for women and benefits increased between 3 and 5 percent for one year of delayed retirement, which is below the actuarially fair rate. With the 2000 pension reform penalties started to rise; initially more so for women than for men, for whom the caps in penalties applied. The 2004 pension reform raised penalties significantly bringing the gain in benefits for one year of delayed retirement up to 8-9%, which is close to actuarially fair.

Individuals with long contribution years, who qualify for the exemption from the ERA increase after the reform, face different financial incentives for early retirement. Men with 45 contribution years always reach the maximum pension coefficient of 0.8 even after accounting for penalties. For women with 40 contribution years penalties for retiring at age 55 apply with the 2000 pension reform. However, the pension reform 2004 eliminated penalties from early retirement for both men and women with long contribution years. For individuals who hit the maximum pension coefficient, financial incentives to delay retirement beyond age 60 (55) are zero. In contrast, leaving the labor force at ages younger than 60 or 55 and claiming benefits at the ERA had minor effects on the pension coefficient before 2000, which created a strong incentive for individuals with long contribution years to exit the labor force before the ERA. The 2000 pension reform changed this incentive, it allowed individuals to claim benefits at age 60 (55) if they reach 45 (40) contribution years, which essentially requires that they stay employed as any job interruption does not count as contribution time. To visualize how financial incentives for exiting before age 60 change over cohorts for individuals with long contribution years, Panels B and D of Figure 2 plot the benefit increase of exiting the labor market with 44 (39) contribution years and claiming at the cohort specific ERA versus claiming benefits at age 60 (55) with 45 (49) contribution years for women and men, respectively.³ The figure shows that before 2000 the financial incentives of exiting at the ERA are very low, individuals who exited

³We consider as alternatives to either remain employed until age 60 and claim benefits with 45 contribution year or to exit employment at age 59 with 44 contribution years. Individuals choosing this second option are eligible to claim UI benefits for up to 12 months and they can apply for disability benefits. However, because eligibility for disability depends on health this option is not open to everybody. We therefore assume that the earliest age at which they can claim pension benefits is the cohort specific ERA. With the 2000 reform benefit cuts would be higher for individuals claiming before the ERA, because higher penalties apply. Large gender differences only 2.4% of women with long contribution years claim disability benefits.

one year early only faced a benefit cut of around 2%.⁴ This basic pattern did not change with the 2000 reform. The reason is that even though penalties for early retirement were increased, caps on the maximum penalties applied to individuals with long contribution years. In 2004 all penalties for retiring at 60 with long contribution years were abolished and the pension coefficient for retiring at 60 was set to 0.8 for both men and women. Individuals with 44 contribution years retiring at their cohort specific ERA still were subject to increased penalties, which raised the cost of choosing this option to about 7% for men and to 12% for women. In addition to benefit cuts, these individuals also faced increasingly long waiting times from age 59 (54) until the cohort specific ERA as the ERA reform schedule progressed.

Overall, Figure 2 illustrates that financial incentives to delay retirement around the ERA increased over the cohorts affected by the 2000 and 2004 pension reforms. These changes do not follow the kinked schedule of the ERA reform in Figure 1, however. Our empirical strategy is to identify responses to the ERA around the kinks in the schedule. If we compare incentives from the ERA schedule change and financial incentives due to the changes in the pension coefficient, we argue that the ERA schedule is much more transparent and easier to understand than the benefit adjustments. Eligibility for ERA is only based on birth cohort, while benefits depend on several factors. The formulas are complex, many different caps apply, and in most cases computations across multiple regimes have to be compared before the final benefit is determined. Furthermore, changes in benefit formulas were introduced repeatedly and with short notice. In several cases the formula was even changed retroactively. For example, the 2004 reform originally stipulated penalties for early retirement at age 60 for individuals with long contribution years (by a law passed in August 2003). However, in December 2004 a new law overruled this regulation, penalties were dropped and benefits for individuals retiring in 2004 had to be re-computed. Another example is the computation of the corridor pension, which was changed in 2007. Given these information problems, it was hard for retirees to optimally respond to financial incentives. Individuals planning to retire at a certain age did not have sufficient information about benefits they would receive at alternative retirement dates. We will therefore attribute the observed changes in exit and claiming ages in the data to changes in ERA rather than financial incentives, also assumed by Staubli and Zweimüller (2013).

⁴The figure is based on the assumption that individuals who exit with 44 contribution years cannot accumulate additional insurance years, say by registering as unemployed. For those individuals the gain in benefits would be zero.

Components of the 2004 pension reforms with long-run perspective

The pension reform passed in 2004 also included steps that aimed at the long-run sustainability of the Austrian pension system and affects cohorts born in 1955 and later. The main components include the scheduled increase in the statutory retirement age for women from 60 to 65 between 2024 and 2034 in half-year steps and the introduction of pension corridor around the uniform NRA of 65. Individuals are free to choose the age at which they start claiming benefits in a 6 year window around age 65, with penalties for early retirement before 65 and bonuses for delayed retirement between 65 and 68. By age 68 all workers are supposed to leave labor force and employment protection is discontinued at this age.

A further change concerns the establishment of a new pension account system that reshapes the defined benefit model. The new system is based on individual accounts and lifelong assessment periods. To phase-in this adjustment, the assessment basis starting increasing from 15 years up to 40 years in 2004 increased by one year each ann cohort.

3 Data and Descriptives

Our empirical analysis is based on administrative data from the Austrian Social Security Database (ASSD, see Zweimüller et al. (2009)). The records are collected with the main aim of verifying individual pension claims and computing individuals' pension benefits. For research they provide unique longitudinal information for the universe of private sector workers throughout their working lives. In particular, we observe employment and earnings careers at a daily level along with information on other insurance states that are relevant for social security such as military service, unemployment, maternity leave and sick leave. At retirement information on spells with receipt of benefits in disability, early retirement, and old age pensions is recorded.

For the analysis of the 2000 and 2004 pension reforms we focus on men born between 1930 and 1948 and women born between 1935 and 1952 and restrict our sample to workers who are still employed at age 53. Using labor market careers we can compute the accumulated insurance and contribution years at age 53 along with other characteristics of the earnings and employment careers.⁵ Starting age 53 we follow the individuals until the day when they (i) exit the labor market, (ii) start claiming pension benefits, or (iii) reach age 70. The observation period in the data ends in 2012 and thus we have virtually no censored observations.

⁵Some data limitations are due to changes in the recording in the ASSD. Insurance careers of men in the older birth cohorts are recorded from retrospective records in the years before 1972 and thus less precise than information from later years. For women born in 1938 and earlier we do not observe full information on maternity leave spells as child care times were not taken into account in the computation of pension benefits before 1993.

To identify individuals who are potentially eligible for the exemption from the ERA increase, we distinguish between two groups based on their insurance careers at age 53. Individuals with *long contribution years* have accumulated 38 or more contribution years at age 53.⁶ If these individuals remain employed until age 60 (55) they can be exempt from the ERA increase with the 2000 pension reform. Individuals with *short contribution years* have accumulated less than 38 contribution years at age 53 and thus cannot be eligible for the exemption at age 60 or 55.

Table 1 provides descriptive statistics for the female and male samples. We distinguish between individuals with short contribution years and the full sample. In total we have 357,147 observations for women and 386,830 for men. Individuals with short contribution years account for 80% of the full sample of women, but only for 60% of men. As expected, individuals with short contribution years have less stable employment careers and lower earnings than the average individual in the full sample. The pathways to retirement also differ by gender. Only 10% of women retire through disability, but the share is almost 40% among men.⁷

3.1 Job Exits and Pension Claims After Age 53

To get a first impression of employment and claiming responses to the reform of the ERA schedule we plot survival curves from age 53 until job exits and pension claims for selected birth cohorts in Figures 3 and 4 for women and men, respectively. Figures 5 and 6 show the corresponding graphs for the samples with long contribution years.

Starting with Figure 3 we investigate women in cohorts with increasing ERAs. The red lines indicate survival rates until job exits and blue dashed lines survival rates until pension claims. The first two panels show cohorts of women not yet affected by the ERA increase. For both cohorts exit patterns are very similar. Between age 53 and 55 about 25% leave their jobs and at age 55 another 25% exit. Pension claims are initially close to zero and there is a large drop of about 40% at the ERA of 55. After age 55 participation gradually decreases, the gap between the red and blue lines are small indicating that individuals who exit their jobs at these ages claim benefits without long delays. The remaining individuals exit the labor market and claim pensions at the NRA of 60.

Among the cohorts affected by the 2000 and 2004 pension reforms we see a shift in the survival curves. The major drops in job exits and pension claims move to the higher cohort

⁶contribution time: employment, voluntary insurance, education, up to 2.5 years of military service up to 5 years of maternity leave.

⁷The share of early retirement is underreported, especially among men, as the ASSD records do not distinguish between different types of pension benefits before the year 1993.

specific ERA's, indicated by the vertical lines. There are smaller drops at age 55 which are due to individuals with long contribution years. Interestingly, the job exit rate before age 55 strongly declines and is less than 10% for the cohort born in 1953. The share of women remaining in the labor force past the ERA until age 60 is also increased over the cohorts. While in the 1943 cohort 20% have not claimed by age 60, this share is almost twice as high in the 1951 cohort.

Corresponding graphs for the male sample are shown in Figure 4. In the pre-reform cohorts 1938 and 1939 participation steadily declines from age 53 to age 60 and a gap opens up between job exits and pension claims. Before age 60 about 45% are claiming disability benefits and roughly 65% of men have exited their jobs. Then we see a big drop in job exits and pension claims at the ERA of 60 and very low shares of individuals remaining in employment. By the NRA of 65 virtually all individuals have left the labor market for a long time.

As for women, we see pronounced shifts in the drops of exit and claiming rates to the post-reform ERAs among men. There are smaller drops at age 60 when individuals with long contribution years become eligible for early retirement benefits. Overall the gaps between job exit and pension claiming ages become smaller across cohorts and especially the gap prior to the ERA is reduced. This indicates that substitution with other social insurance programs such as UI or sick leave is not a major response to the increase in the ERA. If individuals would still exit their jobs at younger ages and move to other programs before they become eligible to claim benefits at the post-reform ERA's we would see a widening of the gaps, which is certainly not the case.

To see how the response of individuals with long contribution years changes, who based on their careers at age 53, are potentially eligible for the exemption from the ERA increase, we plot survival graphs for these samples.⁸ In Figure 5 we see that in the pre-reform cohorts a substantial fraction of women with long insurance years already exit their jobs before age 55. Subsequently, roughly 75% of each cohort claim early retirement pensions and the remaining individuals leave the labor market shortly after that. For post-reform cohorts we also see drops in the exit and claiming rates at age 55 but much smaller in magnitude, around 30%, than among pre-reform cohorts. The probability of job exits before age 55 decreases among the post-reform cohorts. This is in line with the strong incentive to remain employed until the age 55 to qualify for the exemption from the ERA increase.

For men the evidence in Figure 6 is similar. While in the pre-reform cohorts a high share of men with long contribution years exit their jobs before age 60, this share declines drastically

⁸We show figures for individuals with short contribution years in the appendix.

among in the post-reform cohorts and the gaps between pension claim and job exit rates become much smaller. In the 1938 and 1949 cohorts 45% claim disability benefits before age 60 and 70% have exited employment. In the 1948 cohort the corresponding shares are about 20% and 25%. There are still large drops in job exits and pension claims at age 60 in the post-reform cohorts but much higher fractions of individuals remain in the labor force between age 60 and roughly 62 than in the pre-reform cohorts.

