The Effect of Pension Subsidies on the Retirement Timing of Older Women

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Abstract

I estimate the effect of additional pension benefits on women's retirement decisions by examining a German pension subsidy program. The subsidies have a kinked relationship with the recipients' past pension contributions, creating a sharply different slope of benefits for similar women on either side of the kink point. I find that a 100 euro increase in the monthly benefit induces female recipients to claim their pensions six months earlier. Recipients also adjust labor supply by using unemployment insurance (UI) as a stepping stone to retirement and by reducing time spent in marginal employment. A back-of-the-envelope calculation suggests that the ratio of behavioral to mechanical costs for this subsidy program is 0.25, which is smaller than that of other income support programs.

Keywords: pension subsidy, pension generosity, retirement, regression kink design
JEL Classification: H55, J18, J21, J26

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1 Introduction

Old-age poverty is an important concern in light of shrinking public pensions and increased longevity (Börsch-Supan and Coile (2018)). This issue is particularly important for elderly women, who are at greater risk of old age poverty than men in almost all OECD countries (OECD (2015)). Increased poverty among elderly women stems from the fact that pension benefits are on average much lower for women; for example, in Germany the public pension benefits of an average woman are only about half those of an average man.[1] Many developed countries have provided safety nets for pensioners with low benefits, however, policymakers face an important trade-off: how to provide old-age income support without further eroding incentives to work. This is especially salient for women, who experience low pensions partly because of a low rate of life cycle labor force participation. Therefore, a central question is how additional pension benefits affect low-income workers' retirement decisions.

This question remains understudied, due in part to the difficulty of isolating exogenous variation in the parameters of the public pension system, such as benefit levels, pension eligibility age, penalties for claiming pensions early, etc. Existing papers on the labor supply response to retirement incentives mostly focus on the policy reforms that bundle changes in parameters (see, e.g., Mastrobuoni (2009), Staubli and Zweimüller (2013), Engels et al. (2017)). For instance, recent pension reforms often raise the pension eligibility age with financial penalties for claiming pensions early. The estimated overall impact of such pension reforms is a combination of labor supply response to changes in the default option - the pension eligibility age (Blundell et al. (2016), Cribb et al. (2016)) - and changes in financial incentives.

In this paper, I study the casual impact of additional pension benefits using a special pension subsidy program in Germany. In 1992, Germany implemented a pension subsidy program to provide additional pension benefits to the most disadvantaged. Two features of the subsidy program generate a natural experiment. First, the subsidy size has a kinked relationship with workers' predetermined contributions; this allows me to compare similar recipients on either side of the kink point. Second, the additional benefits from this subsidy program occur without any changes to other pension system parameters, such as the statutory retirement age; this allows me to isolate the impact of

[1] Excluding other income sources.

changes in pension benefits on the recipients' retirement decisions.

Studying this subsidy program has important policy relevance. Compared with other welfare programs, this subsidy program has low administrative costs. The subsidy size does not depend on household income or living costs, and is not ex-post means-tested. This is achieved by paying a subsidy to all eligible pensioners. The amount is computed by applying a built-in formula and added directly to the recipient's pension account. Additionally, the majority of the recipients of this program are women who are part of the population most at risk of experiencing poverty in their old age. Thus, the program provides an opportunity to study the effects on this key population. Understanding the extent to which retirement decisions respond to subsidy programs of this kind can provide key insights so as to inform debates in the design of anti-poverty programs for the elderly overall, and for women in particular.

Using high-quality administrative data from the Research Data Center of the German Pension Insurance (FDZ-RV), I provide the first investigation of this program and isolate the causal impact of additional pension benefits using a regression kink (RK) design. The data from FDZ-RV provide a key advantage; they contain panel information on workers' pension contribution histories from age 14 onward at monthly frequencies, and the recipients' exact subsidy levels. The baseline sample consists of female subsidy recipients in West Germany who were born between 1935 and 1951. On average, the subsidy program increases recipients' pension benefits by around 90 euros per month, which is equivalent to a 15 percent increase in the pension benefit level.

I examine three aspects of the retirement decision making process: claiming the pension, exiting from employment and choosing among various early retirement pathways. A large proportion of the recipients do not transition directly from employment to retirement. Therefore, the pension claiming age is not necessarily the same as the age at exiting employment.[2] I find that a 100 euro additional monthly pension benefit induces female recipients to claim a pension six months earlier. The impact on age at exiting employment has similar magnitude but is insignificant. The estimated elasticity of age at claiming pension with respect to women's pension benefits is -0.047, the elasticity of retirement rate from age 55 to 65 is 0.97, and the elasticity of employment rate from age 55 to 65 is -0.56. Recipients also adjust labor supply by using unemployment insurance (UI) as a stepping stone to retirement and by reducing time spent in marginal employment. These findings

[2]In the literature, retirement age is usually the age at exiting employment.

suggest that a higher pension income allows and incentivizes workers to leave the labor force earlier. However, the impact of additional pension benefits is smaller than the combined impact of financial penalties on early claiming and the raising of the legal retirement age, as estimated in other studies (Mastrobuoni (2009), Engels et al. (2017), Manoli and Weber (2018)).

I provide various tests for the robustness of the Regression Kink estimates. These tests include graphical and regression-based tests of the identifying assumptions as well as kink-location tests. Moreover, I test the functional dependence between the assignment variable and the outcomes by using the otherwise similar non-recipients. The results are robust to these checks.

My study extends and complements the literature by making two contributions. First, it contributes to the limited evidence on the causal impact of additional pension benefits, this adding to the literature by effectively isolating the casual impact of additional pension benefits. Moreover, much of the literature explores the effect of pension cuts. In the United States, for example, most of the evidence is based on an unanticipated decline in social security wealth for the US "notch" cohort (Stock and Wise (1990), Krueger and Pischke (1992), Snyder and Evans (2006), Gelber et al. (2018a).). In Germany, Puhani and Tabbert (2016) exploit a cut made to pensions for a special low-skilled population group. Puhani and Tabbert (2016) find no delay in pension receipt in response to the pension cut because the affected workers are frozen in a corner-solution equilibrium in which they prefer to draw benefits as early as possible. This restriction should not bound the impact of a benefit rise.

Second, this paper complements other efforts to elicit evidence on the labor supply of a special population group; that is, low-income older women (Hanel and Riphahn (2012), Lalive and Staubli (2015)). This group is of particular interest because women are more exposed to old-age poverty than men. Additionally, compared to men, women's labor supply responses tend to have a greater financial consequence, as women, on average, live longer, and have a larger labor supply elasticity.

The results have two main policy implications. First, the empirical results suggest that this subsidy program is relatively less distortionary than other income support programs. A back-of-the-envelope calculation suggests that in order to increase the mechanical transfer to the lifetime pension income by 1 euro, the government has to raise an additional 0.25 euros. This implies that the ratio of behavioral cost to mechanical cost of this subsidy program is 0.25. This ratio is much smaller than that of other welfare programs, such as Unemployment Insurance benefit extensions.

Second, I show that the phasing out of this subsidy program accounts for around 16 % of the increase in the age at which women claimed their pensions over the past decade in West Germany.

The rest of the paper proceeds as follows: Section 2 describes the core features of the German pension system and the details of the subsidy program. Section 3 discusses the expected impacts of the subsidies. Section 4 presents the data and describes the sample selection. Section 5 describes the empirical design. Section 6 presents results and Section 7 concludes.

2 Institutional Details

Key Features of the Public Pension System in Germany The German Public Pension System is an earnings-related points system financed on a pay-as-you-go basis.[3] Participation is mandatory, except for civil servants and the self-employed. On average, the public pension replaces around 50% of pre-retirement wage, net of income and payroll tax. As at the end of 2018, the average monthly pension benefit of the insured was around 1,114 euros for men and 719 euros for women.

The statutory retirement age for a regular old-age pension remained at 65 year old throughout almost all of the sample period; the only prerequisite being to make a contribution for at least five years.[4] Several alternate pathways make retiring before 65 years of age possible.[5] Notably, women can claim the pension at age 60 via the old-age pension for women. Almost all recipients of the subsidy program are eligible for this pathway, [6] and is the reason I focused on investigating the impact on hazard rate to claim the pension at age 60.

In Germany, pension benefit levels are closely tied to the lifetime wage incomes. The main determinant of pension benefits is the sum of individually accumulated earnings points (Entgeltpunkte, (EP)). Essentially, for each year τ of contribution, a worker i accumulates some earnings points $EP_{i\tau}$, which are determined by the individual wage $w_{i\tau}$ relative to the average wage of all

[3]The pension system is manly financed with mandatory contribution payments, which are normally shared equally by employers and employees. In 2019, the total mandatory contribution rate was 18.6 %.

[4]Starting from 2012, the statutory retirement age for cohorts younger than the birth year of 1947 began increasing from 65, and this will reach age 67 for cohorts younger than the birth year of 1964. See Appendix A.3 for more details.

[5]There are four main early retirement pathways: old-age pensions for long-term insured, old-age pensions for women, old-age pensions due to unemployment (and, later, part-time work); and old-age pensions for severely disabled persons (Boersch-Supan and Wilke (2004)).

[6]The eligibility requirement for this pathway is 15 years of contributions, of which at least 10 years must have occurred after age 40. This pathway was abolished for women born after 1952. I therefore restrict the baseline sample to women born before 1952. See Appendix A.3 for more details.

the insured $\bar{w_\tau}$. For example, a worker whose wage is half of the average wage in the contribution year τ will accumulate 0.5 point in that year. Equation 1 shows the monthly pension benefits for individual i who retires in year t.

$$PB_{it} = \underbrace{(\sum_{\tau} EP_{i\tau} + \text{ Subsidy}_i)}_{\text{Personal Pension Base}} \times PV_t \text{ , where } EP_{i\tau} = \frac{w_{i\tau}}{\bar{w_\tau}} \tag{1}$$

The amount of pension benefit PB_{it} is the personal pension base multiplied by the pension value.[7]

The worker's personal pension base is the sum of the EPs accumulated over time, plus additional EPs credited by the subsidy program. For example, an average wage earner with 15 contribution years accumulates 15 EPs. At the time of the claim t, this personal pension base is scaled up by the pension value PV_t, which is determined aggregately by factors such as the average wage of all insured, the contribution rate and demographic changes. This pension value PV_t is adjusted on July 1 of each year. For example, one EP was equivalent to 31.03 euros per month in 2018 (Rentenversicherung (2018)).

Overall, workers with short contribution years or low relative wage incomes are more likely to face old age poverty. On average, one less year of full value contribution decreases the gross replacement rate by around 1.17%. This is one of the reasons that women are the majority of the subsidy recipients as they have short employment periods and lower wage over their life cycle.[8]

Pensioners can work while claiming their pensions, however, they face a stringent earnings test between the early retirement age (ERA) and the normal retirement age (NRA). If pensioners work at jobs paid more than 450 euros per month, they need to file for partial retirement.[9] This makes working at a regular job while claiming a full pension impossible. After the NRA, pension

[7]This benefit level will also be adjusted by an adjustment factor AF_{it}. The adjustment factor penalizes early claims. Benefit levels decrease by 0.3 percent for each month before the full retirement age is reached. See Appendix A.3 for more details on pension reforms and the impact of the adjustment factor. The pension benefit also depends on the type of pension. This factor is equal to one for old-age pension, and is less than one for disability pensions. Almost all subsidy recipients claim old age pension.

[8]See Appendix A.6 for details on gender difference in activities over a life time in Germany.

[9]Before 2017, workerscould not claim a pension while working. Workers use a partial retirement scheme, which allows them to work part-time and receive additional supplementary income from age 55. One example is the Altersteilzeit (ATZ) policy. See Tolan (2017); OECD (2017) for more details. After 2017, flexible retirement allows people to receive a partial pension payout before the normal retirement age while still working. However, for those with annual earnings above EUR 6,300 (roughly the income from mini jobs), the full pension is reduced by 40% of the additional earnings.

recipients no longer face earnings tests. [10]

Pension Subsidies to Low-pay Workers The pension subsidy program studied in this paper was introduced during the German pension reform in 1992.[11] The primary policy consideration of this subsidy program is to ensure adequate old-age income, which credits additional earnings points to eligibility individuals. The target recipients are workers with low lifetime pension contributions.[12]

According to the statistics from the Research Data Center of the German Pension Insurance, in December 2015, 14% of old age pensioners — 4% of all male pensioners and 26% of all female pensioners — were recipients of this subsidy program. Recipients, on average, receive around 90 euros as a monthly subsidy, which is equivalent to a 15% increase in pension income. In 2015, the total payments for this subsidy program were approximately 3 billion euros.

The subsidy size is predetermined. The determinants of subsidy size are the total EPs contributed before 1992 and the average EPs contributed before 1992. The subsidy formula for individual i retires in year t is:

$$Subsidy_i = min\left(0.5 \times \sum_{\tau<92} EP_{i\tau} \text{ , } 0.75T_i^{92} - \sum_{\tau<92} EP_{i\tau}\right) \tag{2}$$

, where T_i^{92} is the number of years contributed before 1992 for individual i. Essentially, the subsidy increases the earnings points contributed before 1992 ($\sum_{\tau<92} EP_{i\tau}$) by 50%, up to a cap that the average annual EP before 1992 ($\frac{1}{T}\sum_{\tau<92} EP_{i\tau}$, denoted as aep_i^{92} from here onward) does not exceed 0.75.[13]

The subsidy formula creates a kinked schedule of subsidy in relationship to aep_i^{92}, holding years contributed before 1992 (T_i^{92}) constant. This is what I rely my identification on. Equation 3 shows that the average subsidy per years before 1992 ($\frac{Subsidy_i}{T_i^{92}}$) has a slope of 0.5 before the kinked point and a slope of -1 after the kink point.

[10] The benefits that are "taxed" away due to the earnings test are not lost but postponed at an actuarially fair rate.

[11] See Appendix A.3 for a summary of other reforms implemented in 1992.

[12] The German name of this subsidy program is "Mindestentgeltpunkte bei geringem Arbeitsentgelt". See German Social Law, vol. 6 clause 262 (SGB VI § 262) for the exact definition.

[13] See Appendix A.2.1 for examples illustrating the calculation of the subsidy amounts. The German Pension Office website provides detailed examples

$$\frac{Subsidy_i}{T_i^{92}} = \begin{cases} 0.5aep_i^{92} & ,aep_i^{92} \leq 0.5 \\ 0.75 - aep_i^{92} & ,0.5 \leq aep_i^{92} \leq 0.75 \\ 0 & ,aep_i^{92} > 0.75 \end{cases} \tag{3}$$

Figure 1 illustrates the policy schedule according to Equation 2 when T_i^{92} is set to the sample average 20 years (Figure 1a) and when T_i^{92} is a random variable with a normal distribution similar as the distribution of T_i^{92} in the baseline sample (Figure 1c, 1d).[14] We can clearly see the kinked policy schedule. Figure 1b illustrates how the subsidy size changes along both aep_i^{92} and T_i^{92}. We can see that individuals worked more years before 1992 and individuals with aep_i^{92} closer to 0.5 are granted more subsidies.

Workers with aep_i^{92} closer to 0.5 receive the most subsidies, because the policymakers aim to reward people who work with a low income rather than people who do not work at all.[15] This subsidy program ensures an adequate pension for people with two characteristics: individuals with a long pension contribution history and workers with low wages. Specifically, individuals need to fulfill two criteria to become eligible for this subsidy program. First, a worker should have at least 35 creditable years, which include contribution periods and parental years given to mothers. The time involved in raising a child counts as part of the creditable years. The package is 10 years for one child, 15 years for two children and 20 years for more than two children. Therefore, the 35-creditable-year requirement is relatively lenient for mothers. In my sample, 55% of female pensioners in West Germany have at least 35 creditable years. Second, the average monthly EPs of full-value contribution years [16] at the time of retirement are below 0.75. This criterion guarantees that workers are not only poor before 1992 but also at the time of the retirement. Only individuals in the bottom 37.5 percentile of the income distribution at the time of retirement are eligible. In practice, this criterion is also relatively lenient. Only 9% of pensioners with aep_i^{92} below 0.75 have *aep* at retirement being higher than 0.75.

[14] See Appendix A.2.2 for details on how I simulate T_i^{92} and plot Figure 1c and 1d.

[15] The preceded subsidy program implemented in 1972 was a flat minimum pension program which guaranteed the average annual EPs before 1972 to be 0.75 for all eligible recipients. The policy debate prior to the 1992 subsidy program focused on not rewarding individuals who do not work. Therefore, the 1992 pension subsidy program introduced the kinked subsidy schedule.

[16] Full value contribution periods are typically periods with gainful employment. See Appendix A.1 for more details of the composition of creditable years, contribution periods and consideration periods

Bridge to Retirement: Unemployment Insurance and Marginal Employment In Germany, a larger proportion of older workers do not transition directly from employment to retirement. They may use unemployment insurance (UI) , marginal employment, and other social support programs as stepping stones into retirement (Hairault et al. (2010), Inderbitzin et al. (2016), Manoli and Weber (2018)). Among people older than age 62 in 2014, only 49% of them claim old age pension immediately after exiting employment. Around 12% of them exit the labor market due to sickness and 27% enter unemployment after exiting the labor force.[17]

There are two main activities which are often adopted by older workers as a bridge to retirement: taking up unemployment insurance and engaging in marginal employment. For example, subsidy recipients who can afford to exit employment earlier can use UI as a pathway. UI provides about 60% as an income replacement and has very lenient job search requirement for older workers. With additional pension subsidies, workers can afford to enjoy more leisure by entering unemployment insurance. In addition, time spent on UI also increases future pension benefits. [18] Another alternative bridge activity is marginal employment. The most popular type of marginal employment in Germany is the "mini job", which is commonly called a "400 euro" job.[19] The marginal jobs are exempt from both social security contributions and income taxation. Two types of individuals have the incentives to work in mini jobs after exiting regular employment: first, workers who plan to delay their pension claim in order to avoid early-claim penalties; and second, workers who plan to continue working in a mini job after claiming their pensions in order to supplement their low pension benefits. [20] With additional pension subsidies, it is expected that the mini jobbers would shorten their time in marginal jobs and claim their pension earlier. Therefore, in the empirical session, I will investigate the impact of additional pension benefits on the bridge activities, such as the probability of using UI to as a bridge to retirement and the length spent in marginal jobs during the gap years.

[17]According to my calculation based on the scientific use file of VSKT in 2014.

[18]See Appendix A.5 for more details about the UI system.

[19]As the informal name implies, these jobs pay 400 euros per month; the maximum amount one can earn that is exempt from both social security contributions and income taxation. This threshold was 325 euros before 2003 and 450 euros after 2013. During most of my sample period, it stayed at 400 euros per month. The majority of exclusive "mini jobbers" are women and older workers (Gudgeon and Trenkle (2019)).

[20]Pensioners can take up mini jobs while claiming their pensions without being subject to any earnings test.

3 Expected Impacts of the Subsidies

I expect the labor supply responses of this subsidy program to differ from the labor supply responses in studies that look at the impact of policy reforms that bundle; for example, changes in the pension eligibility ages with financial penalties to retire early. This is because the subsidy amount is independent of the actual retirement age. Delaying retirement will not change the subsidy amount: it is different from other interventions which almost always change the pension amount if the work alters retirement decisions. Moreover, I expect the labor supply response to be smaller than the labor supply response to in-work welfare programs. This is because the subsidy amount is determined by ex-ante earnings rather than by ex-post earnings. The subsidy recipients have little incentive to alter their concurrent employment status to receive higher benefits.

More specifically, I expect the subsidies to induce people to reduce their labor supply. The impacts on the age at claiming a pension and the age at exiting employment is a combination of a wealth effect and a substitution effect. The wealth effect comes from higher lifetime income due to the additional subsidies. The substitution effect exists because a higher benefit level means a higher forgone pension amount if the worker delays retirement after the eligibility age. Both wealth and substitution effects work in the same direction.

Figure 3 illustrates the stylized lifetime budget constraint for a worker with and without subsidy.[21] Additional pension benefits not only shift the budget set upwards but also change the slope of the budget set. The dashed black line in Figure 3 is the budget without a subsidy, and the solid red line is the budget with subsidies. These two lines are parallel before age 60, and imply that if a worker leaves employment before age 60, and in the absence of the subsidies, the additional lifetime income leads this worker to leave employment earlier due to a pure wealth effect. After age 60, the subsidies change both the level and slope of the budget set. Compared to the non-recipients, recipients have a higher lifetime income and lower incentives to work. The return to work is lower because the forgone pension benefits are now higher due to additional subsidies. Because working while claiming pension is impossible before normal retirement age, delaying retirement leads to forgoing pension benefits. The higher the subsidy, the higher the forgone pension, thus the higher the disincentive to work. The pension subsidies make working less attractive.

[21] See Appendix B for more details about the lifetime budget constraints.

No matter where the individual is located on the budget line in the absence of the subsidy program, additional pension benefits induce this worker to exit and claim earlier. The average impact on labor supply depends on the distribution of the age at exiting employment in the absence of subsidies. The workers who exit employment before age 60, and claim pensions immediately at age 60 in the absence of the subsidies are affected only via the wealth effects. However, I cannot observe the counterfactual distribution of the recipients.

4 Data and Sample Selection

This paper uses administrative data from the Insurance Account Sample (Versicherungskontenstichprobe, (VSKT)) of the German Federal Pension Register. The main dataset is assembled from 13 years of cross-sectional waves (2004 to 2017). The dataset contains 20% random sample of individuals with an active public pension insurance account in Germany, who were between the ages of 30 and 67 at time of data collection. Each cross-sectional wave contains around 240,000 individuals, among which around 32,000 are subsidy recipients. It includes time-invariant information (such as accumulative pension points, gender, birth month, number of children and age at claiming pension, etc.) for the insured person at the time of data collection. Each wave also contains the earnings' biographies from age 14 onwards, at a monthly frequency.

Two important advantages of the data are worth noting. First, these data contain accurate information on the level of subsidies. The accurate measurement of the treatment is crucial to implement the regression kink design. Second, these data provide all relevant information to calculate the assignment variable; that is, the average earnings points from full value contribution before 1992 and at retirement. This information is available because each cross-sectional wave of the VSKT dataset has a panel feature that contains monthly biographical information for each insured person. This information includes social employment status and other details that are relevant for pension benefit calculation and pension points accumulated in each month. Therefore, it allows me to recover the assignment variable aep_{92}. Unfortunately, other potentially useful information is lacking; for example, education and occupation are not accurately measured. Additionally, it is not possible to observe the marital status and link spouses in the data.

4.1 Sample Construction

The main sample is restricted to female subsidy recipients who are at least 63 years old at the sample year, who have at least 35 service years, and who have never worked in East Germany. I exclusively examine the effects on female workers for two main reasons: first, the majority of the subsidy recipients are female workers; and second, the nature of the kink itself dictates this decision. Around the kink, more than 80 percent of the recipients are women, with so few are males that they cannot serve as a reliable subject of study. The explanation for the relative absence of males stems from the fact that men consist of only small fraction of the subsidy recipients, and that the average earning point of 0.5 is at the bottom tail of man's income distribution. I exclude individuals who worked in East Germany because they face different pension rules that are not comparable to those of West Germans. Moreover, two-thirds of the recipients have never worked in East Germany. I also exclude people who are civil servants and self-employed. I further restrict the sample to workers who are older than the 1952 cohort, and have at least 15 years of contributions. These restrictions ensure that all individuals in the sample are eligible to retire at age 60 via the old-age pension for women.[22] I restrict the sample to workers who are at least 63 years old at the sample year to ensure that workers are old enough to claim their pensions. In the original data set, most women claim old-age pensions by age 63. Therefore, I can observe the age at which most female recipients in the sample claim their pensions. The final sample contains 30,172 individuals, covering cohorts born from 1935 through to 1951.

4.2 Summary Statistics

In the sample, among all female pensioners, 27% were subsidy recipients. The distribution of the female recipients' post-subsidy pension benefits is centered around 680 euros. The majority of the recipients' pension benefits are in between 370 and 996 euros.

Table 1 reports descriptive statistics of some key variables for the baseline sample and female recipients around the kink. The baseline specification focuses on the window of recipients whose aep_{92} are from 0.25 to 0.65; that is, 0.2 EPs on either side of the kink. There are 26,614 individuals

[22]Old-age pension for women is one of the early retirement pathways in Germany. For cohorts born prior to 1952, women can retire as early as age 60 by claiming the women's old age pension if they have made at least 15 years' worth of contributions. Women born in 1952 and later can no longer retire at age 60.

in this window. The average subsidy is 3 EPs with a standard deviation of 1.7, which is equivalent to 90 euros per month and around 15% of the monthly pension benefits.[23] These women on average worked 19 years before 1992. On average, the recipients start working at age 18, gave birth to their first child at age 23 and their last child at age 27. They experience the first episode of unemployment at age 48, exit employment at age 58 and claim an old-age pension at age 62. The recipients around the kink are those whose aep_i^{92} are from 0.4 to 0.5 — that is, 0.05 EPs on either side of the kink. Their average subsidy size is around 3.51 EPs with a standard deviation of 1.9, which is slightly higher than the sample average. The average age at which they claiming pensions (61.90), and age at which they exit employment (57.62) are similar to the sample mean.

5 Empirical Methodology

5.1 Regression Kink Design

The kinked schedule of this subsidy policy allows me to identify the causal effect of pension subsidies. Following Landais (2015), Card et al. (2015) and Card et al. (forthcoming), I use a Regression Kink method to estimate the local average treatment effect of the pension subsidies. I examine the induced change in the slope of the relationship between the outcome of interest (Y) and the assignment(running) variable (r) at the kink in the policy formula. The average treatment effect of subsidy B on Y at the kink ($r = 0$) is expressed as:

$$\mathbb{E}(\frac{dY}{dB}|r = 0) = \frac{\lim_{r_0 \to 0^+} \frac{d\mathbb{E}(Y|r)}{dr}|_{r=r_0} - \lim_{r_0 \to 0^-} \frac{d\mathbb{E}(Y|r)}{dr}|_{r=r_0}}{\lim_{r_0 \to 0^+} \frac{d\mathbb{E}(B|r)}{dr}|_{r=r_0} - \lim_{r_0 \to 0^-} \frac{d\mathbb{E}(B|r)}{dr}|_{r=r_0}} = \frac{\widehat{\Delta \frac{dY}{dr}}}{\widehat{\Delta \frac{dB}{dr}}}$$

The average treatment affect is obtained by dividing the estimated slope change in the outcome variables by the estimated slope change in the pension subsidy with respect to aep_i^{92}. I obtain the estimates of the numerator and denominator by running parametric polynomial regressions of the following forms:

$$Y_i|(r = 0) = \alpha_y + [\sum_{p=1}^{p=\bar{p}} \rho_p r_i^p + \beta_p r_i^p \times \mathbb{1}(r_i \geq 0)] + \theta_y X_i +_i \ \text{, where } |r_i| \leq h \tag{4}$$

[23] All monetary values are CPI adjusted and expressed in 2010 euros.

$$B_i|(r=0) = \alpha_b + [\sum_{p=1}^{p=\bar{p}} \tau_p r_i^p + \gamma_p r_i^p \times \mathbb{1}(r_i \geq 0)] + \theta_b X_i +_i \quad \text{, where } |r_i| \leq h \tag{5}$$

, where r is aep_i^{92} centered around the kink. $\mathbb{1}(r_i \geq 0)$ is an indicator for aep_i^{92} being above the kink, p is the polynomial order, h is the bandwidth size. Y represents the outcome variables — age at claiming a pension, age at exiting employment, the hazard rate to claim a pension at 60, etc. B is the pension subsidy level. The estimated change in the slope of Y around the kink $\frac{dY}{dr}|r=0$ is β_p, the estimated change in slope of B around the kink $\frac{dB}{dr}|r=0$ is γ_p. In the baseline analysis, I show results in a linear case with a bandwidth of 0.2 EPs. h is set to be between 0.25 and 0.65. This window contains female recipients whose average monthly wage income before 1992 was around 500 on either side of the kink point.