4 Empirical Strategy

The graphical previous section shows clear responses to the pension reforms in 2000 and 2004 in terms of exit and claiming ages. The spikes in exit and claiming ages shift to the higher cohort-specific ERA's, but also other parts of the distribution of exit and claiming ages change. To quantify the overall response to the pension reform, we exploit the kinked schedule that links quarterly birth cohorts and early retirement ages in 1. In particular, the green line that shows the change in ERA's without exemptions, features two kinks where the slope between birth cohort and ERA changes: the first at the onset of the 2000 pension reform and the second at the 2004 reform. We will exploit both kinks to measure the average response of the exit and claiming ages to the ERA.

Our strategy is to use corresponding kinks in the relationship between exit and claiming ages and birth cohorts and relate slope changes in the outcome relationship to the slope changes in the policy rule according to the 2 pension reforms using a regression kink (RK) design. Since the ERA is a function of birth date, it is likely to be correlated with other characteristics that determine labor supply. A regression kink design circumvents this endogeneity problem by using the quasi-experimental variation induced by the pension reform.

Specifically, let Y be the outcome of interest, i.e. claiming age or age at exit from the labor force, ERA the early retirement age as determined by the policy rule, and V the birth date. Card et al. (2015) show that under smoothness conditions, the RK estimand

$$\frac{\lim_{v_0 \rightarrow 0^+} \frac{dE[Y|V=v]}{dv} \Big|_{v=v_0} - \lim_{v_0 \rightarrow 0^-} \frac{dE[Y|V=v]}{dv} \Big|_{v=v_0}}{\lim_{v_0 \rightarrow 0^+} \frac{dE[ERA|V=v]}{dv} \Big|_{v=v_0} - \lim_{v_0 \rightarrow 0^-} \frac{dE[ERA|V=v]}{dv} \Big|_{v=v_0}} \quad (1)$$

identifies a weighted average of the marginal effects of the ERA on Y . The identification assumptions in Card et al. (2015) give rise to the testable implication that the distribution of V and the conditional expectation function of any pre-determined characteristics are continuously

differentiable at $V = 0$.

In a sharp RKD, the ERA is a deterministically linked to the birth date and thus a deterministic function of V . In this case the denominator of 1 is a known constant. In our application we consider estimates separately by gender but we want to apply them to different samples, composed of individuals who are potentially not all subject to the same ERA rule. For example, some men are eligible to retire with under the corridor pension at 62 which is earlier than the cohort specific ERA according to the policy schedule, if we pool them with other men who are not eligible for the corridor pension the average ERA in this group is not determined by the schedule. To account for the compositional differences it is more convenient to apply a fuzzy RKD and to estimate the slope change of the first stage function $E[ERA|V = v]$.

For estimation we follow Card et al. (2015) and adopt local polynomial estimators for the slope changes in the numerator and denominator of 1. We present local linear linear estimates using alternative bandwidths, as well as the bias-corrected estimates per Calonico et al. (2014). However, the asymptotic of the formal estimators do not fully apply in our case, as the policy formula is not continuous but defined at the quarterly level. This does not allow us to choose very small bandwidths that are arbitrarily close to the cutoff.

To define the individual ERA according to the reform schedules in the 2000 and 2004 reforms we apply the following procedure. We assume that eligibility for different types of ERA's – early retirement with long insurance years, corridor pension, and the exemption for individuals with long contribution years are determined by an individual's insurance career at age 53 and that every individual stays employed from age 53 until the exit from their last job. We thus set the ERA equal to the gender and cohort specific ERA for individuals with short contribution years (with less than 38 contribution years at 53) and for men who have accumulated less than 29.5 insurance years at age 53. We define the ERA as 62, the corridor pension age, for men with short contribution years and with more than 29.5 insurance years at age 53. For individuals with long contribution years, we define the ERA as age 60 for men and 55 for women.

Before we discuss estimation results, we check the validity of the design via the testable implications on identifying assumptions. First, the identifying assumptions in Card et al. (2015) imply a continuously differentiable density of the running variable V following the argument that endogenous sorting would invalidate this assumption. In our case, the ERA is defined by birth cohort, which is obviously exogenous and not subject to manipulation for individuals close to retirement. As the pension reforms are implemented with a long-run perspective it is also

not plausible that policy makers would have chosen particular cohorts to start the reform. We plot the frequency of observations by birth cohorts in Figure 7 for four samples, women and men with short contribution years, and the full samples of women and men. The patterns in these figures do not appear smooth around the vertical lines marking the 2000 and 2004 pension reforms. They are driven by strong fluctuations in birth rates around the second world war. It is important to note that the fluctuations in our sample directly mirror patterns by birth cohorts in the overall population.

As second check we assess the smoothness of pre-determined covariates around the cutoff dates. Table 6 shows estimation results of local linear regressions for a set of observable characteristics. Most of the coefficient estimates are insignificant which supports our assumptions. To combine multiple covariates we estimate composite covariate indices by predicting the individual claiming and exit ages by information on employment and earnings histories at age 53. For some samples the predicted ages appear kinked according to the estimate in Table 6. However, the coefficients are very small, an order of magnitude smaller than the actual claiming and exiting ages which are presented below. Therefore we conclude that kinks in covariates are not driving the main results. Figures 8 and 9 provide a graphical confirmation of the smoothness of predicted exit and claiming ages around the reform cutoffs.

Gelber et al. (2016) Gelber et al. (2013)

5 Results

This section presents results from the fuzzy RKD analysis. We first present graphical evidence and then turn the regression estimates. Figure 10, 11 and 13 present the main graphical results of the RKD analysis as the plot the first stage and reduced form exiting and claiming age results respectively. In each figure, we present results for individuals with short contribution years for whom the pension reforms were more likely to be directly binding without any exemptions, as well as for the full sample of individuals.

The plots in Figure 10 illustrate that for women with short contribution years, the pension reforms lead to roughly a 2-year increase in the ERA between the 1945 and 1948 cohorts, and another 2 year increase in the ERA between the 1949 and 1954 cohorts. For men with short contribution years, the pension reforms led to a 2-year increase in the ERA between the 1940 and 1943 cohorts, and a 0.5 year increase between the 1944 and 1949 cohorts. The plots for the full sample illustrate similar results, but the plots show slower increases in the ERAs across

cohorts as some individuals in the full sample were exempt from the pension reforms. In the full sample of women, the ERA increased by roughly 1.5 years between the 1945 and 1948 cohorts, and then again by 1.5 years between the 1949 and 1954 cohorts. For men in the full sample, the ERA increased by roughly 1 year between the 1940 and 1943 cohorts, and then by 0.5 years between the 1944 and 1949 cohorts.

Figure 11 presents the reduced form plots of average job exiting ages across quarterly birth cohorts. The plots illustrate evidence of increases in the average exiting ages exactly for the cohorts affected by the reforms, and the increases in the average exiting ages across cohorts appear to slow down when the increases in the average ERAs slow down. For women with short contribution years, the average exiting age appears to increase by roughly 1 year between the 1945 and 1948 cohorts, and by about 0.5 years between the 1949 and 1954 cohorts. The full sample results for women show increases of similar magnitudes. For men with short contribution years, the average exiting ages increase by about 1 years between the 1940 and 1943 cohorts, and by about 0.5 years between the 1944 and 1949 cohorts. The full sample results for men show slightly smaller increases in average exiting ages. Interestingly, the rate of increases in the average exiting ages for later (or more recent, younger) cohorts does not seem very different from the rate of increase for older cohorts subject to similar increases in the ERA. This suggests that short-run and medium-run labor supply responses to the increases in the ERA are similar. This is interesting to note since the more recent cohorts had more time to adjust to and anticipate the higher ERAs that applied to them. The results demonstrate that, even with the additional time, the increases in the ERA led to similar responses in exiting ages.

Figure 13 presents the reduced form plots of average claiming ages across quarterly birth cohorts. Following the increases in the ERAs across birth cohorts, the plots demonstrate sharp increases in claiming ages for cohorts affected by pension reforms. The plots for women with short contribution years show increases in average claiming ages of roughly 1.25 years between the 1945 and 1948 cohorts, and of roughly 0.25 years between the 1949 and 1954 cohorts. The plot for the full sample of women shows increases in average claiming ages of similar magnitudes. The plot for men with short contribution years shows increases in average claiming age of roughly 2 years between the 1940 and 1943 cohorts, and roughly 0.5 years between the 1944 and 1949 cohorts. The plot for the full sample of men illustrates slightly lower increases in average claiming ages of roughly 1.5 years between the 1940 and 1943 cohorts, and roughly 0.5 years between the 1944 and 1949 cohorts.

Table 9 presents the corresponding regression results. These results serve to quantify the changes in the slopes of the average ERAs, exiting ages and claiming ages across birth cohorts illustrates in the figures. By taking the ratio of these slope changes, the fuzzy RKD analysis yields estimates of the impacts of an increase in the ERA on exiting and claiming ages. First, Table 9 presents estimates for the 2000 pension reform. The first stage results estimate the changes in the slope of the ERA across cohorts. The results for individuals with short contribution years show a change in the slope of 0.666 years per annual birth cohort, corresponding to an increase in the ERA of roughly 2 years across 3 annual birth cohorts. In the full samples, the estimated slope changes are slightly smaller. The reduced form results in Table 9 present the estimated slope changes in the average exiting and claiming ages across cohorts around those cohorts just before and after the 2000 pension reform applied. We will focus on the magnitudes of these slope changes in more detail below in the discussion of the fuzzy RKD estimates.

Table 9 presents similar first stage estimates for the changes in the slopes of the average ERAs for those cohorts just before and after the 2004 pension reform took effect. These estimated slope changes are negative since the pension reform reduced the rate of increase in the ERAs across cohorts (i.e. the reform made the slopes flatter). For example, the reform changes the ERAs across cohorts so that, rather than continue to increase the ERA by 2 years for every 3 annual cohorts (equivalently 0.666 years per cohort), the ERA would increase by 2 years for every 6 cohorts (equivalently 0.333 years per cohort). This implies a change in the rate of increase in the ERA across cohorts of -0.333 years per cohort. Similarly for men, the reform reduced the rate of increase in the ERA for men with short contribution years from 0.666 years per cohort to roughly 2 months (equivalently 0.167 years) per cohort, so the slope in the ERA changed by roughly -0.533 years per cohort. The slope changes for the full sample are smaller in magnitude given that some individuals were exempt from the changes in the pension reforms.

We turn to the fuzzy RKD estimates in Table 4 to present the estimated effects of changes in the ERAs on average exiting and claiming ages. The fuzzy RKD estimates reflect the impact of increasing the ERA by 1 year on average exiting and claiming ages. These estimates are based on the ratios of the estimated slope changes in the ERAs and the corresponding reduced forms. For example, for women with short contribution years, based on the 2000 pension reform, we estimate that a 1-year increase in the ERA increases the average exiting age by roughly 0.39 years. This estimate reflects the ratio of a change in the slope of average exiting ages of 0.259 years per cohort divided by a change in the slope of the ERA of 0.666 years per cohort ($0.259/0.666$

= 0.39).