5.2 First Stage: Kinked Subsidy Schedule

Figure 2 plots actual total subsidies measured in 2010 euros against $aep92$ for the main sample. The actual subsidies exhibit the kinked relationship predicted, similar to Figure 1. The overall shape of Figure 2 is similar to Figure 1.

However, there are two main deviations from the policy schedule. First, the observed kink is at 0.45 rather than 0.5. Those deviations are due to measurement errors as a result of the fact that $aep92$ is constructed rather than recorded in the data. The deviations occur because the majority of the baseline sample are women who have had long childcare periods, which involve complex accounting. Because the subsidy is precisely recorded in the administrative dataset, I use the observed kink as the baseline cutoff. Second, the estimated change in slope when subsidies are measured in 100 euro is -5 while the change in slope using simulated T_i^{92} in Figure 1d is -9.3. The mismatch may come from two sources: first, the simulated T_i^{92} is not the same of the actual T_i^{92}; and second, the observed kink is at 0.45 rather than 0.5. Because the observed relationship between pension subsidy B and r varies from the policy rule, I adopt a fuzzy RK approach. Table A1 reports the estimated change in slope of benefit level B around the kink (First Stage) according to Equation 5.

5.3 RKD Assumptions

There are two main assumptions to obtain a valid regression kink design. First, both the density and the partial derivative of the density with respect to aep_i^{92} should evolve smoothly around the kink. Intuitively, this assumption rules out the situation that the induced changes in Y are not due to changes in B, but rather due to sample selection. This can be tested by checking the smoothness of the density function at the kink.

Figure 4a plots the density of the recipients around the kink. It shows the number of recipients observed in each bin of aep_i^{92}. The bin size is 0.007625 EP, which is equivalent to 20 euros in monthly wage. The density shows a quadratic relationship with aep_i^{92} with the mode of the density being around the kink point. To formally test for discontinuity of level and partial derivative of the density, I performed McCrary tests, as done in Landais (2015).[24] The results of the discontinuity of the density and the discontinuity of the slopes with linear, quadratic and cubic specifications are reported in Figure 4a. The results suggest that the density is smooth around the kink, and also shows that the discontinuity in the partial derivative of the density is not statistically significant for quadratic and cubic specifications, however statistically significant it is when using a linear specification.

The above results could be problematic; however, the nature of this subsidy program makes the discontinuity in the slope of the density less of a concern. The smoothness assumption is to make sure that there is no manipulation of the assignment variable at the kink. Therefore, workers to the left and the right of the kink are comparable. Because this subsidy program was announced in 1992, and the assignment variable is aep^{92}, which is the average EP from full-value contribution before 1992, manipulating the system is virtually impossible. It is unlikely that individuals sort themselves to one side of the kink. Moreover, there are no strong incentives to manipulate the system because the benefit levels change only slightly across the kink.

To confirm results, I plot the density of the non-recipients around the kink in Figure 4b and the density of all workers in West Germany around the kink in Figures 4c and 4d. Figure 4b shows the density of female workers in West Germany with less than 35 creditable years. Those women are

[24]Following Landais (2015), I regress the number of observations N_i in each bin on polynomials of aep_i^{92} in each bin and the interaction term of being above the kink. The coefficient in front of the aep_i^{92} interacted with a dummy variable for being above the kink is the estimate of the change in slope of the density.

not eligible for the subsidies, therefore the bell-shaped density similar in Figure 4a cannot be driven by manipulation in response to the subsidy program. Moreover, Figure 4c shows the distribution of female and male workers in West Germany along with female and male subsidy recipients in West Germany.[25] We can again see that the shape of the density is not unique for female subsidy recipients, but rather is a pattern common for all female workers. The red circles in Figure 4c show the distribution of female workers in West Germany. The distribution is bell shaped and centers at the kink. The green hollow triangles show the distribution of male workers in West Germany. This distribution is also bell-shaped, but centers at 0.6 EPs to the left of the kink. This is because male workers have higher average wages and pension benefits.

The second assumption is that the conditional expectations of predetermined covariates evolve smoothly with the assignment variable at the kink. This assumption further rules out the chance that the kink in outcomes is caused by kinks in recipients' characteristics. Figure 5 shows the predicted values of five outcome variables using the predetermined covariates: age at claiming old-age pension, age at claiming disability pension, age at exiting employment, hazard to claim at age 60, and hazard to exit at age 60. I use individual characteristics, such as the number of children, age at first birth, age at last birth, and pension years as the explanatory variables. I also add social economics status (SES) before 1992, as proxied by months receiving unemployment insurance payments or unemployment assistance payments, in childcare, and on sick leave. The predicted distributions of the outcome variables by the predetermined covariates are smooth across the kink. Figure A2 shows the bin scatter plots for the covariates separately. Table 2 shows that the slopes of density and predetermined covariates are smooth around at the kink point. Similar to Gelber et al. (2017), I run regressions in the form of Equation 4 with polynomials of order of 1 to 12. Table 2 reports the coefficient for the polynomial order that minimizes the corrected Akaike Information Criterion (AICc). Using a baseline specification without controls, I find that the covariates evolve smoothly at the kink, except for the age at the first birth.

[25]The only restriction is that they are at least 63 years old in the sampling year. This restriction applies to all samples in this paper.

6 Results

In this section, I present the estimated impact of pension subsidies on the age at which women choose to claim their pensions, the age at which they choose to exit employment, and labor supply activities during the bridge years. I also show several robustness tests of the RK estimates and present heterogeneous responses for subgroups.

6.1 Graphical Evidence

Figure 6 plots the age at claiming the old-age pension (Figures 6a and 6b) as a function of aep_i^{92} and the hazard rate to claim the pension at age 60 (Figures 6c and 6d) and at age 63 (Figures 6e and 6f) as a function of aep_i^{92}. Figure 7 plots the relationships with respect to age at exiting employment (Figures 7a and 7b) and the hazard rate to exit employment at age 60 (Figures 7c and 7d) and age 63 (Figures 7e and 7f). The solid lines are the linear fitted lines for individuals to the left and right of the kink. The left panel shows the bin scatter plots using the raw data (diamond bins), and the right panel shows the bin scatter plots of predicted outcome variables after controlling for covariates and cohort fixed effects (dotted bins).

Visually, one can see that additional pension benefits induce workers to claim the old-age pension earlier. There is a kinked relationship between aep_i^{92} and age at claiming a pension. The slope becomes flattened to the left of the kink. If I assume that age at claiming pension decreases linearly as aep92 increases, then the age at claiming old-age pension would be around age 62 in the absence of the subsidies (that is, the average value for workers within 0.2 EPs of the kink), in contrast to age 61.8 at the kink. Extra pension income induces workers to claim their pension earlier.

Similarly, I see a sharp visible change in the slope of the relationship between aep_i^{92} and the hazard to claim a pension at age 60. The raw bin scatter plots for the hazard to claim a pension at 63 show no visible slope change. However, I do see a pattern after controlling for covariates.

Figure 7 suggests that the changes in the slope of the exiting behaviors are not as salient as that of the claiming behaviors. Visually, I spot no slope changes at the kink for the age at exiting employment and the hazard to exit employment at age 60. I see a kinked relationship between aep_i^{92} and hazard to exit employment at age 63 after controlling for covariates.

6.2 Regression Results: Effect of Subsidies on Claiming and Exiting Behavior

In Table 3, I present fuzzy RK estimates of the local average treatment effects of an additional 100 euro of monthly pension benefits ($\frac{dY}{dB}$). The results are obtained from the linear regressions as Equation 4 and Equation 5 with a bandwidth of 0.2 EPs around the kink for a range of controls. The standard errors are obtained using delta method.[26] The average values of the outcomes are also reported. Column 1 shows the results of linear regressions without controls. Column 2 shows the results of linear regressions with cohort fixed effects. The cohort fixed effects account for the incentive changes caused by raising the statutory retirement age, which was implemented gradually by cohorts. Column 3 adds to the regression further observed controls, such as the number of children, the age at first employment, age at first birth, age at last birth, credible pension years, socioeconomic status (months spent in unemployment insurance, sick leave, childcare periods) before 1992, etc. The estimation results are similar across specifications.

Panel A shows the impact on claiming behaviors, including the age at claiming an old-age pension, the average retirement rate from age 55 to 65, [27] the hazard of claiming at age 60, age 63, and age at claiming a disability pension. I find that a 100 euro additional monthly pension benefit induces the female recipients to claim their pension 0.5 years (six months) earlier and increases the average retirement rate by 5.8 percentage points. However, it has no significant impact on the age at claiming a disability pension. A 100 euro additional monthly pension benefit significantly increases the hazard of claiming a pension at age 60 by 12.5 percentage points.

Panel B shows the impact on exiting behaviors, including the age at exiting employment, the average employment rate from age 55 to 65, the hazard of exiting at age 60, age 63. I find that an extra 100 euro monthly pension benefit decreases the average employment by 4.2 percentage points and increases the hazard of exiting employment at age 63 by 20 percentage points at a 5 percent significant level.

Even though the estimated impact on the age at exiting employment is not statistically significant,

[26]See Table A1 for the estimated change in the slope of Y around the kink (Reduce-form) and the estimated change in the slope of benefit level B around the kink (First Stage). The standard errors are obtained using the delta method of the first stage and reduced-form regressions. I have also calculated standard errors using a bootstrap method. The results are similar.

[27]The retirement (employment) rate at each age is calculated as the average share of retired (employed) women at each age among women eligible for subsidy by bins of aep_i^{92}.

it has a similar magnitude to the estimated impact on the age at claiming a pension. The main reason for larger standard errors is that the age at exiting employment is more dispersed. Figure A7 shows the distribution of those two ages. We can see that the age at exiting employment is much more spread out. Around 9% of the sample exit employment before age 50. Among those individuals, 24.21% exit employment due to sickness. I expect that they are less likely to adjust their labor supply due to the subsidies since many of them exit employment due to an incapacity to work. Censoring those outliers might gain more precision.

Figure A9 shows the relationship of aep_i^{92} with respect to the adjusted age at exiting employment (setting the value to missing for everyone who exits before age 50) and censored age at exiting employment (drop everyone who exits before age 55). The patterns are similar. No visible slope changes are detected. I present the result for the adjusted age at exiting employment and the censored age at exiting employment in Panel B. The estimated impact on adjusted age at exiting employment is smaller and more stable across specifications. However, after eliminating the outliers, I still find no significant impact on age at exiting employment.[28]

To show the full picture of the subsidies' impacts on workers' labor market decisions, I plot the estimated change in the hazard of claiming pensions, and the hazard of exiting employment from age 50 to age 65. Figure 8a plots the estimated change in the hazard of claiming pensions, when there is a 100 euro additional monthly pension benefit. Figure 8b plots the estimated change in the hazard of exiting employment. Figure 8c and Figure 8d plot the estimated survival rate when monthly pension benefits increase by 100 euros.

I observe that most of the actions happen at statutory retirement ages: ages 60, 63, and 65. Given the salience of the statutory retirement ages, these patterns are reasonable. Subsidies increase the hazard to claim and to exit at age 60 and 63, and decrease the hazard to claim and exit at age 65 (insignificantly). Particularly, the hazard to exit at age 63 increases massively. This suggests that the recipients are more likely to claim a pension via some sort of early retirement pathways, such as via unemployment insurance. In Section 6.3 , I indeed find that the recipients are more likely to transition to a pension claiming via UI. Moreover, the hazard to exit at age 55 and age 58 increases slightly. One explanation is that workers age 58 and older can receive unemployment benefits

[28]I also run the regressions when dropping everyone exit before age 55. The estimated impact on age at exiting employment is -0.367 with controls and the standard error is 0.249. The impact remains insignificant.

without actively looking for a job. The pattern is hard to interpret. Nevertheless, the responses at ages before 60 suggest that additional pension benefits also change workers' activities during the bridge years.

6.3 Effect of Subsidies on Bridging Activities

In Germany, many older workers do not transition directly from employment to retirement. With additional pension benefits, recipients adjust their transitional behaviors along two margins: duration spent (intensive margin) and pathway to retirement (extensive margin).

First, I investigate the impact on time spent on other activities after exiting regular employment. Regular jobs are jobs with mandatory social security contribution obligations. For the female recipients in my sample, the gap between the age at last regular employment and the age at claiming pension is around 4.6 years, among which 1.3 years are spent in unemployment and 0.5 years are spent in marginal employment. The results in Table 4 suggest that a 100 euro additional monthly pension benefit induces workers to reduce time spent in marginal jobs during the bridge years by about four months. This is reasonable because the gain of staying in marginal jobs is smaller. The forgone wage from marginal jobs is lower, and the additional time spent in marginal jobs does not increase future pension entitlements. I also find that workers prolong their time spent on unemployment by around five months. Both estimates are statistically significant at the 10 percent level.

Second, I test the impact of a 100 euro additional monthly pension benefit on the probability of being in different activities after exiting regular employment and before claiming a pension. After exiting their regular employment, 40 percent of the female recipients claim old-age pension; only 2 percent claim disability insurance; 32 percent were unemployed, and 18 percent were on sick leaves. I do not find significant impacts along this margin (Table 5). The likelihood of entering UI increases, however, insignificant. I also show the effects on activities before claiming a pension in Panel B of Table 5. Before claiming their pensions, 43 percent of the female recipients were working in regular employment; 28 percent were unemployed; 7 percent were in marginal employment; 3 percent were on sick leave; and the rest were inactive. Again, I do not find significant impacts on activities before claiming an old-age pension. Additional pension benefits have a positive effect on the likelihood of using UI as a pathway to early retirement. However, the effect is statistically insignificant.

The findings from Table 4 and Table 5 suggest that female recipients reduce their time spent in marginal jobs while increase time spent being unemployed. Workers switch from working marginal jobs to relying on unemployment insurance. This is in line with a higher increased hazard rate of exiting employment at age 58 and the higher hazard rate of claiming a pension at age 63, which is the statutory retirement age associated with the UI pathway.

I provide various placebo tests of the RK estimates. As Card et al. (2015) point out, one main concern with the RKD identification assumptions is the functional dependence between the assignment variable and the outcome variable. To ensure that the estimated impact on the age at claiming a pension is not caused by the quadratic functional form but by the kinked schedule in the subsidy, I run some placebo tests.

First, I use West German women with less than 35 creditable years as a placebo sample. Those women are not eligible for the subsidies but have similar earnings' histories as those of the female recipients. Figure A3 shows scatter plots for the age at claiming a pension and the hazard of claiming a pension age 60 using the placebo sample. The scatter plots show the relationship of the outcome variables with average earnings points before 1992 for those non-recipients. There are no visible changes in slope at the kink. The regression results in Table A3 confirm the graphical pattern. I find no significant changes in slope at the kink of all main outcome variables. The results suggest that the estimated changes in slope for the recipients are not caused by the quadratic functional form.

Moreover, I use placebo kinks. I test for the existence and location of the kink. Figure A4 shows the R-squares of the regressions using placebo kinks for four outcomes: age at claiming a pension, the hazard to claim at age 60, age at exiting employment and the hazard to exit at age 63. We can see that the R-square decreases sharply as one moves away from the actual kink point, and increases when one moves closer to the kink point. The R-squares are maximized at kinks close to the actual kink for most outcomes except for the age at exiting employment. However, this is not surprising, as the estimated impact for the age at exiting employment is not statistically significant.

I also perform a permutation test as in Ganong and Jäger (2018) using the placebo kinks. Figure A5 shows that the reduced-form estimates and 95 percent confidence intervals using the "placebo" kinks for four outcomes: age at claiming a pension, the hazard to claim at age 60, age at exiting employment and the hazard to exit at age 63. The figures show that the absolute value of the estimate at the actual kink point is larger than most of the estimates at the placebo kinks.

Lastly, I use the average EP after last employment as a placebo forcing variable instead of aep_i^{92}. The average EP after last employment is a good proxy for lifetime earnings, but not directly correlated with aep_i^{92}. Table A4 shows the estimated changes in all outcome variables using mean EP five years, four years, three years, two years, and one year after last regular employment as the placebo forcing variables. It shows that the $\frac{dY}{dB}$ estimates are insignificant across all placebo specifications. I observe no kinked relationship of the outcomes with the placebo forcing variables.

6.4 Heterogeneity and Robustness

Heterogeneous Behaviors I look at the heterogeneous responses for subgroups by pension subsidy size, health status and labor market attachment. Table 6 shows the estimation results. The regression results suggest that the impacts are only significant for workers with higher than the average subsidies. Female recipients with higher than average subsidy size claim pension earlier by around eight months. Their hazard to claim a pension at age 60 and hazard to exit employment at age 63 increases by 12 percentage points and 33 percentage points, respectively. This might be a result of an insignificant slope change in subsidy size for recipients with lower than average subsidies. It also suggests that when the subsidy level is smaller than a certain threshold, workers' labor supply is not responsive to the additional benefits. It would be interesting to measure the continuous impact of a subsidy on retirement behavior. However, I don't have enough observations to perform a quantile regression. I also test for the heterogeneous effects by years worked before 1992. The number of years worked before 1992 is one determinant of the subsidy level. I find that women who worked less than 20 years before 1992 respond more in their claiming behaviors. However, the test for difference in the estimated impacts is statistically insignificant.

Health status is a key factor that affects retirement decisions. Poor health makes it harder to stay in employment and induces workers to claim their pension earlier. Workers with poor health also value leisure more. I expect unhealthy individuals to reduce their labor supply more when pension benefits increase. I proxy unhealthiness using a dummy of spending some time on sick leave before age 50. The estimation results suggest that the additional pension benefits lead healthy workers to claim pensions about eight months earlier, and unhealthy workers are not as responsive to the incentives. The results look puzzling at first glance. However, first of all, the difference in impacts on the pension claim age is statistically insignificant. Secondly, the unhealthy are less responsive in their claiming behavior because the majority of them were to claim pension as early as possible in the absence of the subsidy. I do find evidence that unhealthy exit employment earlier. Unhealthy workers are 58 percentage points more likely to exit employment at age 63, while healthy workers are unresponsive.

I further separate female recipients by the number of children and years worked before retirement. Both variables proxy for labor market attachment. First, I look at mothers with more than one child. Because the labor force attachment of women is strongly affected by their child-bearing activities, mothers with more children are less likely to be attached to employment. I expect mothers with more than one child are more responsive to the additional pension income. Row 4 in Table 6 confirms this hypothesis. The impact of additional income on women with no children or with only one child is notably smaller than the impacts on mothers with more than one child. When I compare women with children and without children, the results are similar. Second, I define workers with less than 28 years of regular employment (sample mean) as having a weaker labor market attachment. Again, I find that workers with a weaker labor market attachment reduce their age at claiming pensions by around 1.4 years, while those with a strong attachment claim three months earlier.

Estimates by Polynomial Order and Bandwidth Several exercises further establish the robustness of the estimates. Similar to previous regression kink design studies (Böckerman et al. (2018); Manoli and Turner (2018); Gelber et al. (2018b)), my results are sensitive to the choice of polynomial order. Column 2 of Table 7 reports the results of the estimation for a linear (Panel A) and a quadratic (Panel B) specification with a bandwidth of 0.2EP around the cutoff. Except for the retirement rate and the employment rate, all estimates become insignificant when I use the quadratic specification, and the magnitude varies.

Table A7 further shows the first stage estimates and RKD estimates in response to a 100 €increase in pension income for a linear, a quadratic, and a cubic specification. The Aikake Information Criterion (AIC) and Bayesian information criterion (BIC) and AICc (AIC with a correction for small sample sizes) with correction are also reported. The estimates are quite sensitive to polynomial orders; however, the differences among AIC, BIC and AICc are small across specifications. According to those criteria, in terms of age at claiming a pension, the linear specification fits the best. For the hazard to claim at age 60 and the hazard to exit at age 63, the quadratic specification fits the best according to AIC and AICc; and the linear specification fits the best according to BIC. In terms of the retirement rate and the employment rate, the cubic specification fits the best. One possible attribute for the sensitivity to polynomial order is the variation in the estimated kink of the endogenous policy variable (monthly subsidies) across polynomial specifications as shown in row one in Table A7. Another explanation is that one should allow the bandwidth choice to vary with the polynomial orders. When paired with the corresponding optimal bandwidth, the estimates are less sensitive to polynomial order. It is confirmed by the results in column 4 of Panel B in Table 7. Moreover, Gelman and Imbens (2019) suggest that high-order polynomial regression is a poor choice in regression discontinuity analyses. They recommend local linear or quadratic polynomials for RD designs for causal inference. In this paper, I use a linear specification as the baseline.

Although my results are sensitive to the choice of polynomial order, they are relatively stable to the bandwidth choice. Figure 9 plots the point estimates and their 95 percent confidence intervals with bandwidths from 0.0625 to 0.3125 EP at 0.0125 intervals, which are the equivalent of from 162.5 to 812.5 €in monthly subsidies at 32.5 €intervals. All the estimations use the linear specification with controls and cohort fixed effects. The dotted, dash dotted, dashed and solid vertical lines correspond to four different bandwidth selections — the Imbens and Kalyanaraman (2012) bandwidth for fuzzy RKD (Fuzzy IK); the bias-corrected estimates per Calonico et al. (2014) (Fuzzy CCT); the "rule-of-thumb" bandwidth based on Fan and Gijbels (1992) (FG); and the baseline bandwidth (0.2). For the age at claiming a pension, the bandwidths are 0.075, 0.068, 0.22, and 0.2 EP, respectively. Figure 10 a suggests that the results are significant and relatively stable for bandwidths larger than 0.125. I find a similar pattern for the estimated impacts on the hazard to claim at age 60 in Figure 10 a. Table 7 displays the estimated impacts and bandwidth for all relevant outcomes using the four bandwidth selection criteria mentioned above. Notice that the estimated impact on the age at claiming a pension from a quadratic specification using the FG bandwidth is -0.454, very similar to the baseline outcome of -0.496. Table A8 also lists the estimation results from a linear specification with a bandwidth of 0.3, 0.25, 0.20 , 0.15, 0.10 and 0.05 EP. It shows that the estimated impact on the age at claiming pension ranges from -0.336 to

-0.503.

6.5 In Comparison with other studies

The estimated impact of claiming a pension six months earlier is at the lower end of the range of existing estimates. I compare my results with three types of studies.

First, I compare my estimates with the results from studies that estimate the impact of policy reforms that bundle; for example, changes in the default option and changes in financial incentives (Mastrobuoni (2009),Engels et al. (2017), Manoli and Weber (2018)). I expect my estimates to be smaller than their estimates since I do not capture responses to changes in the default option. My estimate captures the sole impact of a single policy parameter; that is, additional pension benefits. For example, Engels et al. (2017) estimates a total effect of pension reform in Germany; that is, a financial penalty of 18 percent combined with a shift in NRA. They find that affected women claim their pension 15 months later, a period that is greater than my estimate. [29] Mastrobuoni (2009) exploit the 1983 Social Security Amendments in the United States, which simultaneously increased the NRA and the penalty for claiming benefits at the ERA. They find that a financial penalty of 1 percent combined with a 1.8- month increase in the NRA increases the retirement age at least by 0.9 months. This is larger than my finding that the retirement age decreases by 0.35 months as a result of a 1 percent increase in benefits.

Second, I compare my estimates with studies of other old-age support programs, such as an increase in the generosity of social security benefits (Friedberg (1999), Neumark and Powers (2000), Marie and Castello (2012), Gelber et al. (2017), Gelber et al. (2018a), Fetter and Lockwood (2018)). I find that my estimates are close to the estimated response in those studies. For example, Marie and Castello (2012) measure the labor supply response to a 36 percent increase in the disability insurance benefits in the United States, and find that the labor force participation rate declined by 8 percent among the disabled individuals who receive the increase in benefits. The magnitude is similar to my finding of a 4 percent decrease in employment rate in response to a 17 percent increase in old-age pension benefits. The paper that is closest to mine is Gelber et al. (2018a), which isolates the impact of additional pension benefits on women by exploring the US "notch" cohort. Gelber et al. (2018a) looks at a pure wealth effect and finds that an increase in lifetime discounted

[29] In my study, €100 additional benefits is comparable to a 17% increase in the pension amount.

Old Age and Survivor's Insurance benefits of $10,000 cause a 1.24 percentage points decrease in the yearly participation rate from ages 61 to 95. To compare with their findings, I calculate the corresponding changes in retirement with respect to changes in lifetime pension wealth. [30] Using the life expectancy statistics from the German Statistic Office and Haan et al. (2019), a 100 €additional monthly pension benefit leads to an increase of €17,235 in discounted wealth at age 60. Therefore, I find that 10,000 dollar of additional lifetime income via the subsidy program leads to a 3.3 percentage point increase in the retirement rate from ages 55 to 65. The magnitude is similar to the estimate of Gelber et al. (2018a).

Lastly, I compare the results with studies exploring policies where the size of the benefit depends on the workers' labor supply decisions, for example, retirement age or job tenure (Brown (2013), Manoli and Weber (2016), Ruh and Staubli (2019)). These studies use non-parametric methods to measure the labor supply responses to discontinuities in the incentives for workers to delay retirement. I expect that the estimated labor supply responses in this paper are smaller, due to the fact that the subsidy amount is independent of the actual retirement age. The benefit level is grandfathered in; however, I find that my estimates are larger. For example, Manoli and Weber (2016) measure the participation responses to discontinuities in the incentives to work due to a severance pay package. The amount of severance pay is linked to retirement timing. Using bunching techniques, they find a change in the participation rate of around 0.6 to 1 percentage points with a change of severance pay amounts to €7330 at the threshold. [31] In this paper, I find an increase in retirement rate of 5.8 percent points with a lifetime subsidy benefits amounting to €24,000. One explanation of the limited responsiveness in Manoli and Weber (2016) is adjustment friction of labor supply.

6.6 Discussion

The primary objective of this subsidy program is to provide additional income support to older workers at retirement. However, this program is gradually being phased out. Low-income workers who never contributed to the pension system before 1992 will not benefit from this subsidy program. The average subsidies of female workers in West Germany declined from €33 per month for cohort

[30]See Appendix B.3 for detailed calculations.
[31]Figure 7 Panel A in Manoli and Weber (2016)

1935 to €20 per month for cohort 1948. Over time, the average subsidy size also decreased from €50 per month to below €10 per month from 1996 to 2014. Figure A6 shows the declining average subsidies and the rising retirement age over time.

In the meantime, the average age at claiming a pension has increased by 1.5 years since the 1990s. From a policy perspective, it would be interesting to know what the retirement age of female workers would be if the subsidy level remains at a high level. A simple extrapolation exercise suggests that phasing out this pension subsidy program accounts for around 16 percent of the increasing trend over the past decade in the age at which female workers have decided to claim their pensions over the past decade. [32]

The main policy implication of this paper is that while this type of income transfer to low-income workers induces early claims, it has a relatively small distortionary effect. I separate the fiscal cost into two parts, mechanical cost (MC) and behavioral cost (BC). The ratio of behavioral cost to mechanical cost (BC/MC ratio) is a context-robust measure of disincentive cost, and helps to compare the disincentive effect of this pension subsidy program with other welfare programs. I find that the ratio of behavioral to mechanical costs for this subsidy program is 0.25. This implies that the government has to raise 1.25 euros, either via income tax or payroll tax, in order to increase the lifetime income of the low-income pensioners by 1 euro. Compared to other income support programs such as the extending unemployment insurance benefit duration, the pension subsidy program has a smaller fiscal externality.[33] This is reasonable because the subsidy amount is determined by ex-ante earnings rather than by ex-post earnings. The subsidy recipients have little incentive to alter their concurrent employment status so as to receive higher benefits.