Focusing on the 2000 pension reform results, for individuals with short contribution years, the results demonstrate that a 1-year increase in the ERA increases exiting ages by roughly 0.4 years and claiming ages by roughly 0.5 years. These results are similar for men and women. The result that the average claiming age does not increase by 1 highlights that many individuals may be exempt from the increase in the ERA. Additionally, the result that the estimated effect for exiting ages is only slightly smaller than the effect for claiming ages highlights that many individuals appear to adjust their retirement so they remain employed longer when the ERA increases, and there is only a slight increase in gap length between job exiting and pension claiming. Thus, there is little evidence of substitution to alternative pathways into retirement such as through UI or DI pensions. Next, the full sample fuzzy RKD estimates show slightly larger effects. The full sample estimates may be larger than the estimates for those with short contribution years because of spillover effects (responses by those for whom the ERA increases did not directly bind). For women with short contribution years, the estimates based on the 2004 pension reform indicate that a 1-year increase in the ERA led to roughly a 1-year increase in the average claiming age. This may have been due to there being fewer exemptions from the increases in the ERA in the 2004 pension reform. The estimate beyond 1 (i.e. an increase in the ERA of 1 year leading to an increase in the average claiming age of roughly 1.3 years) for the full sample of women in the 2004 pension reform may be further evidence of potential spillover effects.

While the graphical evidence thus far has primarily focused on individuals with short contribution years or the full sample, Figure XX presents separate graphical evidence on average exiting and claiming ages specifically for individuals with long contribution years. It is useful to look at these individuals separately from the rest of the sample since this group of individuals was likely to be exempt from the increases in the ERA. The plots for women demonstrate noticeable discontinuous increases in average exiting and claiming ages for cohorts first affected by the 2000 pension reforms. These discontinuous increases can be accounted for by some women shifting their retirements from the ERA to the NRA (age 60 for women) once the increases in the ERA begin to take effect. The plots for men demonstrate noticeable kinks in average exiting and claiming ages. These patterns highlight that many men who were exempt from the ERA increases adjusted their labor supply in a way similar to men who were not exempt from the ERA increases. These spillovers to exempt individuals may have been driven by employers

changing retirement policies (either explicit or implicit contracts) for all male employees and by unawareness about exemption status.

Lastly, to complement the earlier evidence on increased labor force participation and delayed exiting and claiming in response to the increases in the ERAs, we also examine durations of jobs held at age 53. Intuitively, when the ERA increases, individuals may continue to exit their job held at age 53 when they would have prior to the increases in the ERA, and they may find temporary jobs to remain employed until they reach the new increased ERA. Alternatively, individuals may be able to remain employed longer in their jobs held at age 53 until they reach the new ERA. Figure XX presents graphical evidence indicating that many individuals are able to respond to the increased ERAs by remaining in their jobs longer rather than finding new jobs. These graphs plot the average duration of jobs held at age 53 by quarterly birth cohort. The plot for women with short insurance years demonstrates that, starting exactly for the cohorts first affected by the 2000 pension reform, average job durations begin to increase. Furthermore, the increases continue as the ERA continues to increase. The plot for the full sample of women shows a similar pattern. Next, the plots for men show kinks in average job durations for the cohorts affected by the 2000 and 2004 pension reforms. These plots for men and women closely follow the same patterns as the earlier graphical evidence on average exiting and claiming ages. Thus, we conclude that many men and women are able to respond to the increases in the ERA by remaining at their jobs longer and exiting at higher ages.

6 Discussion

References

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Table 1: Summary Statistics

	Women		Men	
	Short Contr. Years	Full Sample	Short Contr. Years	Full Sample
Continuously Employed				
Age 50 - 53	0.71 (0.45)	0.75 (0.43)	0.68 (0.47)	0.76 (0.42)
Any sick leave	0.15 (0.64)	0.14 (0.65)	0.17 (0.62)	0.16 (0.63)
Av Annual Earnings	20610 (10594)	21852 (10787)	30978 (99276)	32244 (92323)
Unemployment Age 43 - 53 (in years)	0.51 (1.12)	0.42 (1.02)	0.50 (1.13)	0.33 (0.91)
Childcare up to Age 53 (in years)	3.43 (2.46)	3.14 (2.42)		
Exits from Job held at 53	0.79 (0.41)	0.81 (0.39)	0.65 (0.48)	0.69 (0.46)
Qualifies for early retirement due to unemployment	0.92 (0.28)	0.93 (0.25)	0.95 (0.21)	0.97 (0.17)
with long insurance years	0.41 (0.49)	0.53 (0.50)	0.75 (0.43)	0.85 (0.36)
First Pension Claim				
Disability	0.10 (0.30)	0.09 (0.28)	0.39 (0.49)	0.38 (0.49)
Early Retirement	0.44 (0.50)	0.51 (0.50)	0.33 (0.47)	0.41 (0.49)
Exit Age	57.07 (2.40)	56.74 (2.33)	58.91 (2.94)	58.78 (2.73)
Claim Age	57.62 (2.08)	57.23 (2.08)	59.72 (2.75)	59.51 (2.54)
Gap bw Exit and Claim (in years)	0.67 (1.15)	0.60 (1.07)	0.83 (1.44)	0.77 (1.39)
Number of observations	282,298	357,147	229,915	386,830

Note: Sample includes birth cohorts 1930 - 1948 for men and 1935 - 1953 for women; individuals still employed at age 53. Sample with short contribution years is defined as having accumulated 38 contribution years at age 53. Individuals qualify for early retirement due to unemployment if they have accumulated at least 20 insurance years, and for early retirement with long insurance years if they have accumulated at least 35 insurance years. We proxy the qualification with insurance years accumulated at 53 and assume individual stays continuously employed.

Table 2: Reduced Form Estimates, Maximum Symmetric Bandwidth

	Short Contribution Years		Full Sample	
	Women	Men	Women	Men
<u>A. Kink Pension Reform 2000</u>				
Early Retirement Age	0.665 (0.003)	0.666 (0.004)	0.501 (0.007)	0.334 (0.009)
Exit Age	0.259 (0.041)	0.239 (0.032)	0.260 (0.033)	0.213 (0.020)
Claim Age	0.359 (0.039)	0.359 (0.033)	0.330 (0.032)	0.309 (0.021)
Observations	83,575	71,880	110,897	133,334
<u>B. Kink 2004</u>				
Early Retirement Age	-0.333 (0.003)	-0.533 (0.016)	-0.219 (0.023)	-0.266 (0.014)
Exit Age	-0.182 (0.040)	-0.104 (0.040)	-0.174 (0.031)	-0.079 (0.032)
Claim Age	-0.342 (0.044)	-0.263 (0.042)	-0.287 (0.031)	-0.212 (0.030)
Observations	84,336	57,642	109,819	112,857

Note: Maximum symmetric bandwidth equals 2.75 years.

Table 3: Fuzzy Regression Kink Estimates, Maximum Symmetric Bandwidth

	Short Contribution Years		Full Sample	
	Women	Men	Women	Men
<u>A. Kink Pension Reform 2000</u>				
Exit Age	0.390 (0.062)	0.358 (0.047)	0.520 (0.067)	0.639 (0.067)
Claim Age	0.540 (0.059)	0.539 (0.049)	0.659 (0.063)	0.925 (0.058)
Observations	83,575	71,880	110,897	133,334
<u>B. Kink Pension Reform 2004</u>				
Exit Age	0.548 (0.121)	0.195 (0.077)	0.794 (0.167)	0.295 (0.127)
Claim Age	1.028 (0.136)	0.492 (0.082)	1.313 (0.195)	0.797 (0.120)
Observations	84,336	57,642	109,819	112,857

Note: Maximum symmetric bandwidth equals 2.75 years. Sample includes birth cohorts 1930 - 1948 for men and 1935 - 1953 for women .

Table 4: Reduced Form Estimates, Global

	Short Contribution Years		Full Sample	
	Women	Men	Women	Men
<u>A. Kink Pension Reform 2000</u>				
Early Retirement Age	0.665 (0.001)	0.665 (0.001)	0.503 (0.004)	0.337 (0.005)
Exit Age	0.297 (0.020)	0.426 (0.023)	0.350 (0.022)	0.343 (0.017)
Claim Age	0.405 (0.022)	0.607 (0.027)	0.433 (0.024)	0.450 (0.017)
Observations	188,498	169,846	240,735	270,249
<u>B. Kink Pension Reform 2004</u>				
Early Retirement Age	-0.332 (0.000)	-0.595 (0.002)	-0.157 (0.005)	-0.258 (0.005)
Exit Age	-0.254 (0.013)	-0.266 (0.021)	-0.177 (0.011)	-0.173 (0.013)
Claim Age	-0.354 (0.010)	-0.456 (0.018)	-0.233 (0.010)	-0.316 (0.012)
Observations	137,428	94,002	173,908	182,069

Note: Estimates based on global sample including birth cohorts 1930 - 1948 for men and 1935 - 1953 for women.

Table 5: Fuzzy Regression Kink Estimates, Global

	Short Contribution Years		Full Sample	
	Women	Men	Women	Men
<u>A. Kink Pension Reform 2000</u>				
Exit Age	0.447 (0.030)	0.641 (0.035)	0.695 (0.044)	1.018 (0.054)
Claim Age	0.609 (0.033)	0.914 (0.041)	0.860 (0.047)	1.336 (0.047)
Observations	188,498	169,846	240,735	270,249
<u>B. Kink Pension Reform 2004</u>				
Exit Age	0.729 (0.116)	0.448 (0.048)	1.132 (0.258)	0.669 (0.099)
Claim Age	1.066 (0.103)	0.766 (0.053)	1.488 (0.270)	1.222 (0.108)
Observations	137,428	94,002	173,908	182,069

Note: Estimates based on global sample including birth cohorts 1930 - 1948 for men and 1935 - 1953 for women.

Table 6: Covariates, Reduced Form

	Kink Pension Reform 2000				Kink Pension Reform 2004			
	Short Contribution Years		Full Sample		Short Contribution Years		Full Sample	
	Women	Men	Women	Men	Women	Men	Women	Men
Predicted Exit Age	0.007 (0.008)	-0.058 (0.009)	0.011 (0.008)	-0.045 (0.006)	0.050 (0.008)	-0.011 (0.010)	0.049 (0.008)	-0.003 (0.007)
Predicted Claim Age	0.007 (0.008)	-0.055 (0.009)	0.017 (0.009)	-0.044 (0.007)	0.050 (0.008)	-0.007 (0.010)	0.041 (0.009)	0.000 (0.007)
Age 50 - 53								
Days Employed	-3.79 (3.29)	-8.30 (3.42)	-3.65 (2.56)	-8.74 (1.96)	12.91 (3.16)	-0.14 (4.11)	9.55 (2.49)	-0.91 (2.26)
Av Annual Earnings	216 (92.7)	-1049 (90.1)	237 (81.8)	-1012 (60.1)	199 (85.1)	-221 (101.6)	114 (76.0)	-174 (64.7)
Any sick leave	-0.002 (0.003)	0.008 (0.003)	-0.002 (0.003)	0.008 (0.002)	-0.014 (0.003)	0.004 (0.004)	-0.012 (0.002)	0.001 (0.003)
Childcare up to Age 53	-0.007 (0.020)		-0.003 (0.017)		-0.072 (0.019)		-0.034 (0.016)	
Insurance years at 53	-0.149 (0.062)	-0.355 (0.069)	-0.183 (0.056)	-0.439 (0.046)	-0.417 (0.060)	-0.020 (0.078)	-0.395 (0.054)	-0.116 (0.049)
Qualifies for early retirement from unemployment	-0.007 (0.002)	-0.006 (0.002)	-0.005 (0.002)	-0.004 (0.001)	-0.008 (0.002)	-0.005 (0.002)	-0.007 (0.002)	-0.003 (0.001)
Qualifies for early retirement with long insurance years	-0.005 (0.004)	-0.020 (0.004)	-0.005 (0.004)	-0.019 (0.002)	-0.020 (0.004)	0.002 (0.004)	-0.018 (0.004)	-0.002 (0.002)
Observations	83,575	71,880	110,897	133,334	91,330	63,223	119,052	123,683

Note: Local linear reduced form estimates with maximum symmetric bandwidth equal 2.75 years. Sample includes birth cohorts 1930 - 1948 for men and 1935 - 1953 for women.