While the BC/MC ratio expresses the fiscal costs of increasing pension benefits, the welfare implications of the subsidy program are difficult to determine. The social value of increasing pension benefits by 1 euro depends on the gap between the marginal utility of subsidy recipients relative to the marginal utility of other pension contributors.

Evaluating social value is beyond the scope of this paper. Additional lifetime income can change the marginal utility from many aspects, with one potential positive impact being increased

[32]The corresponding changes in retirement age are shown as the grey area between the solid black line and blue dash-dot line in Figure A6. For instance, the extrapolated age at claiming pension has increased by around 1.25 years from 1996 to 2014.

[33]See Appendix C for detailed calculations and comparisons.

life expectancy. Moreover, long-term health care is a part of the pension entitlement in Germany. Claiming pensions earlier might improve the longevity of workers who frequently experience health shocks. Therefore, it is crucial to keep in mind that the subsidy recipients might have longer and healthier lives after retirement due to an additional pension income.

7 Conclusion

This paper presents a transparent setting in which to estimate the disincentive effect of an increase in public pension benefits. Exploring a pension subsidy program in Germany with predetermined benefit levels and a kinked benefit schedule, I study the labor supply effect of additional pension benefits for low-wage female workers. The specific feature of the German pension system allows me to identify the effect of additional pension benefits on retirement decisions in an environment in which the statutory pension eligibility ages remain unchanged. This is the first paper to utilize this particular quasi-experimental design to study the effect of additional pension benefits in the literature.

I find that female workers claim their pensions around six months earlier when they receive €100 additional monthly pension benefits. This result is driven by higher hazard rates of claiming pensions at ages 60 and 63. I find a stronger response to pension subsidies among women who have a weak labor market attachment, who have more than one child, or who have had some episodes of sickness before age 50; that is, those who are likely to value leisure more or who have more flexible jobs; they also respond to pension subsidies more strongly. The impact on the age at which women exit employment is of a similar magnitude, however it is not statistically significant. However, I find that strong impacts on the hazard to exit employment at age 63 and employment rate. I also find suggestive evidence that recipients are more likely to use UI as a pathway to early retirement and shorten the time spent in marginal jobs as a result of higher pension benefits.

The estimated elasticity of age at claiming a pension with respect to pension benefits is -0.047 and the elasticity of retirement rate from age 55 to 65 is 0.97. Using the causal estimates of various subgroups, I find the corresponding elasticities of age at claiming pension of range from -0.029 to -0.13. [34]

[34]Note that I could not take the family structure, spouse income, and other household income information into account due to the limitations of the dataset. Wives who have access to their husbands' incomes can be less responsive to the

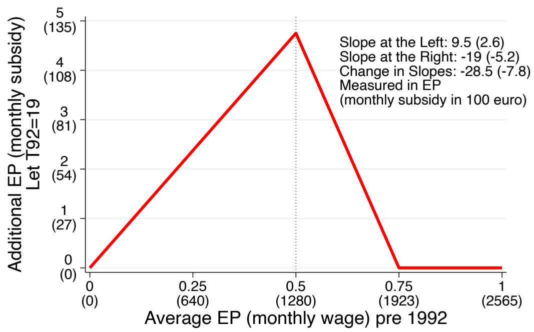
This paper offers some general insights. First, it provides an estimated impact of subsides on the labor supply of low-income older women. This is of particular interest because women on average live longer, and are more at risk of old-age poverty. The magnitude of the subsidies' disincentive effect is relevant for public policy and budgetary considerations, particularly at a time at which the public purse in many countries faces considerable strain in the face of growing elderly populations.

Second, this paper links to the policy debate on designing transfer programs; particularly, as this subsidy program is being phased out gradually, and therefore younger cohorts will not benefit from it. Understanding the consequence of this program can help the design of new income support programs for the future generations. I find that the magnitude of the impact of this subsidy program on the age at which workers claim their pension is close to the estimated response in papers in which the wealth effect dominates. One reason could be that the subsidy amount is determined by ex-ante earnings rather than by ex-post earnings, as is the case for most in-work programs. Therefore, the recipients of the pension subsidy program have little incentive to alter their concurrent employment status while receiving benefits.

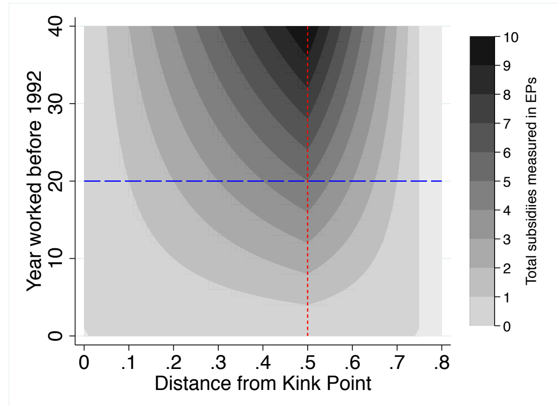
One major caveat of this pension subsidy program is that it might subsidize women in wealthy households because the subsidy is a function of individual income rather than household income. Unfortunately, household-level information is not available in the dataset. Nonetheless, the findings of this paper will help policymakers to evaluate recommendations aimed at alleviating old-age poverty.

availability of subsidy. Therefore, the elasticity with respect to family pension wealth should be higher.

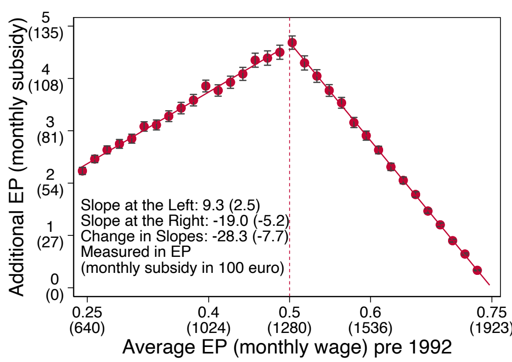
8 Figures and Tables



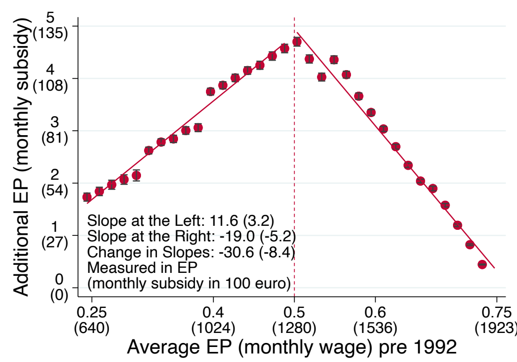
(a) Subsidy Schedule($T92 = 19$)



(b) Subsidy size along T_i^{92} and aep_i^{92}



(c) Subsidy Schedule($T92 \sim N(19, 6.4)$, $n = 25000$)



(d) Subsidy Schedule
($T92$ with more details, $n = 25000$)

Figure 1: Subsidy size as a function of average monthly EP before 1992

Note: Figure 1 plots the subsidy schedule. Figure 1(a) shows the subsidies measured in EP for recipients who have contributed for 19 years before 1992, which is the average value for the baseline sample. The theoretical slope of subsidies measured in EP changes from 9.5 to -19. Figure 1(b) shows a contour plot of subsidy schedule along both aep_i^{92} and T_i^{92}. We can see that individuals worked more years before 1992 and individuals with aep_i^{92} closer to 0.5 are granted more subsidies. Figure 1(c) and Figure 1(d) show the theoretical subsidies if T_i^{92} follows a normal distribution. Figure 1(c) uses a roughly simulated distribution of T_i^{92} and Figure 1(d) uses a more finely simulated distribution of T_i^{92}. In Figure 1(c), there are 136 observations for each bin (50 bins). T_i^{92} of the simulated 25000 (136*50) individuals follows a normal distribution N(18.73,6.41). In Figure 1(d), I separately generate T_i^{92} in six subgroups with six different normal distributions. Figure 1(d) takes into account the variations in T_i^{92} as aep_i^{92} increases, as shown in Figure A9. $T92$ is more dispersed when aep_i^{92} is low. The slope of subsidies are displayed.
Source: Author's own construction according to SGB VI § 262 and distribution of T_i^{92} in the baseline sample.

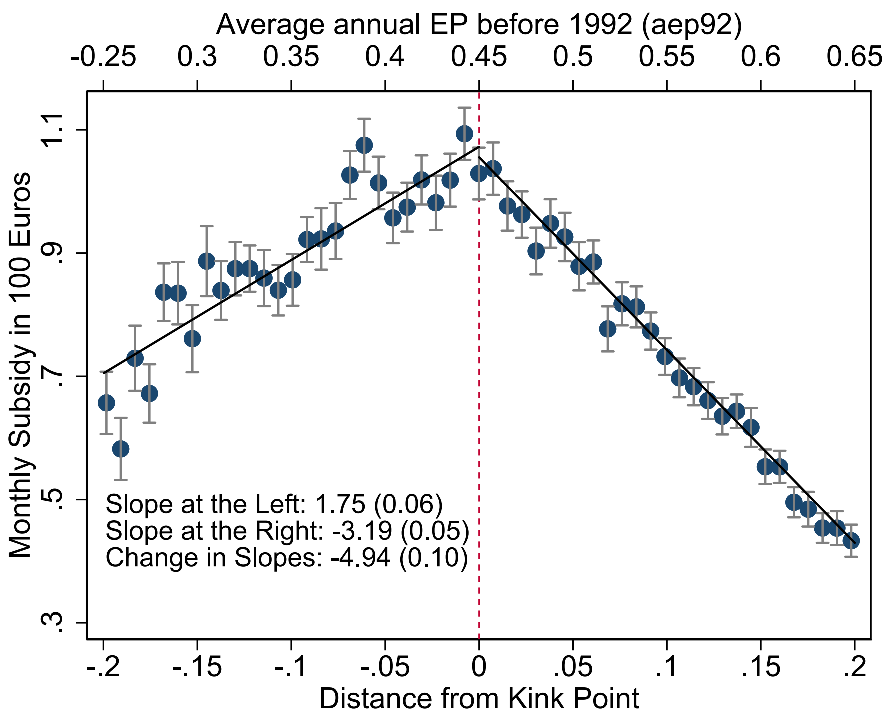


Figure 2: First stage: observed subsidy schedule

Note: Figure 2 plots the observed monthly subsidy size measured in euro for the recipients. It shows that the relationship between aep_i^{92} and subsidy size is consistent with the policy schedule in Equation 1. The monthly subsidy is measured in 100 euros. The reduced form regression without controls reports an estimated change in slopes of subsidy around the kink of -5.6. The corresponding slope change when subsidy is measured in earnings points is -19.9, from 6.9 to -12.9.

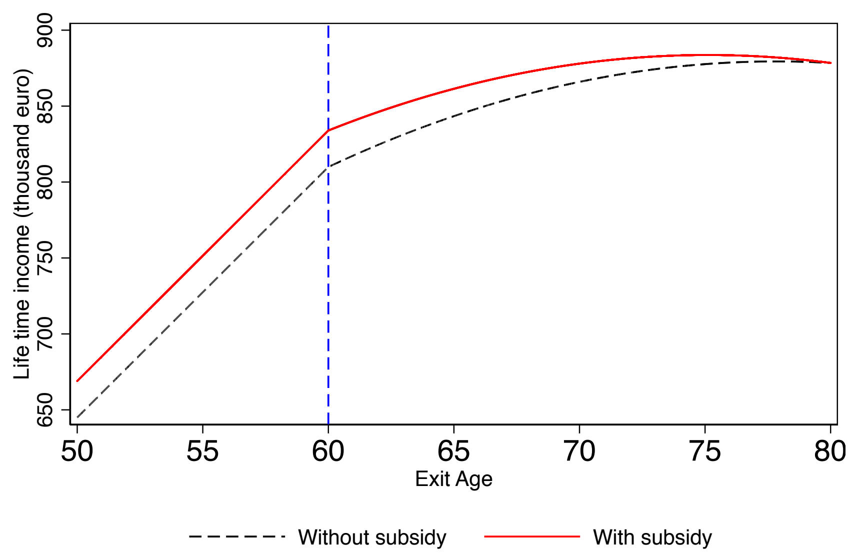
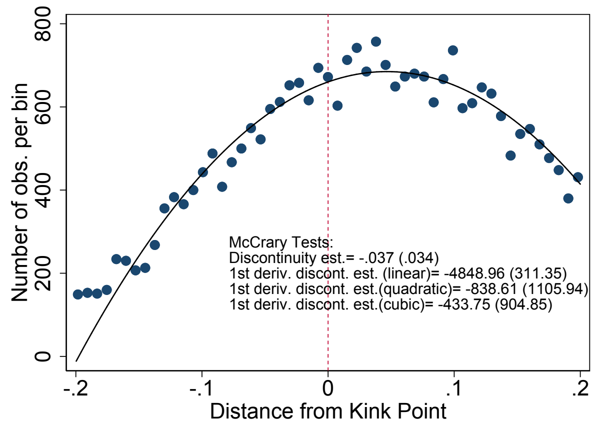
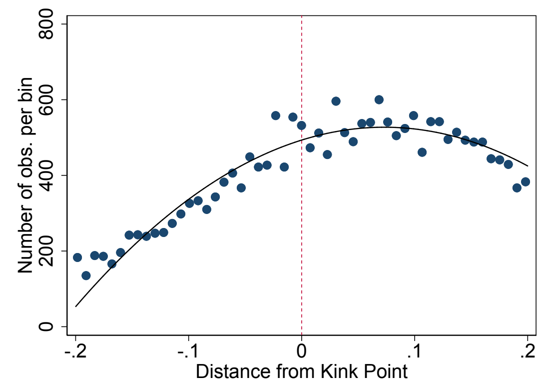