Table 7: Mechanisms: Gap between Claiming and Exiting, Duration of Job at Age 53

	Short Contribution Years		Full Sample	
	Women	Men	Women	Men
<u>A. Kink Pension Reform 2000</u>				
Claim Age - Exit Age	0.085 (0.011)	0.095 (0.015)	0.059 (0.011)	0.074 (0.017)
Job Duration	0.173 (0.040)	0.157 (0.041)	0.189 (0.033)	0.127 (0.031)
Observations	84,336	57,642	109,819	112,857
<u>B. Kink Pension Reform 2004</u>				
Claim Age - Exit Age	-0.154 (0.016)	-0.136 (0.017)	-0.109 (0.011)	-0.109 (0.019)
Job Duration	-0.106 (0.045)	-0.158 (0.053)	-0.120 (0.035)	-0.106 (0.039)
Observations	83,575	71,880	110,897	133,334

Note: Reduced form estimates with maximum symmetric bandwidth equal 2.75 years. Sample includes birth cohorts 1930 - 1948 for men and 1935 - 1953 for women. Job duration is measured as the remaining duration of the job held at age 53.

Table 8: Effect Heterogeneity

	Any Sick Leave Age 40-53		Earnings Bottom Quartile		Earnings Top Quartile	
	Women	Men	Women	Men	Women	Men
<u>Kink Pension Reform 2000</u>						
Exit Age	0.482 (0.069)	0.684 (0.152)	0.446 (0.084)	0.685 (0.057)	0.666 (0.130)	0.437 (0.155)
Claim Age	0.745 (0.077)	0.948 (0.177)	0.650 (0.067)	0.954 (0.082)	0.681 (0.097)	0.842 (0.111)
Observations	16,453	20,488	27,741	33,253	27,447	28,272

Note: Fuzzy RKD estimates with maximum symmetric bandwidth equal 2.75 years. Sample includes birth cohorts 1930 - 1948 for men and 1935 - 1953 for women .

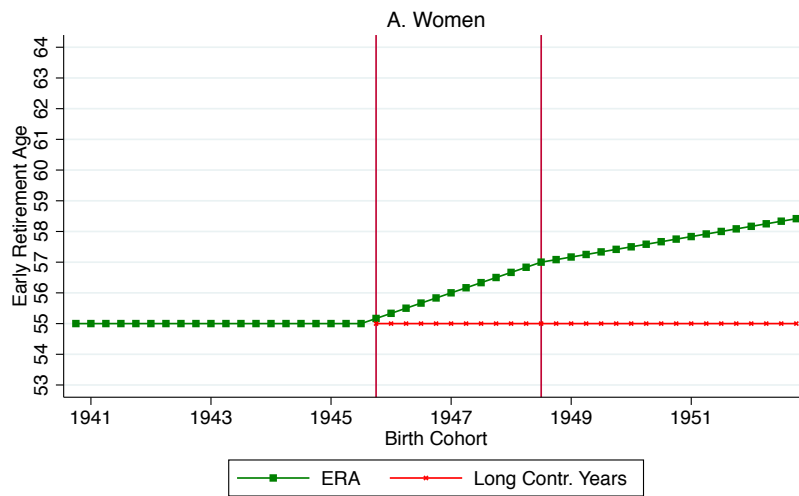
Table 9: Alternative Estimators and Bandwidths

	Kink Pension Reform 2000				Kink Pension Reform 2004			
	Women		Men		Women		Men	
	Exit Age	Claim Age	Exit Age	Claim Age	Exit Age	Claim Age	Exit Age	Claim Age
Default CCT (regularization)								
Main Bandwidth (Pilot)	0.50 (1.25)	0.49 (1.14)	0.69 (1.49)	0.76 (1.59)	0.47 (1.03)	0.38 (0.95)	0.88 (1.60)	0.86 (1.62)
Estimated Kink	1.76	1.40	0.94	1.04	-1127.24	-0.57	0.37	0.08
(conventional std error)	(0.53)	(0.48)	(0.36)	(0.29)	(258666.10)	(1.88)	(0.84)	(0.76)
Bias-corrected Estimate	2.33	1.73	0.80	0.95	-7004.45	-5.49	1.27	0.07
robust conf. Interval	[1.01, 3.64]	[0.51, 2.95]	[-0.30, 1.89]	[0.08, 1.81]	[-14438.70, 429.80]	[-11.45, 0.47]	[-1.52, 4.06]	[-2.39, 2.53]
CCT with no regularization								
Main Bandwidth (Pilot)	6.87 (1.58)	0.65 (1.29)	0.91 (1.73)	1.96 (1.82)	0.58 (1.16)	0.38 (0.95)	1.11 (1.82)	1.21 (1.79)
Estimated Kink	0.48	1.66	0.54	1.00	2.48	-0.57	0.75	0.69
(conventional std error)	(0.02)	(0.34)	(0.29)	(0.08)	(3.31)	(1.88)	(0.40)	(0.29)
Bias-corrected Estimate	-0.65	2.02	0.29	1.15	-0.11	-5.49	1.91	1.54
robust conf. Interval	[-2.73, 1.43]	[1.05, 3.00]	[-0.62, 1.20]	[0.40, 1.90]	[-8.69, 8.46]	[-11.45, 0.47]	[0.31, 3.50]	[0.27, 2.82]
Fuzzy CCT (no regularization)								
Main Bandwidth (Pilot)	5.47 (3.23)	0.53 (1.19)	1.61 (1.91)	1.64 (1.56)	0.63 (1.37)	0.35 (0.87)	0.92 (1.57)	1.03 (1.67)
Estimated Kink	0.43	1.70	0.78	1.23	0.11	-0.57	0.28	0.66
(conventional std error)	(0.02)	(0.39)	(0.11)	(0.10)	(2.08)	(1.88)	(0.54)	(0.39)
Bias-corrected Estimate	0.41	2.22	0.92	1.37	0.13	-5.00	1.28	1.57
robust conf. Interval	[0.08, 0.74]	[1.18, 3.26]	[0.20, 1.64]	[0.45, 2.28]	[-4.59, 4.85]	[-11.40, 1.40]	[-0.86, 3.41]	[0.07, 3.08]
Fuzzy IK (no regularization)								
Main Bandwidth (Pilot)	1.75 (2.72)	3.38 (1.97)	1.64 (2.15)	3.33 (1.58)	1.09 (2.10)	0.66 (2.47)	1.48 (1.48)	3.29 (1.52)
Estimated Kink	0.48	0.64	0.78	0.93	0.71	0.56	0.40	0.97
(conventional std error)	(0.07)	(0.03)	(0.11)	(0.04)	(0.22)	(1.69)	(0.22)	(0.06)
Bias-corrected Estimate	0.33	0.69	1.12	1.13	0.80	-0.03	1.43	0.91
robust conf. Interval	[0.03, 0.63]	[0.03, 1.35]	[0.52, 1.72]	[-0.64, 2.91]	[0.05, 1.55]	[-2.94, 2.88]	[-0.30, 3.17]	[-1.44, 3.27]
FG								
Main Bandwidth (Pilot)	1.15 (3.19)	0.87 (4.78)	1.51 (3.35)	1.95 (0.44)	0.60 (2.27)	0.50 (1.45)	1.81 (7.62)	1.30 (3.76)
Estimated Kink	0.43	0.66	0.65	0.11	0.11	1.61	0.21	0.69
(conventional std error)	(0.15)	(0.20)	(0.12)	(0.05)	(2.08)	(2.36)	(0.15)	(0.25)
Bias-corrected Estimate	0.43	0.67	0.56	1.50	-0.29	2.59	0.15	0.35
robust conf. Interval	[0.09, 0.78]	[0.26, 1.08]	[0.19, 0.92]	[0.75, 2.25]	[-3.96, 3.37]	[-2.65, 7.83]	[-0.39, 0.69]	[-0.31, 1.02]

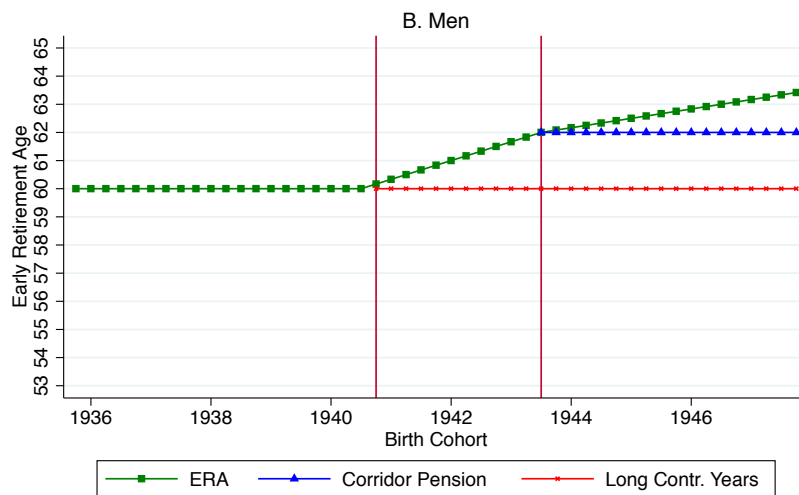
Note: Estimations based on full sample, birth cohorts 1930-1948 for men and 1935 - 1953 for women. Conventional point estimates and standard errors are obtained from 2SLS regressions described in Card et al. (2012). The default CCT bandwidth, CCT with no regularization, and the robust CI's are obtained by a variant of the Stata package described in Calonico et al. (2015). The fuzzy CCT and fuzzy IK bandwidths are author's calculations.

Figure 1: Changes in the Early Retirement Age in the 2000 and 2004 Pension Reforms

Early Retirement Age by Cohort

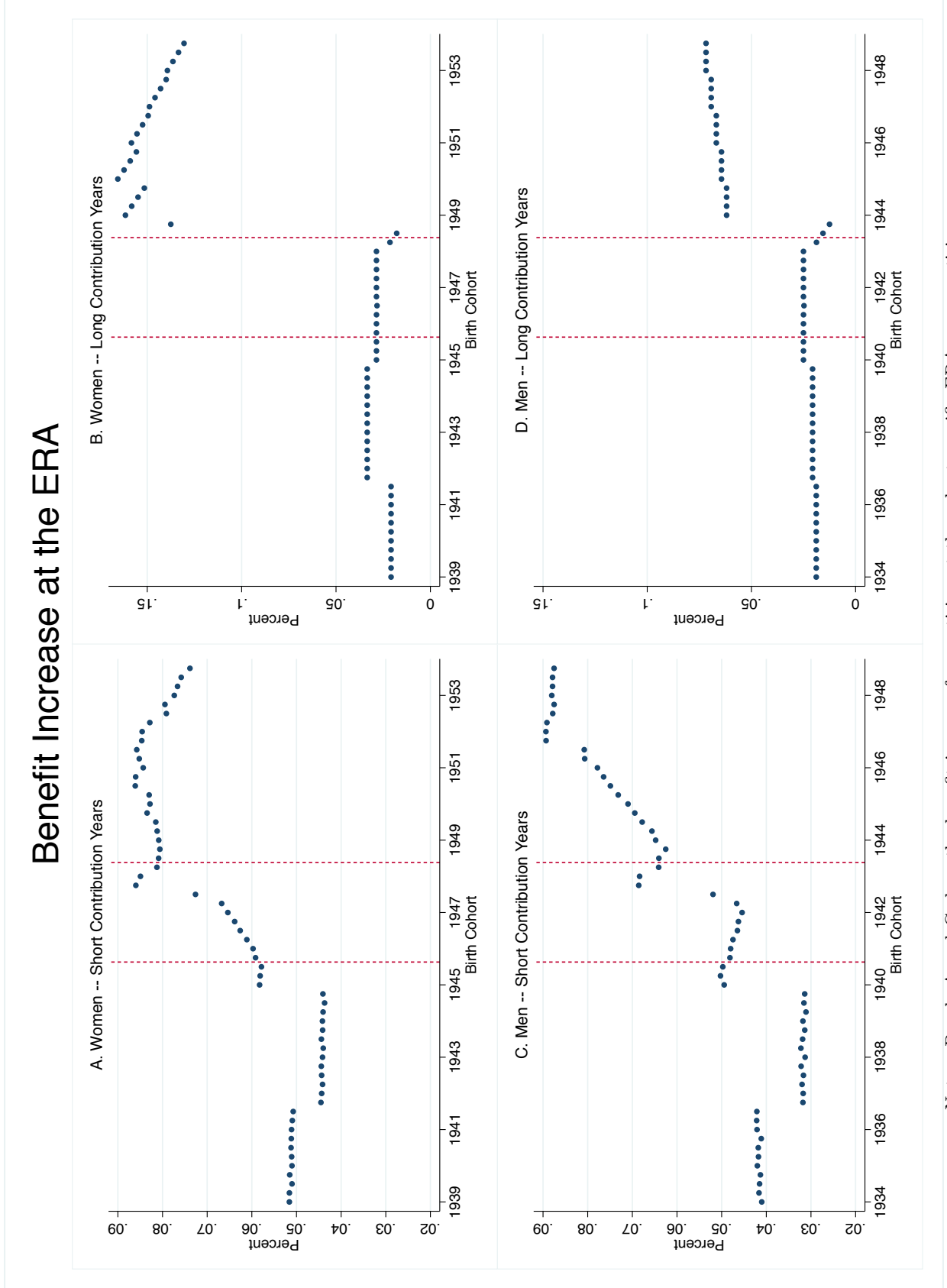


Note: Vertical lines mark the beginning of the 2000 and 2004 pension reforms



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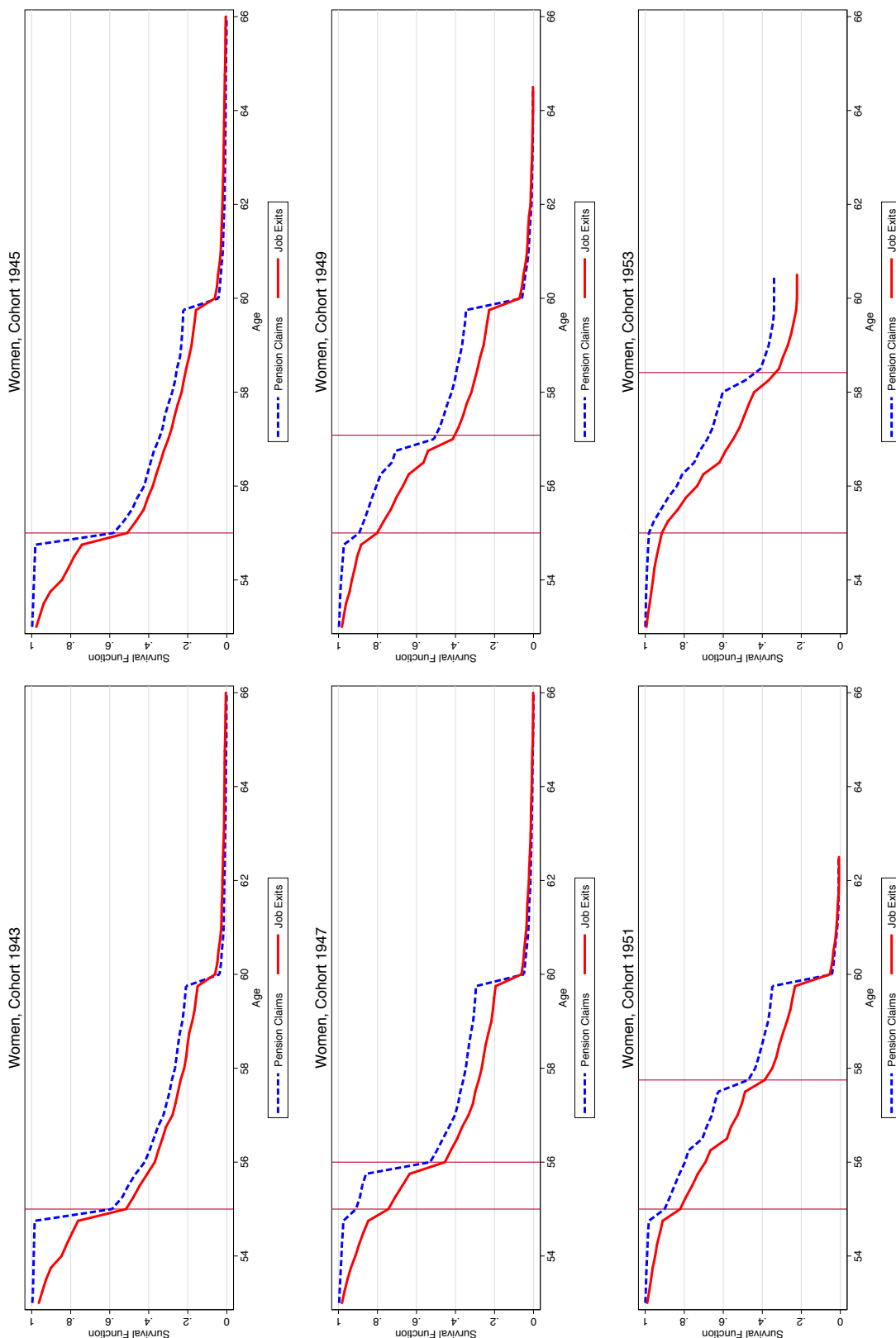
Figure 2: Increases in Benefits at the ERA



Notes: Panels A and C show the benefit increase from retiring at the cohort specific ERA versus retiring one year after the ERA for women and men who do not qualify for the exemption based on long contribution years. Panels B and D show the benefit increase of exiting the labor market with 44 (39) contribution years and retiring

Figure 3: Survival in the labor market after age 53, Women

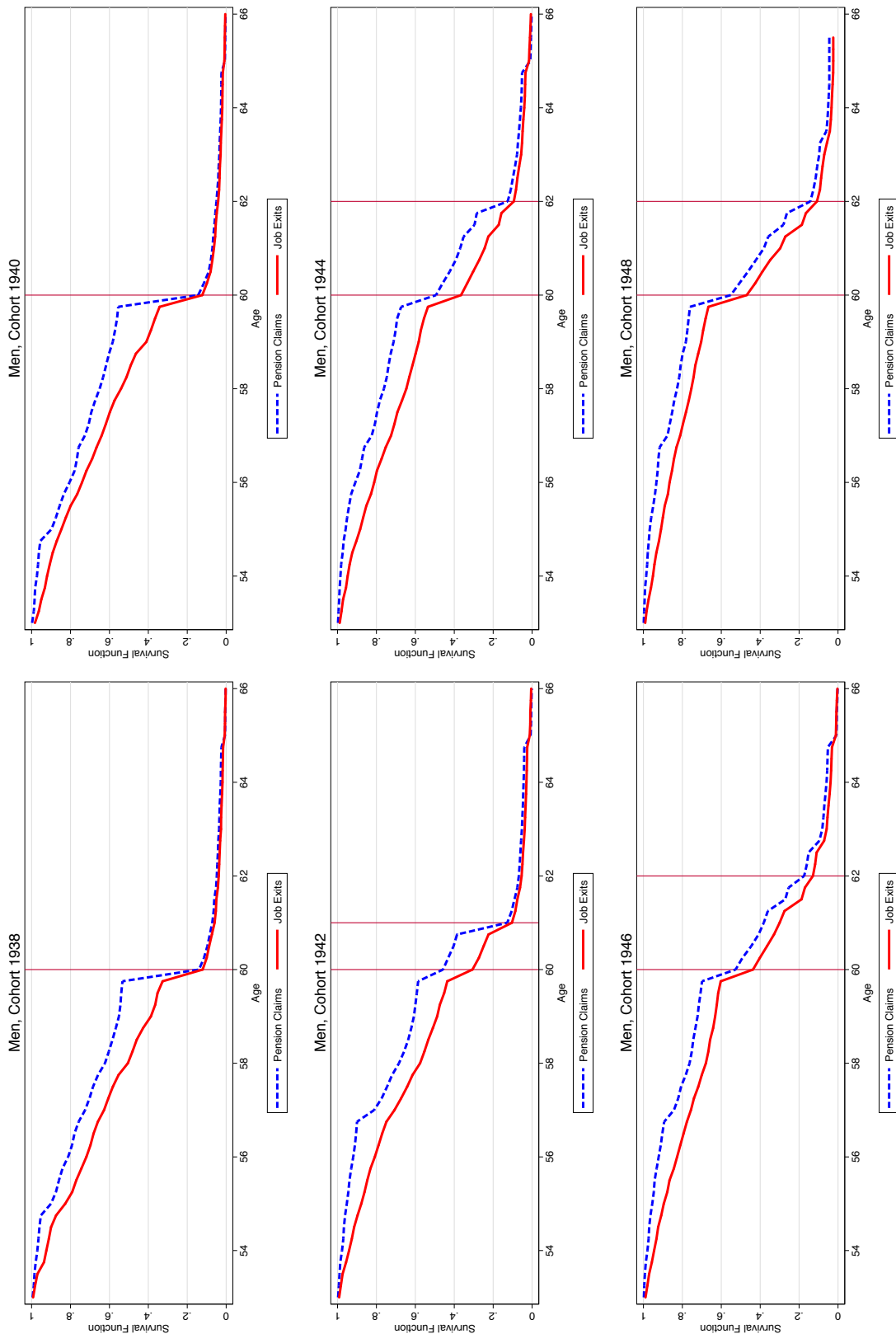
Women Full Sample



Notes: Survival rates until pension claims and job exits for selected birth cohorts. Vertical lines mark age 60 and the cohort specific ERA.