Figure 3: Illustration of lifetime budget constraint

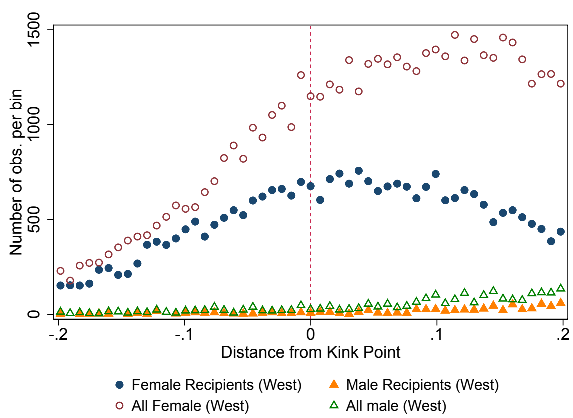
Note: Figure 3 plots the lifetime budget constraint to age at exiting employment with and without subsidies. The black solid line is the lifetime budget constraint of non-recipients and the blue dashed line is that of recipients. Here, age 60 is the earliest possible age to claim pension and age 80 is the age at death. For simplicity, this figure does not describe "bridge" activities. I assume that if workers exit employment before age 60, they will claim an old-age pension immediately when they are 60.
Source: Author's own construction



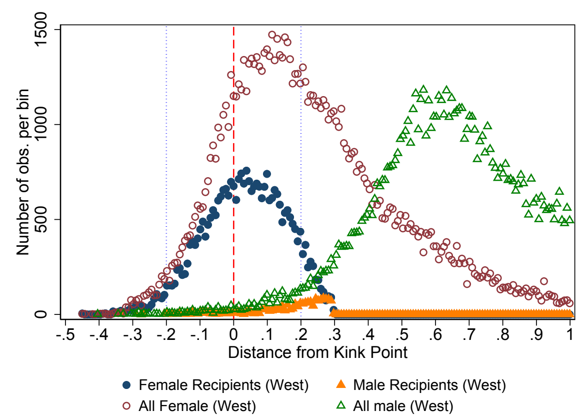
(a) Density of the recipients around the kink



(b) Density of the non-recipients around the kink



(c) Density of the all workers in West Germany around the kink



(d) Density of the all workers in West Germany around the kink (zoom out)

Figure 4 : Smoothness of the density around the kink

Note: Figure 4a shows the density plot of aep_i^{92}, normalized at the kink point. The bin size of 0.007625 (~ 20 €in 2010) is used in this figure. I display the results of a standard McCrary test of the discontinuity of the p.d.f. at the kink. Also, the test results of the discontinuity of slope of the p.d.f for a linear, quadratic and cubic specifications are reported. Figure 4b shows the density of female workers with less than 35 service years in West Germany (non-recipients). Figure 4c (zoomed in) and 4d (zoomed out) show the density of female and male individuals in West Germany (without any restrictions) and recipients in West Germany. Figure 4b,4c and 4d show that the bell shaped density for the female recipients is not unique but rather a pattern that is common for all female workers in the pension system in West Germany.

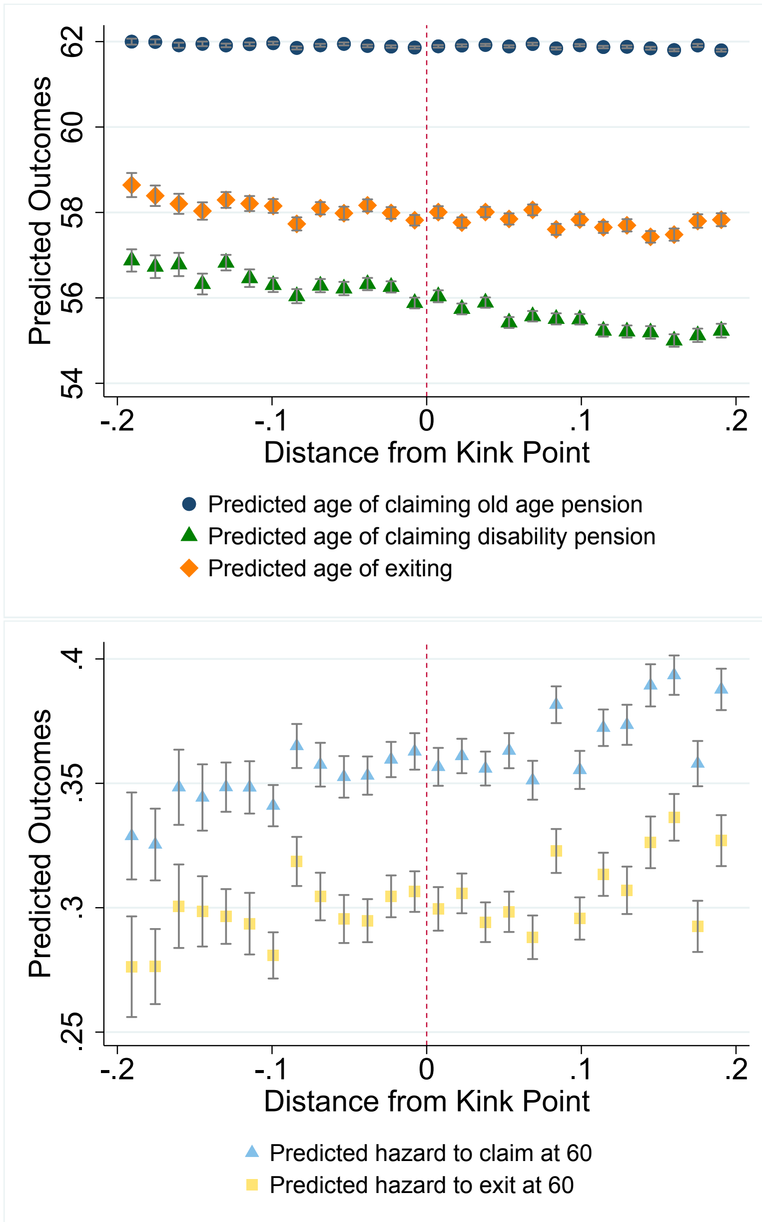
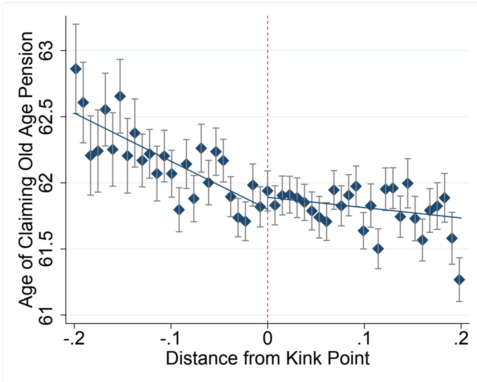
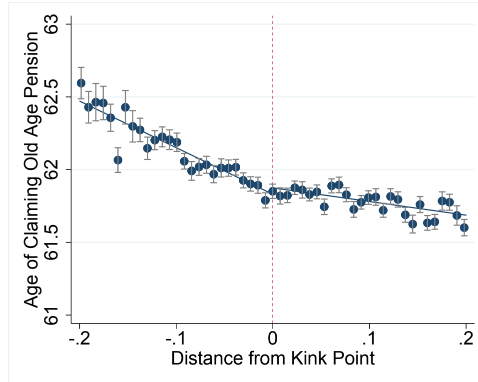


Figure 5: Predicted outcomes by predetermined covariates

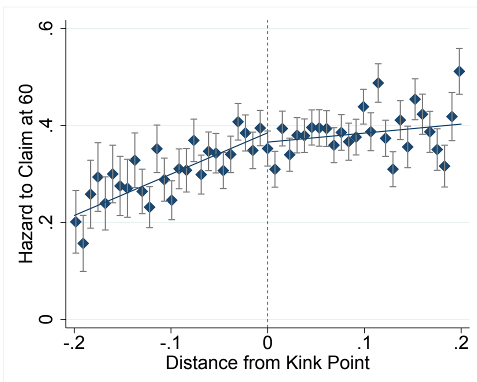
Note: Figure 5 shows the predicted values of outcome variables in bins around the kink point. The outcome variables are predicted with predetermined covariates as shown in Figure A1 and Table A1. The estimated changes in slope of the predicted values of outcome variables are not statistically significant. Figure 5 shows that, based on predetermined covariates, the predicted distribution of outcomes is smooth across the kink.



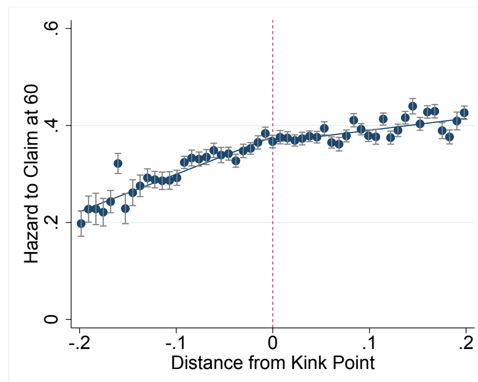
(a) Bin plots: Age at claiming old age pension



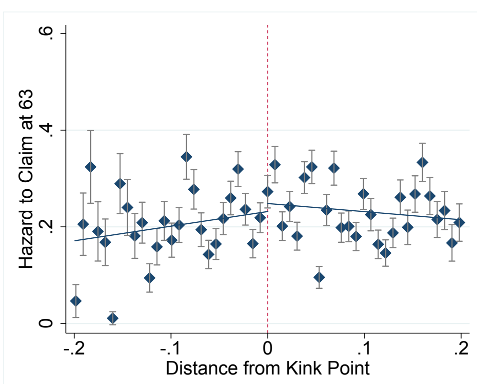
(b) Bin plots: Age at claiming old age pension (w. ctrl.)



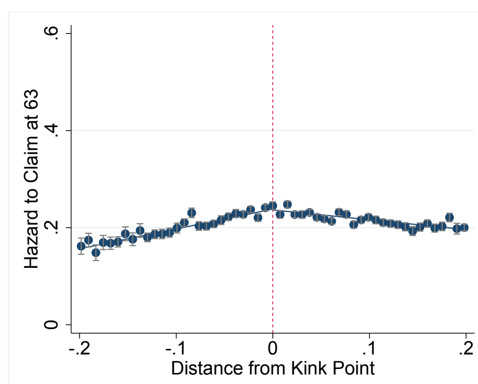
(c) Bin plots: hazard to claim old age pension at age 60



(d) Bin plots: hazard to claim old age pension at age 60 (w. ctrl.)



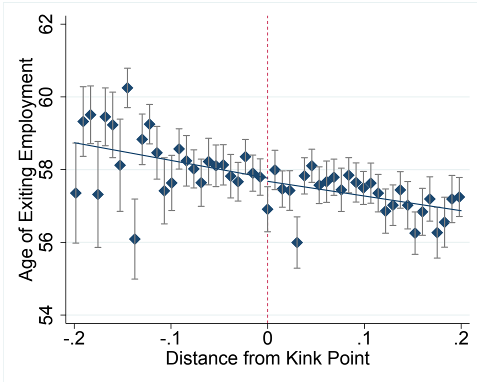
(e) Bin plots: hazard to claim old age pension at age 63



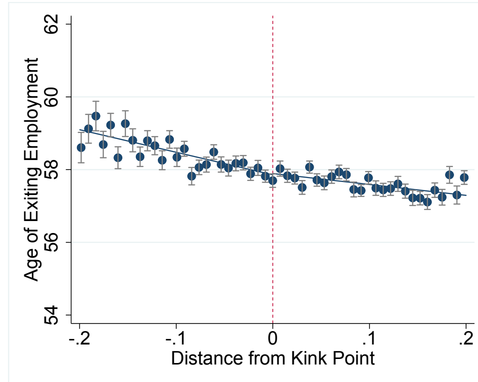
(f) Bin plots: hazard to claim old age pension at age 63(w. ctrl.)

Figure 6: Scatter plots of claiming behavior around the kink

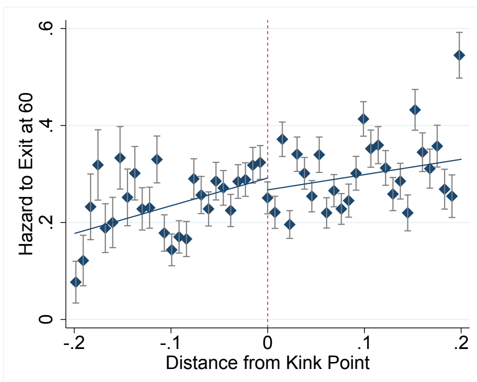
Note: Figure 6 shows the scatter bin plots of aep_i^{92} in 0.007625 (~ 20 €in 2010) bins as a function of distance to the observed kink point for the main outcome variables: age at claiming an old age pension pension and the hazard rate to claim an old age pension at age 60. The solid lines are the linear fitted lines. The left panels (diamond bins) are bins from raw data. The right panels (dotted bins) are bins from the predicted outcome variables with the assignment variables, controls and cohort fixed effects. The estimated slope changes without and with controls are reported in the figure.



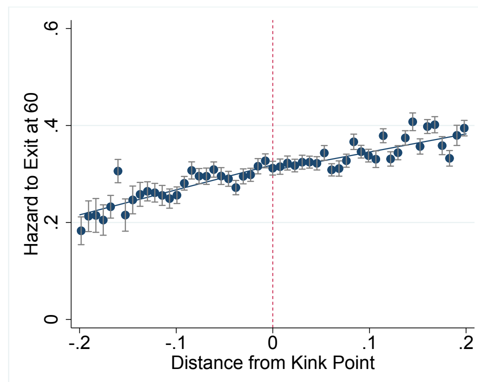
(a) Bin plots: age at exiting employment



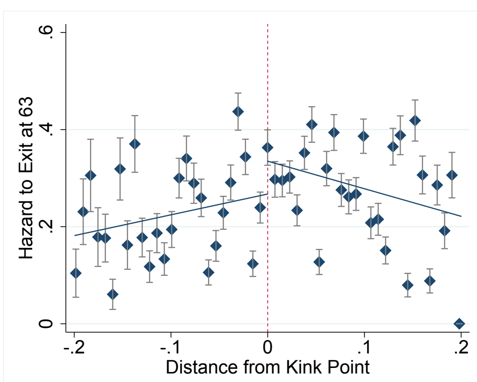
(b) Bin plots: age at exiting employment(w. ctrl.)



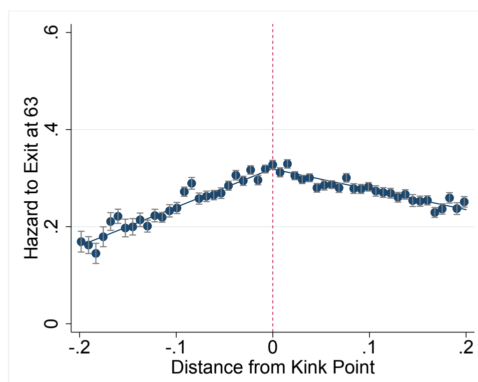
(c) Bin plots: hazard to exit employment at age 60



(d) Bin plots: hazard to exit employment at age 60(w. ctrl.)



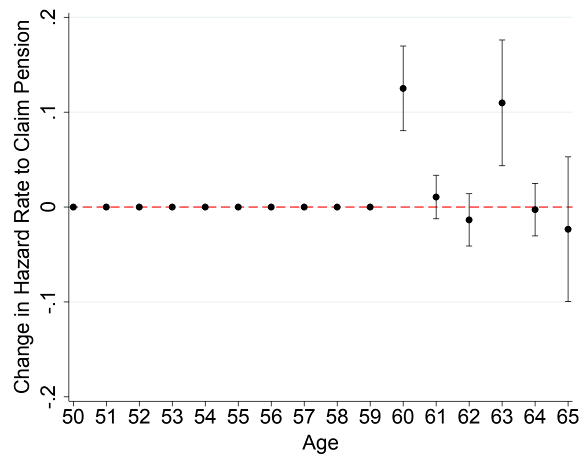
(e) Bin plots: hazard to exit employment at age 63



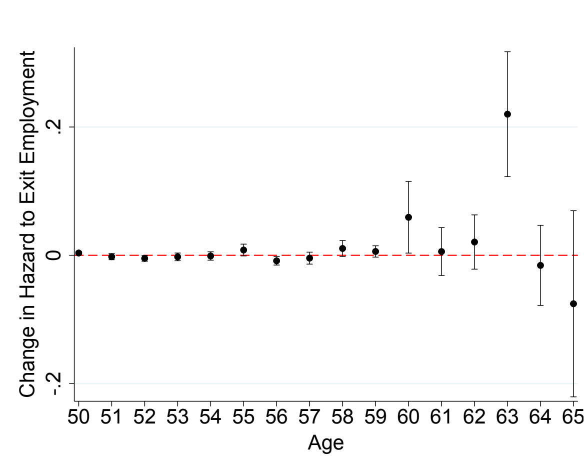
(f) Bin plots: hazard to exit employment at age 63(w. ctrl.)

Figure 7: Scatter plots of exiting behavior around the kink

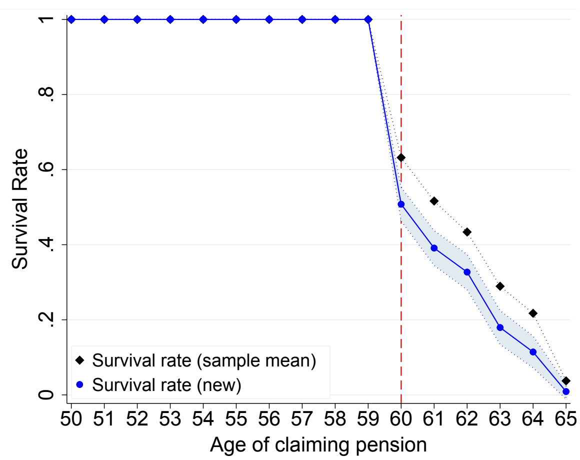
Note: Figure 7 shows the scatter bin plots of aep_i^{92} in 0.007625 (~ 20 €in 2010) bins as a function of distance to the observed kink point for the main outcome variables: age at exiting employment and the hazard rate to exit employment at age 60. The solid lines are the linear fitted lines. The left panels (diamond bins) are bins from raw data. The right panels (dotted bins) are bins from the predicted outcome variables with the assignment variables, controls and cohort fixed effects. The estimated slope changes without and with controls are reported in the figure.



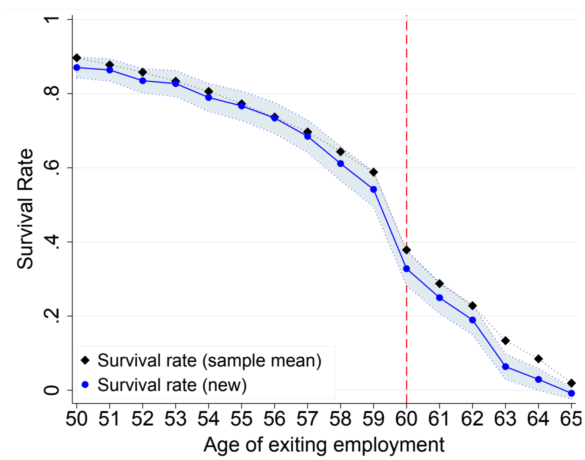
(a) Change of hazard to claim pension with 100 euro pension subsidies



(b) Change of hazard to exit employment with 100 euro pension subsidies



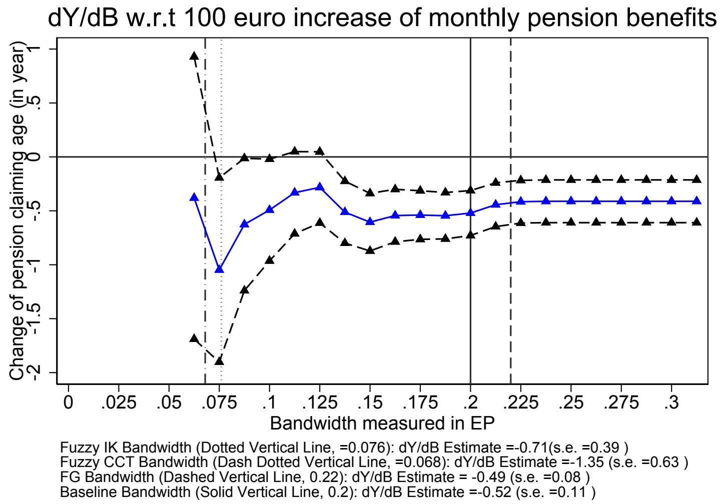
(c) Change in survival rate in terms of age at claiming pension



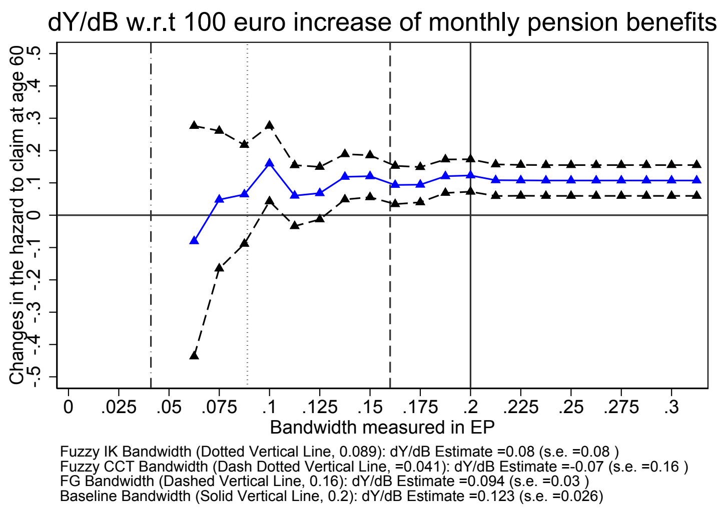
(d) Change in survival rate in terms of age at exiting employment

Figure 8: Hazard and survival analysis from age 50 to age 65

Note: Figure 8 shows the estimated percentage change of hazard rate (survival rate) to claim an old-age pension and the estimated change of hazard rate (survival rate) to exit employment at ages from 50 to 65 when there is an increase of pension benefits of €100 per month. The estimates are capped with 95% confidence interval. The estimates are statistically significant at 0.05 level are marked in red. The blue solid lines in Figures (c) and (d) show the estimated survival rate and the black dotted lines show the average survival rate of the sample.



(a) Age at claiming old age pension



(b) Hazard to claim old age pension at age 60

Figure 9: RKD estimates by bandwidth

Note: Figure 9 shows the point estimates and 95 percent confidence intervals (on the y-axis) for the impact of a €100 increase in monthly pension benefits on age at claiming pension and hazard rate to claim an old-age pension at age 60. The estimations are obtained using linear specifications with controls and cohort fixed effect. The vertical lines correspond to four different bandwidth selections: the Imbens and Kalyanaraman (2012) bandwidth for fuzzy RKD (Fuzzy IK), the bias-corrected estimates per Calonico et al. (2014) (Fuzzy CCT), the "rule-of-thumb" bandwidth based on Fan and Gijbels (1992) (FG), and the one used in the baseline analysis. For age at claiming old age pension, the four bandwidths are 0.076, 0.068, 0.22, and 0.2, respectively. They correspond to 246, 220, 711, and 647 euros per month.For age at claiming an old-age pension, those four bandwidths are 0.089, 0.041, 0.16 and 0.2, respectively. They correspond to 288, 133, 517, and 647 euros per month.

Table 1: Summary statistics

Variables	Baseline sample Mean	s.d.	N	Around kink Mean	s.d.	N
Subsidy related characteristics						
Subsidy in EP	2.97	1.71	26614	3.51	1.89	8717
Subsidy in Euro/Month	83.27	48.59	26367	98.64	53.79	8649
Subsidy share	15%	10%	26614	18%	10%	8717
Years worked before 92	18.73	6.41	26614	18.24	6.24	8717
Mean annual EP	0.55	0.1	26614	0.53	0.09	8717
Mean annual EP pre92	0.48	0.1	26614	0.45	0.03	8717
Mean wage	1452	283	26373	1402	240	8626
Mean wage before 92	1288	266	26614	1222	78	8717
Pension related characteristics						
Total pension benefits	679.68	191.04	26367	668.92	182.88	8649
Total EP	24.41	6.86	26614	24.03	6.59	8717
EP from full contribution periods before 92	9.14	4.06	26614	8.26	2.93	8717
EP from full contribution periods	16.95	5.45	26614	16.1	4.66	8717
EP from consideration periods	20.86	5.68	5975	20.7	5.27	1997
Pension years	41.98	3.88	26614	41.96	3.93	8717
Full contribution years	30.91	7.68	26614	30.56	7.53	8717
Contribution years	33.13	6.58	26614	32.72	6.45	8717
Consideration years	5.96	4.48	26614	6.35	4.26	8717
Credited periods	2.89	2.15	26614	2.88	2.15	8717
Outcome variables						
Age at claiming old-age pension	61.92	1.98	26570	61.9	1.97	8709
Hazard to claim at 60	0.36	0.48	26288	0.36	0.48	8617
Hazard to claim at 63	0.22	0.42	9963	0.25	0.43	3216
Age at claiming disability pension	53.64	6.4	4327	53.42	6.75	1331
Age at exiting employment	57.63	7.16	26614	57.65	7.2	8717
Hazard to exit at 60	0.28	0.45	14106	0.28	0.45	4656
Hazard to exit at 63	0.26	0.44	4875	0.30	0.46	1577
% claim regular pension	0.13	0.34	26614	0.13	0.33	8717
% claim women's pension	0.53	0.50	26614	0.54	0.50	8717
% claim pension for unemployed	0.03	0.17	26614	0.03	0.17	8717
% claim disability pension	0.17	0.38	26614	0.17	0.38	8717
% claim pension for long-term	0.05	0.22	26614	0.05	0.22	8717
% claim REC pension	0.06	0.23	26614	0.05	0.23	8717
Individual characteristics						
Number of kids	1.94	1.04	26614	2.05	.98	8717
Age at first birth	22.76	3.77	24834	22.63	3.62	8311
Age at last birth	27	4.94	24834	27.08	4.81	8311
Age at first employment	18.51	5.04	26614	18.62	5.18	8717
Age at first unemployment	47.52	10.05	15169	48.01	9.81	4944
Birth cohort	1945	4.01	26614	1945	3.94	8717

Notes: Table 1 reports descriptive statistics for the baseline sample of female workers and female recipients around the kink. The baseline specification focuses on the window of recipients whose aep_i^{92} are from 0.25 to 0.65, 0.2 EPs around the kink 0.45. There are 5,218 individuals in this window. The recipients around the kink are the ones whose aep_i^{92} are from 0.4 to 0.5. REC pension refers to reduced earning capacity pension.

Source: FDZRV-VSKT 2004 to 2017, author's own calculations.