Figure 4: Survival in the labor market after age 53, Men

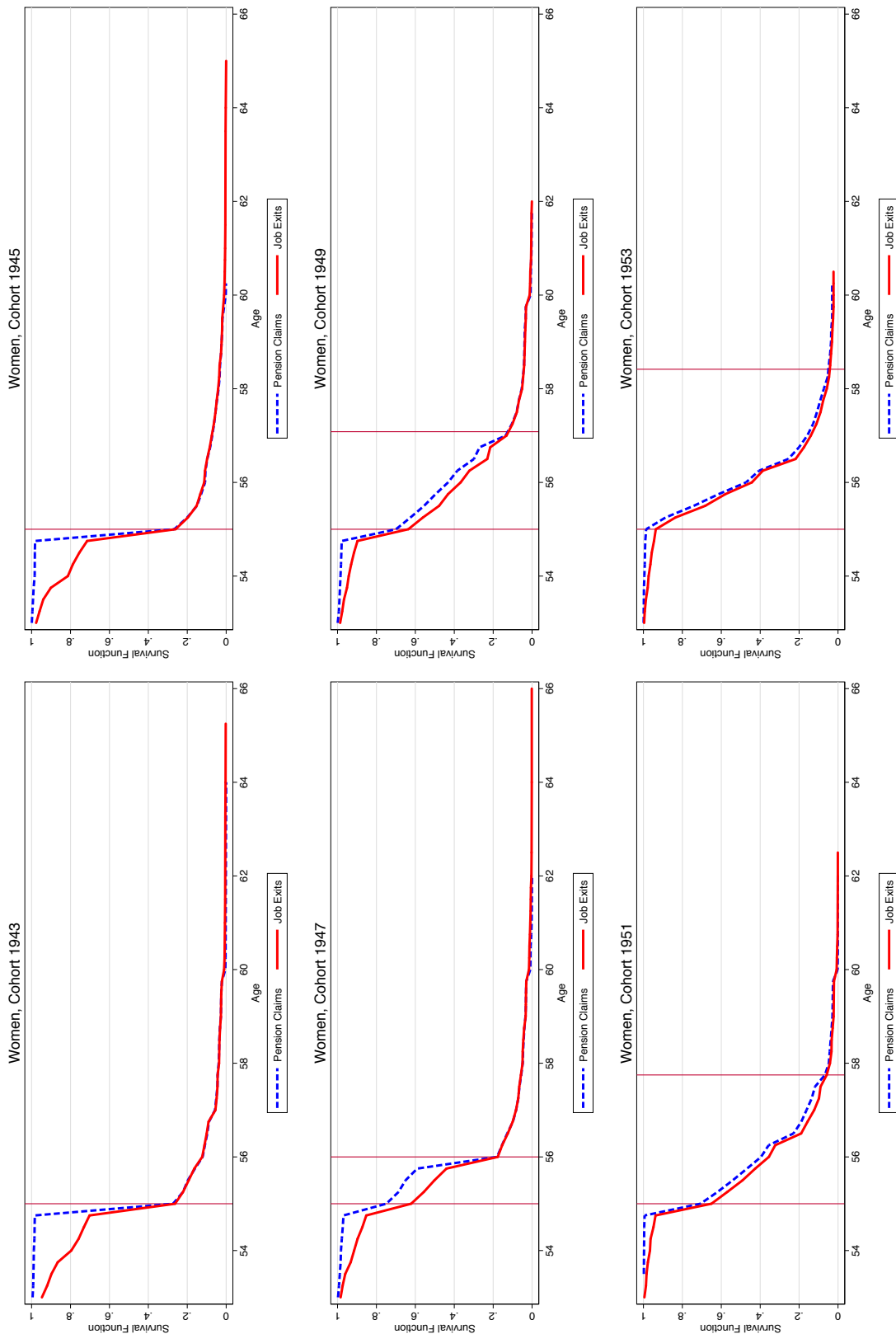
Men Full Sample



Notes: Survival rates until pension claims and job exits for selected birth cohorts. Vertical lines mark age 60 and the cohort specific ERA.

Figure 5: Survival in the labor market after age 53, Women with long contribution years

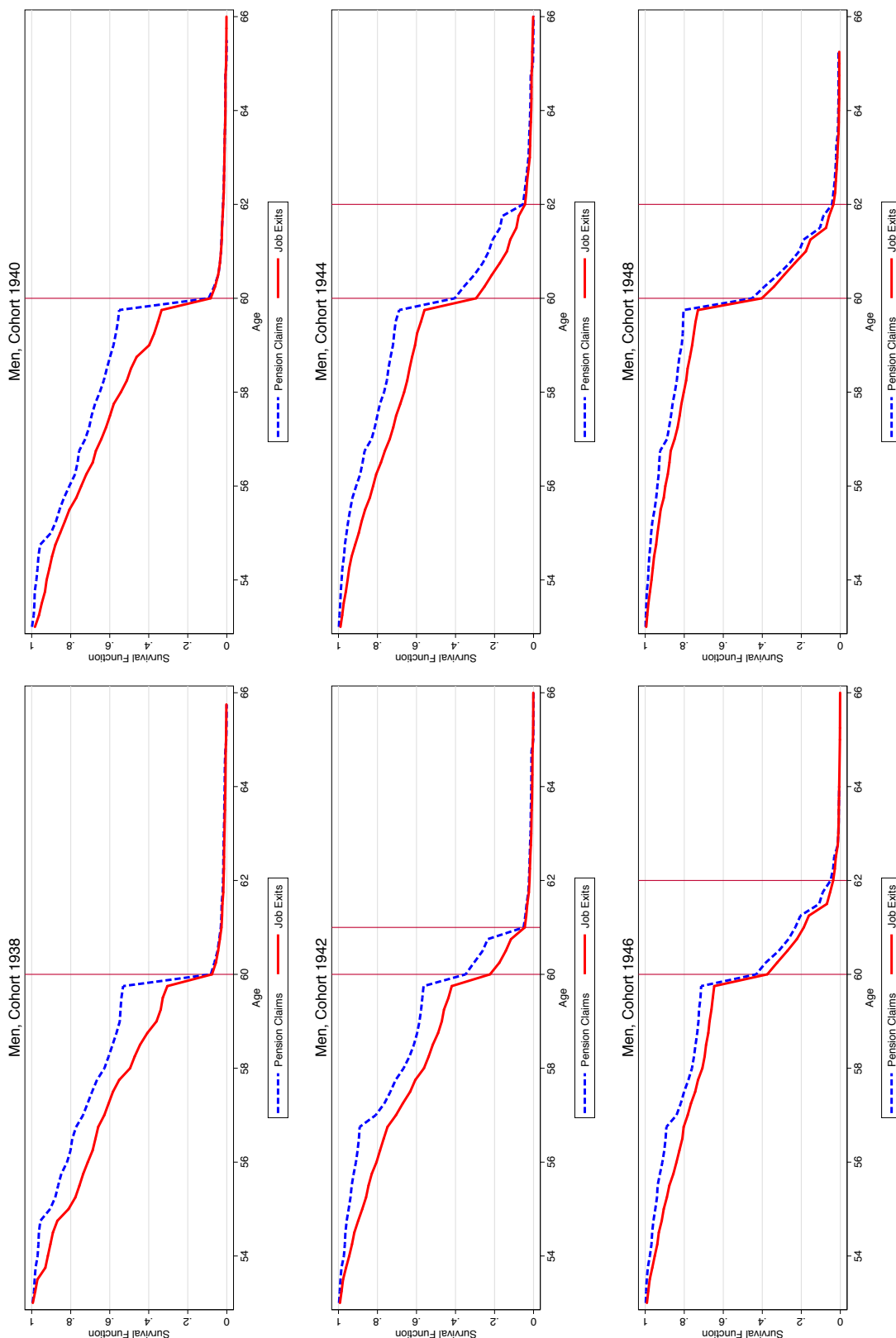
Women with Long Contribution Years



Notes: Survival rates until pension claims and job exits for selected birth cohorts. Vertical lines mark age 60 and the cohort specific ERA.

Figure 6: Survival in the labor market after age 53, Men with long contribution years

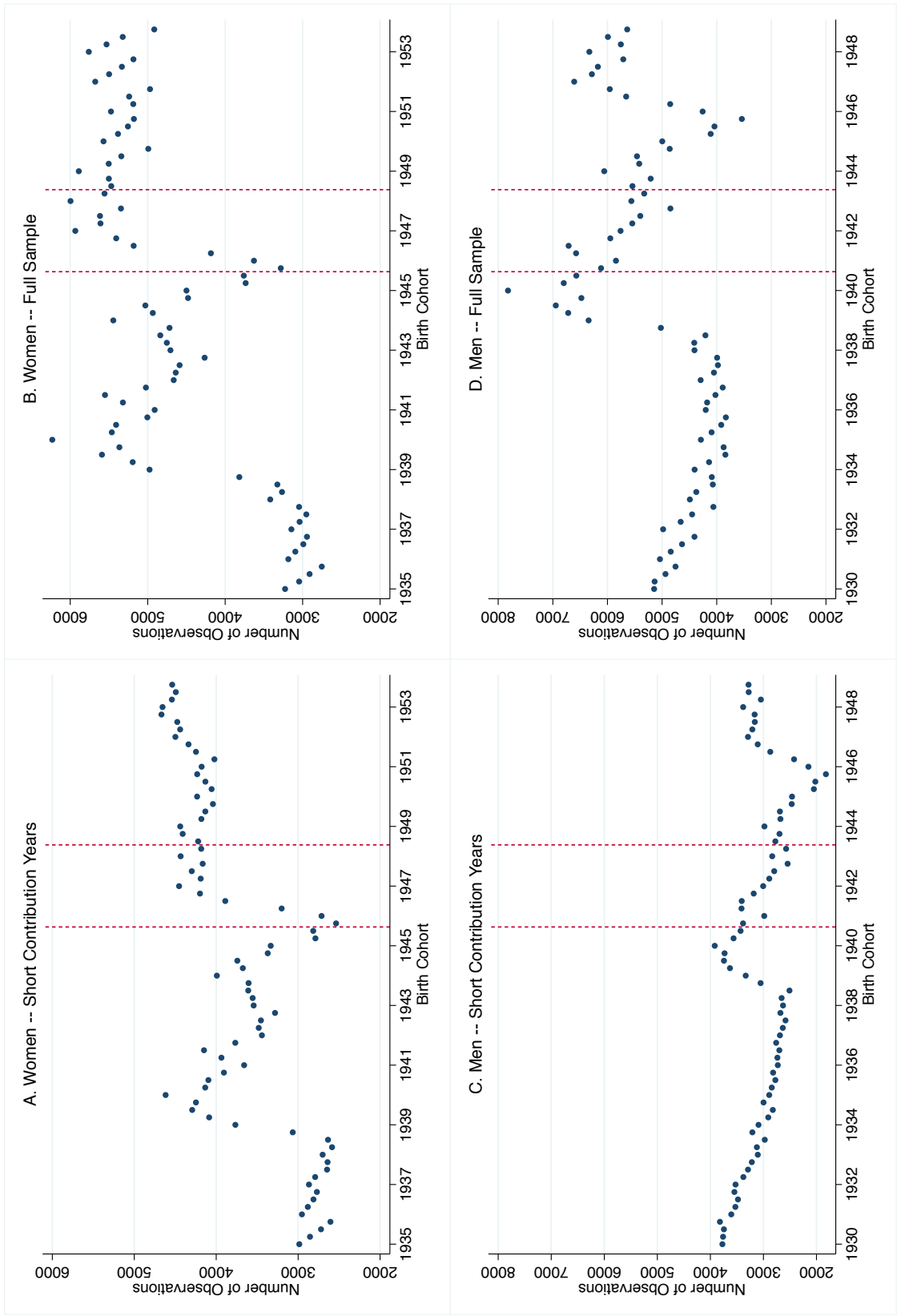
Men with Long Contribution Years



Notes: Survival rates until pension claims and job exits for selected birth cohorts. Vertical lines mark age 60 and the cohort specific ERA.

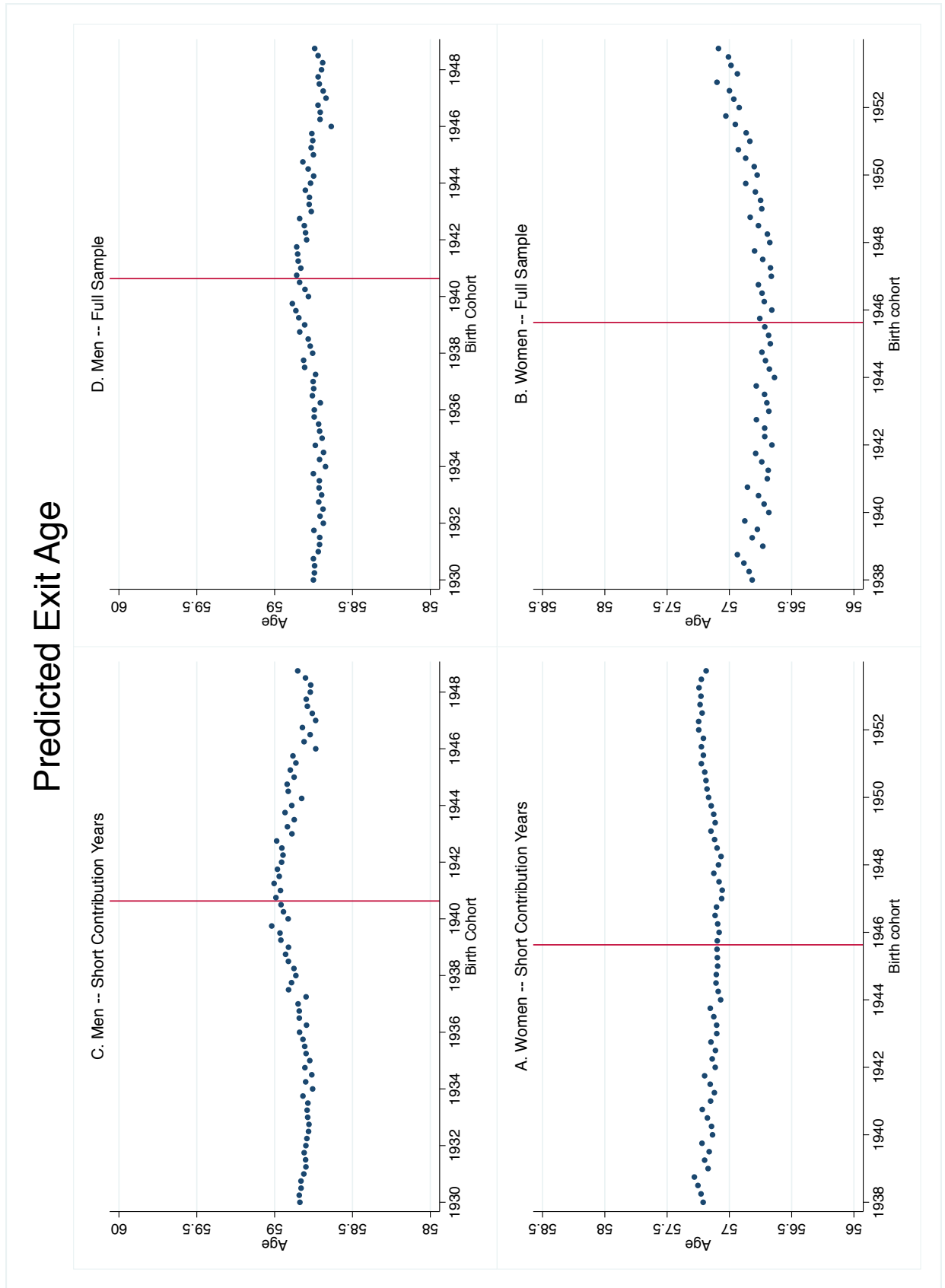
Figure 7: Distribution of birth cohorts

Frequency of Observations by Birth Cohort



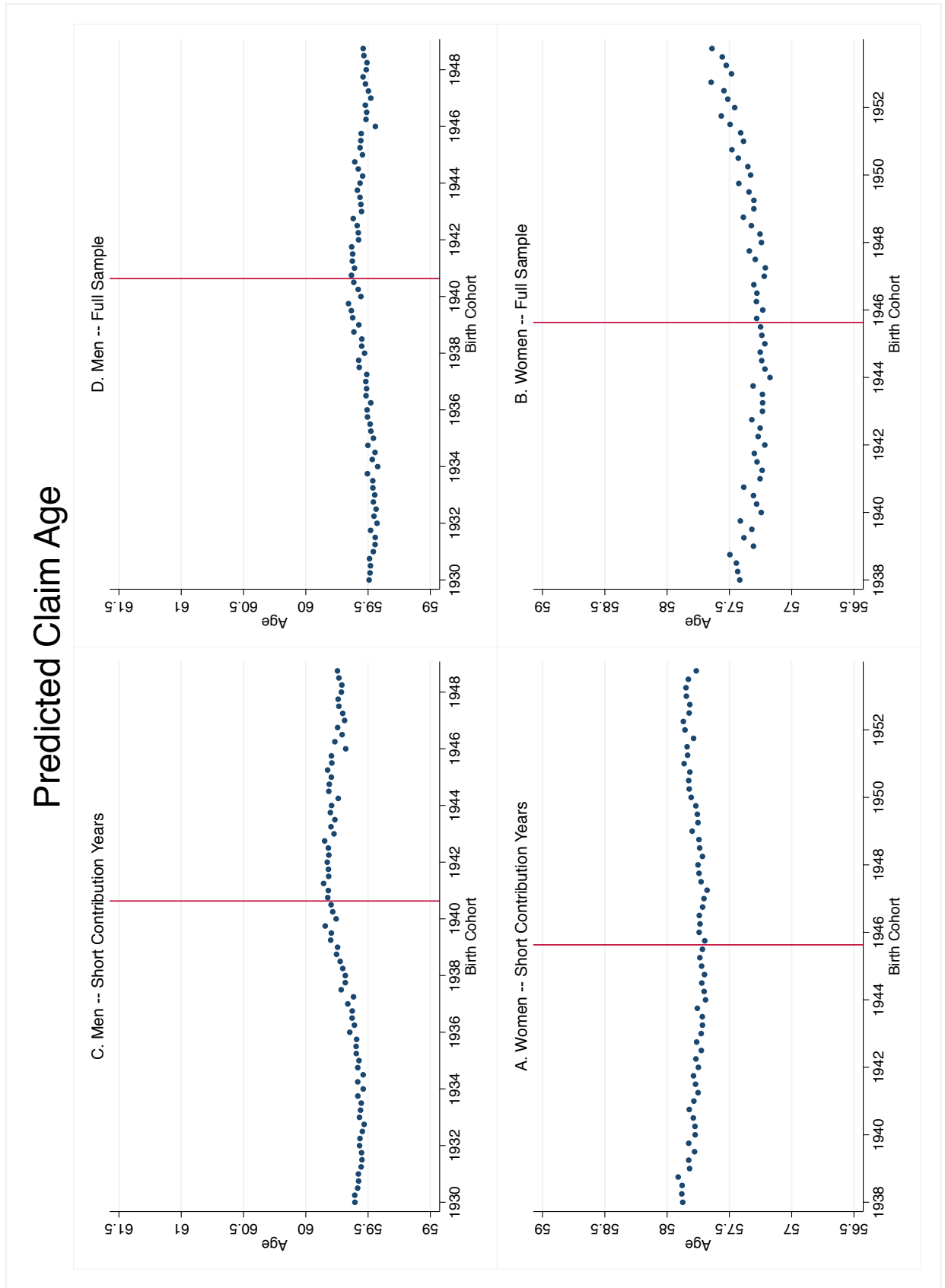
Notes: Number of observations by quarterly birth cohort.

Figure 8: Distribution of birth cohorts



Notes: Number of observations by quarterly birth cohort.

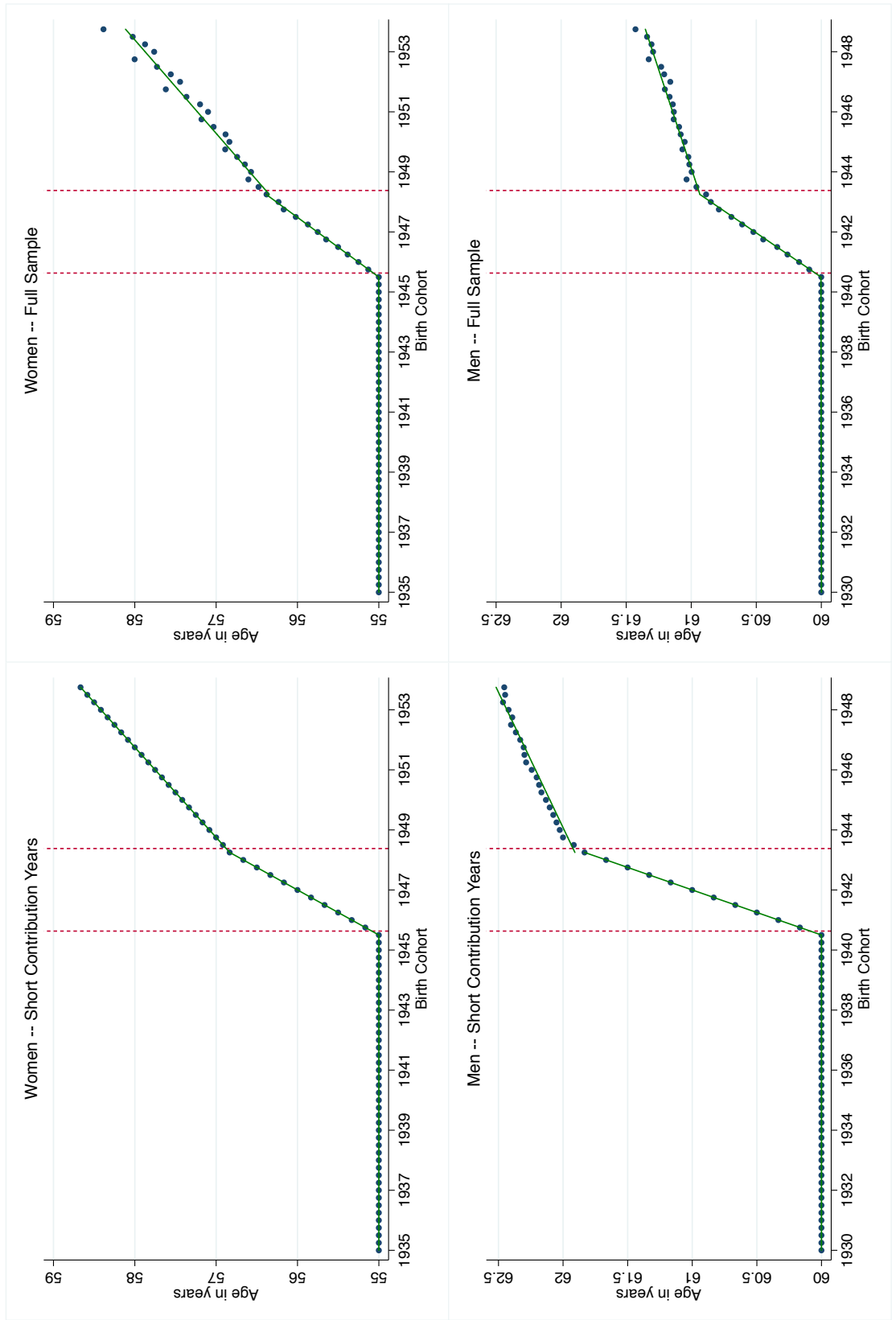
Figure 9: Distribution of birth cohorts



Notes: Number of observations by quarterly birth cohort.

Figure 10: Early Retirement Age by Quarterly Birth Cohort

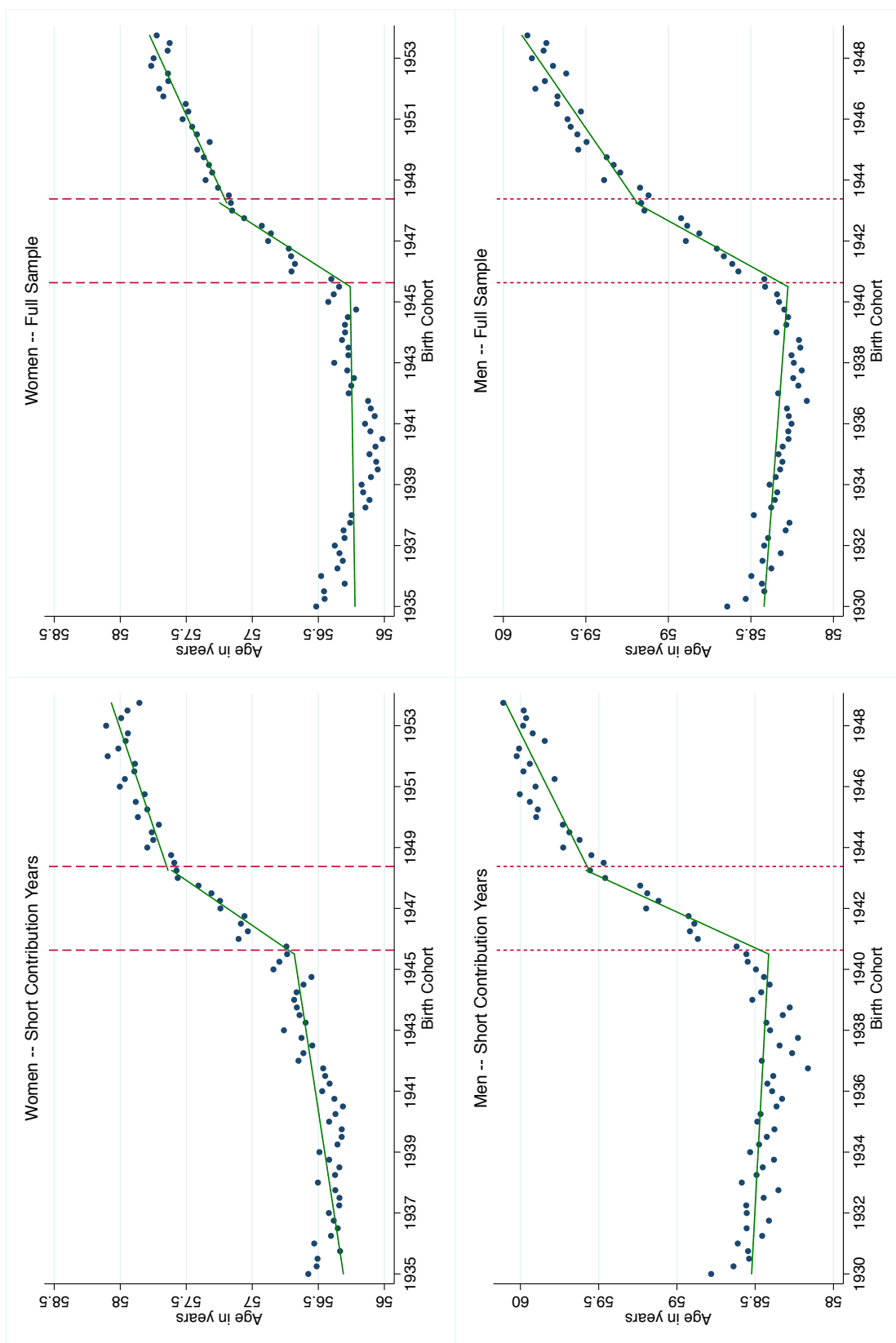
First Stage



Notes: Early Retirement Age by quarterly birth cohorts.

Figure 11: Exit Age from the Labor Force

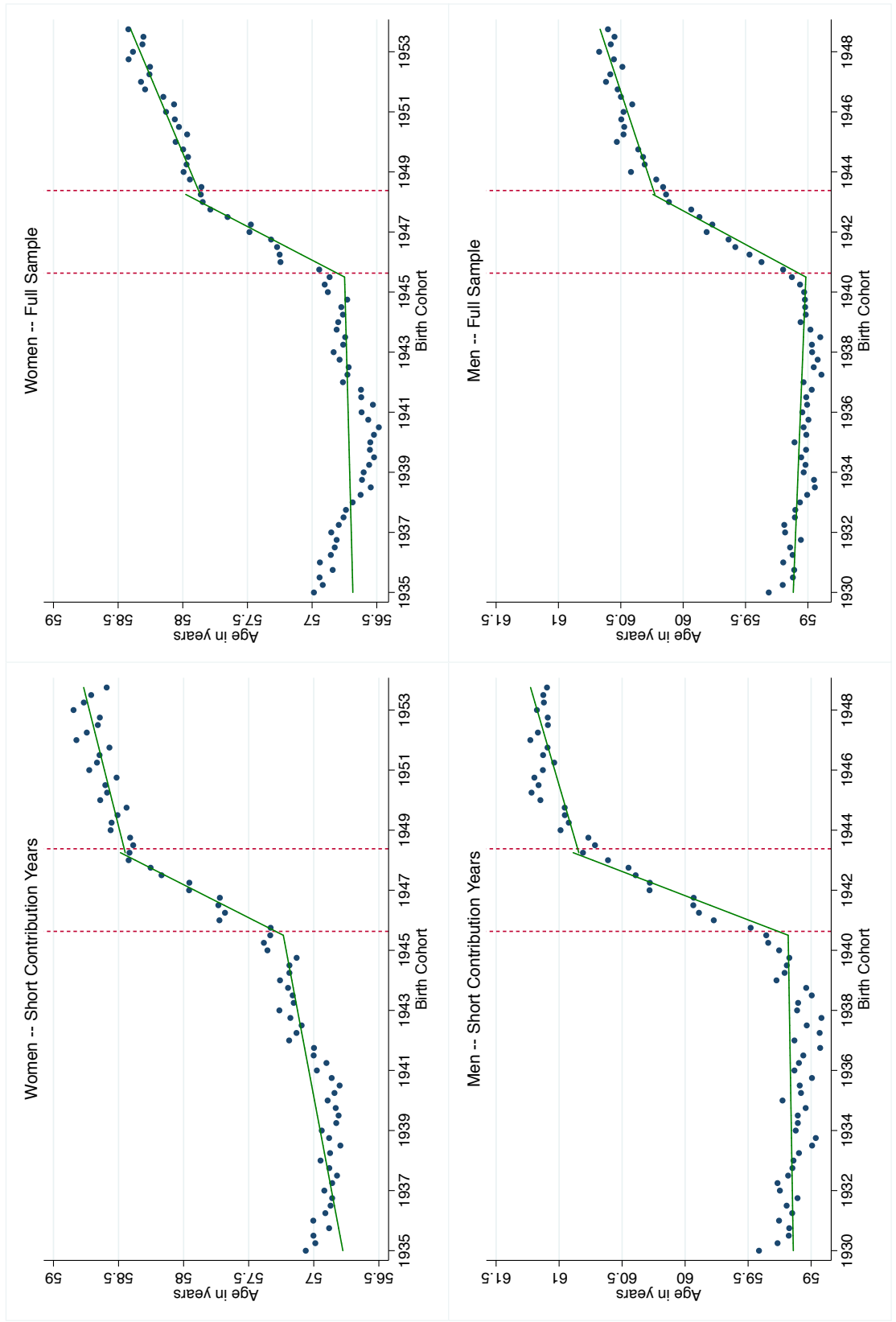
Reduced Form



Notes: Average by quarterly birth cohort.

Figure 12: Pension Claiming Age

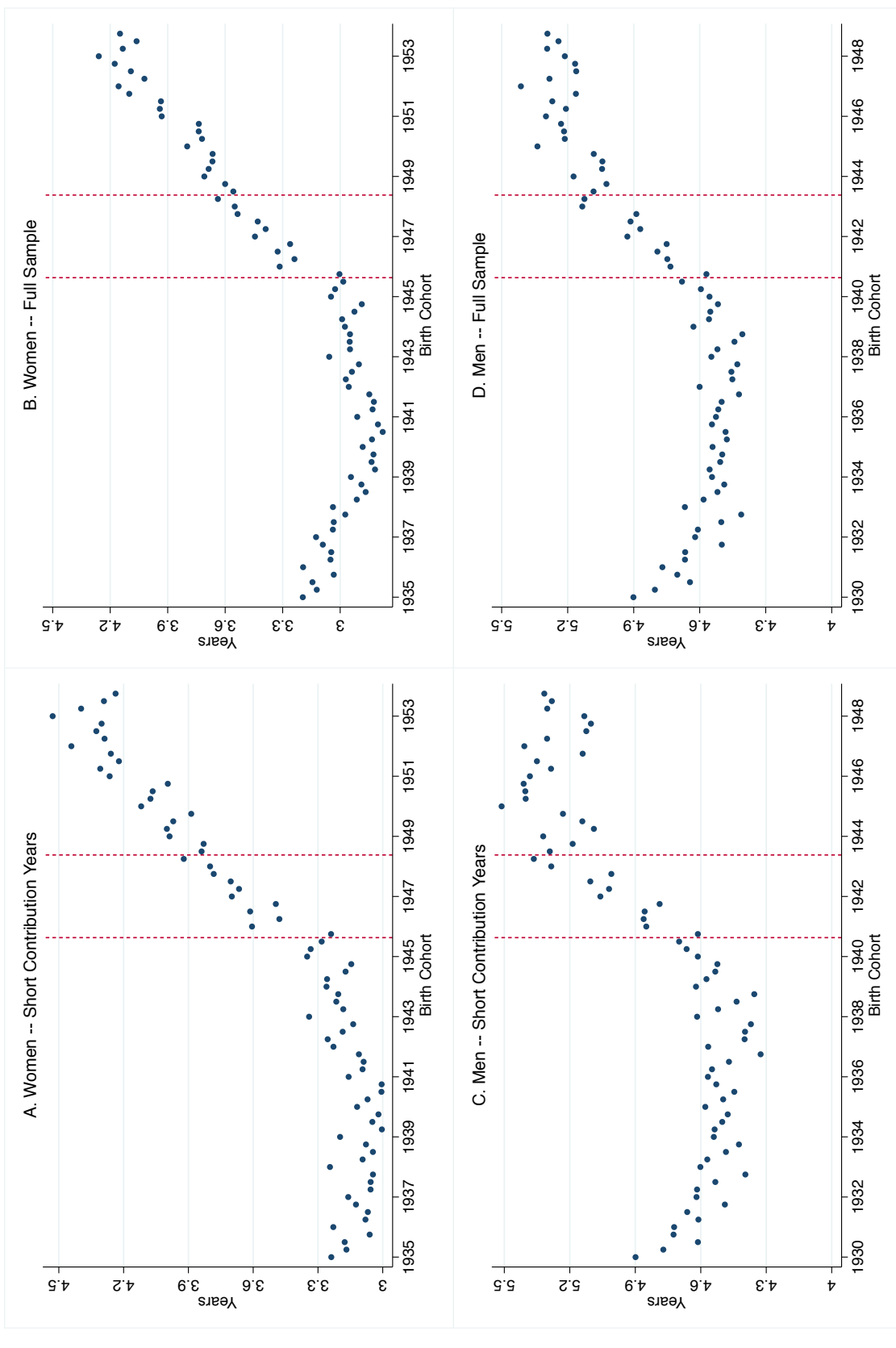
Reduced Form



Notes: Average by quarterly birth cohort.

Figure 13: Remaining Duration of Job Held at 53

Remaining Duration of Job Held at 53



Notes: Average job duration in years by quarterly birth cohort.