Table 2: Smoothness of the density and covariates around the Kink

Covariates	Polynomial minimizing AICc	Coeffi.	s.d.	sample mean	s.d.
Number of observations	12	6,770	(4,008)	26,614	
Fixed Characteristics					
Number of children	2	1.619	(1.273)	1.94	(1.04)
Age when having 1^{st} child	2	-13.434*	(5.362)	22.76	(3.77)
Age when having last child	1	0.295	(2.084)	27	(4.94)
Age at first employment	3	-13.330	(9.527)	18.51	(5.04)
Pension years	1	-2.510	(2.136)	41.96	(3.93)
Total EPs without the subsidies	1	2.583	(2.280)	21.38	(6.84)
Duration of SES before 1992					
Months of UI	1	0.467	(1.666)	1.31	(3.97)
Months of UA	1	8.237	(6.995)	5.4	(12.72)
Months of childcare	2	195.928	(103.241)	89.78	(61.59)
Months of sickness	1	0.333	(1.973)	1.67	(4.44)
As a share of total years before 1992					
Share on UI	1	0.001	(0.005)	0.004	(0.011)
Share on UA	1	0.020	(0.019)	0.015	(0.035)
Share on childcare	2	0.525†	(0.275)	0.241	(0.168)
Share on sickness	1	0.000	(0.005)	0.004	(0.012)

Notes: Standard errors are in parentheses †$p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Table 2 shows that the slopes of density and predetermined covariates are smooth around at the kink point. I report the estimated change in slope using polynomials of order 1 to 12. For each variable, the table shows: the polynomial order that minimizes the corrected Akaike Information Criterion (AICc) , the estimated change in slope at the kink point and standard error. The results are from regressions with a bandwidth of 0.2 EP around the kink. The sample is collapsed in bins of 0.007625 (~ 20 €in 2010). The table shows smoothness in the distributions of individual characteristics, such as the number of children and the age at first employment, year of pension waiting period, etc. I also show that social economics status, such as months spent in unemployment insurance (UI), unemployment assistant (UA), childcare and sickness leaves before 1992 are also smooth around the kink.

Table 3: Estimated impacts on labor supply

	Change per €100 more subsidy $\Delta\frac{dY}{dB}$ (1)	(2)	(3)	Means at the kink	Sample means	Obs.
Panel A: Claiming behavior						
Age at claiming old-age pension	-0.551**	-0.531**	-0.496**	61.90	61.92	24796
	(0.171)	(0.170)	(0.181)	(1.97)	(1.98)	
Retirement rate (age 55-65)	0.054***	0.054***	0.058***	0.355	0.352	24649
	(0.003)	(0.003)	(0.002)	(0.012)	(0.023)	
Hazard to claim at age 60	0.129**	0.127**	0.125**	0.36	0.36	24834
	(0.042)	(0.042)	(0.045)	(0.48)	(0.48)	
Hazard to claim at age 63	0.099	0.106†	0.110†	0.25	0.22	24834
	(0.060)	(0.060)	(0.066)	(0.43)	(0.42)	
Age at claiming disability pension	-1.279	-1.356	-0.748	53.42	53.64	24802
	(1.330)	(1.320)	(1.178)	(6.75)	(6.40)	
Panel B: Exiting behavior						
Age at exiting employment	-0.193	-0.153	-0.530	57.65	57.63	24834
	(0.642)	(0.649)	(0.643)	(7.196)	(7.156)	
Adjusted age at exiting employment	-0.280	-0.207	-0.183	59.56	59.54	24781
	(0.336)	(0.337)	(0.336)	(3.568)	(3.595)	
Censored age at exiting employment	-0.271	-0.201	-0.178	59.56	59.54	22564
	(0.325)	(0.326)	(0.328)	(3.568)	(3.595)	
Employment rate (age 55-65)	-0.038***	-0.039***	-0.042***	0.445	0.447	24649
	(0.003)	(0.003)	(0.003)	(0.041)	(0.017)	
Hazard to exit at age 60	0.047	0.056	0.068	0.28	0.28	24704
	(0.054)	(0.053)	(0.056)	(0.45)	(0.45)	
Hazard to exit at age 63	0.207*	0.208*	0.206*	0.30	0.26	24690
	(0.090)	(0.089)	(0.098)	(0.46)	(0.44)	
Controls	No	No	Yes			
Cohort Fixed Effect	No	Yes	Yes			

Notes: Standard errors in parentheses † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The results show the estimated impacts of 100 euro additional subsidies on labor supply. The estimates are obtained from local linear regressions with a bandwidth of 0.2 EP around the kink. The standard error is obtained from delta method. See Table A1 for the estimated change in slope of Y around the kink (Reduce-form) and the estimated change in slope of benefit level B around the kink (First Stage). The adjusted age at exiting employment 50 is the age at exiting employment when setting the value to missing for everyone who exits before age 50. The censored age of exiting employment is the age at exiting employment when dropping individuals who exit before age 50. I drop individuals exit before age 50 because they are most likely exit due to sickness rather than financial incentives. The retirement (employment) rate is the average of retirement (employment) rate from age 55 to 65. The retirement (employment) rate at each age is calculated as the average share of women retired (employed) at each age among women eligible for subsidy by bins of aep_92.

Table 4: Estimated impacts on months spend in activities between last regular employment and pension claiming

	Change per €100 more subsidy $\frac{dY}{dB}$ (1)	(2)	(3)	Means at the kink	Sample means	Obs.
Total duration	-9.282	-8.724	-5.546	54.93	55.96	24834
	(7.561)	(7.648)	(7.517)	(84.70)	(84.71)	
Month in unemployment	2.326	2.001	4.890†	16.63	15.82	24834
	(2.811)	(2.835)	(2.765)	(33.10)	(30.94)	
Month in marginal employment	-3.424†	-2.966	-4.068†	6.10	6.62	24834
	(2.038)	(2.034)	(2.227)	(21.19)	(22.61)	
Month in sickness	0.246	0.282	0.287	1.98	1.97	24834
	(0.437)	(0.443)	(0.464)	(5.16)	(4.98)	
Month in other activities	-6.186	-5.765	-5.429	19.50	19.31	24834
	(6.066)	(6.138)	(5.959)	(67.47)	(65.60)	
Controls	No	No	Yes			
Cohort Fixed Effect	No	Yes	Yes			

Notes: Standard errors in parentheses † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The results show the estimated impacts of 100 euro additional subsidies on transitional behaviors. The estimates are obtained from local linear regressions with a bandwidth of 0.2 EP around the kink. The standard error is obtained from the delta method. Time spent in unemployment include months spent in both unemployment insurance and unemployment assistance.

Table 5:Estimated impacts on probabilities of activities after exiting employment and before claiming a pension

	Change per €100 more subsidy $\frac{dY}{dB}$ (1)	(2)	(3)	Means at the kink	Sample means	Obs.
Panel A: Status after exiting regular employment						
Claiming an old-age pension	0.047	0.051	0.036	40.83%	39.91%	24834
	(0.046)	(0.046)	(0.048)	(0.492)	(0.489)	
Claiming a disability pension	-0.012	-0.013	-0.010	2%	2.28%	24825
	(0.013)	(0.013)	(0.014)	(0.140)	(0.149)	
Being unemployed	0.048	0.041	0.062	31.96%	31.77%	24825
	(0.042)	(0.042)	(0.046)	(0.466)	(0.466)	
Being in marginal employment	-0.010	-0.009	-0.014	1.76%	1.85%	24825
	(0.014)	(0.014)	(0.015)	(0.132)	(0.135)	
Being on sick leaves	-0.013	-0.013	-0.019	17.63%	18.03%	24825
	(0.036)	(0.037)	(0.039)	(0.381)	(0.385)	
Staying in other activities	-0.038*	-0.038*	-0.029	3.15%	3.39%	24825
	(0.019)	(0.019)	(0.019)	(0.175)	(0.181)	
Panel B: Status before claiming a pension						
Being in regular employment	-0.022	-0.022	-0.013	43.02%	42.50%	24674
	(0.022)	(0.023)	(0.643)	(0.495)	(0.494)	
Claiming a disability pension	-0.280	-0.207	-0.183	6.11%	6.55%	24674
	(0.336)	(0.337)	(0.336)	(0.240)	(0.247)	
Being unemployed	0.069	0.059	0.078	28.22%	27.07 %	24674
	(0.047)	(0.047)	(0.051)	(0.450)	(0.444)	
Being in marginal employment	-0.013	-0.012	-0.024	7.23%	7.67%	24674
	(0.029)	(0.029)	(0.031)	(0.259)	(0.266)	
Being on sick leaves	0.014	0.015	0.015	2.99%	2.75%	24674
	(0.017)	(0.017)	(0.015)	(0.170)	(0.163)	
Staying in other activities	-0.042†	-0.042†	-0.042	4.91%	5.12%	24674
	(0.024)	(0.024)	(0.026)	(0.216)	(0.220)	
Controls	No	No	Yes			
Cohort Fixed Effect	No	Yes	Yes			

Notes: Standard errors in parentheses $^{\dagger}p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The results show the estimated impacts of a 100 euro additional subsidies on activities after exiting employment and before claiming an old-age pension. The estimates are obtained from local linear regressions with a bandwidth of 0.2 EP around the kink. The standard error is obtained from the delta method.

Table 6: Heterogeneous estimated impacts

Outcome variables		Age at claiming pension		Hazard to claim at age 60		Hazard to exit at age 63		
ΔB = €100		$\frac{dY}{dB}$	p-value	$\frac{dY}{dB}$	p-value	$\frac{dY}{dB}$	p-value	Obs.
Subgroups								
Subsidy Size	High	-0.6964**	0.0028	0.1263*	0.3200	0.3344**	0.0004	12285
		(0.2365)		(0.0613)		(0.1321)		
	Low	-0.5079		0.2440†		0.0489		12549
		(0.6329)		(0.1449)		(0.3030)		
T_{92}	More	-0.3100†	0.5134	0.1171*	0.2195	0.3426***	0.0000	11546
		(0.1832)		(0.0482)		(0.1039)		
	Less	-1.4222*		0.2855**		0.0757		13262
		(0.5703)		(0.1348)		(0.2847)		
Older than	Yes	-0.1576	0.0546	0.1253†	0.3639	-0.1672	0.0012	7269
age 50		(0.2497)		(0.0671)		(0.1946)		
in 1992	No	-0.6670**		0.1191*		0.3030**		17565
		(0.2461)		(0.0599)		(0.1170)		
Sick period	Yes	-0.3228	0.1535	0.1839†	0.0819	0.5834**	0.0000	9944
before age 50		(0.2231)		(0.0755)		(0.1870)		
	No	-0.6077**		0.0983*		0.0526		14890
		(0.3158)		(0.0570)		(0.1127)		
More than	Yes	-0.7221**	0.1277	0.1802**	0.0028	0.2854*	0.2938	18175
1 child		(0.2334)		(0.0568)		(0.1265)		
	No	-0.1793		-0.0006		0.0788		6659
		(0.2304)		(0.0579)		(0.1135)		
Weak labor	Yes	-1.3830**	0.0244	0.2877**	0.1625	0.3939	0.7469	12621
market		(0.4547)		(0.1086)		(0.2567)		
attachment	No	-0.2617		0.0728		0.1364		12212
		(0.1705)		(0.0447)		(0.0904)		
Cohort F.E.		Yes		Yes		Yes		
Controls.		Yes		Yes		Yes		

Notes: Standard errors are in parentheses $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. The RKD estimates are the changes in outcome variable in response to an €100 additional pension income from the subsidy. Subsidies are measured in €100. The results are from local linear regressions with a bandwidth of 0.2 EP around the kink for the baseline specification.The high subsidies group are recipients with subsidies above average (82 euro/month). High T_{92} group are recipients who contributed more than 20 years before 1992. I define the healthy group as workers who have never experienced any sick leave before age 50. I also look at recipients who have more than one child. Lastly, I define workers with less than 28 years of regular employment before retirement as workers with a weaker labor market attachment. All regressions control for predetermined covariates and cohort fixed effect. The p-values are from a test of the hypothesis that the coefficients are equal within such category.

Table 7: Estimated Impacts on Outcome Variables with Varying Bandwidth and Polynomial Orders

	Baseline		FG		Fuzzy IK		Fuzzy CCT	
	BW	Est. $\frac{dY}{dB}$	Main [Pilot] BW	Est. $\frac{dY}{dB}$	Main [Pilot] BW	Est. $\frac{dY}{dB}$	Main [Pilot] BW	Est. $\frac{dY}{dB}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Local Linear Models								
Age at claiming pension	0.2	-0.496**	0.23	-0.486***	0.076	-0.712†	0.069	-1.356***
		(0.181)	[0.96]	(0.080)	[0.10]	(0.397)	[0.08]	(0.397)
Hazard to claim at age 60	0.2	0.125**	0.161	0.094***	0.090	0.084	0.042	-0.071
		(0.045)	[0.33]	(0.031)	[0.07]	(0.078)	[0.09]	(0.159)
Age at exiting employment	0.2	-0.530	0.108	-1.181	0.068	-4.665†	0.038	3.452
		(0.643)	[0.32]	(0.787)	[0.09]	(2.453)	[0.08]	(2.505)
Hazard to exit at age 63	0.2	0.110†	0.124	0.473**	0.147	0.331**	0.067	1.129*
		(0.066)	[0.30]	(0.152)	[0.06]	(0.114)	[0.12]	(0.444)
Age at claiming a disability pension	0.2	-0.748	0.089	3.278	0.108	0.900	0.057	-2.333
		(1.178)	[0.25]	(2.393)	[0.09]	(1.561)	[0.10]	(5.333)
Retirement rate (age 55-65)	0.2	0.058***	0.085	0.0769***	0.014	0.160	0.002	-0.000
		(0.002)	[0.22]	(0.007)	[0.03]	(0.159)	[0.02]	(0.006)
Employment rate (age 55-65)	0.2	-0.042***	0.034	-0.089***	0.007	-0.001	0.003	-0.001
		(0.003)	[0.16]	(0.016)	[0.02]	(0.001)	[0.01]	(0.002)
B. Local Quadratic Models								
Age at claiming pension	0.2	-0.018	1.066	-0.454*	0.114	-1.927	0.104	-2.088
		(1.057)	[0.48]	(0.213)	[0.13]	(1.388)	[0.16]	(1.532)
Hazard to claim at age 60	0.2	-0.126	0.366	0.109*	0.079	-0.281	0.066	-0.068
		(0.266)	[0.33]	(0.055)	[0.07]	(0.379)	[0.09]	(0.214)
Age at exiting employment	0.2	-7.286†	0.36	-2.508**	0.100	-4.567	0.071	-4.323
		(3.977)	[0.48]	(0.853)	[0.19]	(6.290)	[0.12]	(3.793)
Hazard to exit at age 63	0.2	0.508	0.33	0.871***	0.07	-1.007†	0.04	0.162
		(0.573)	[1.19]	(0.283)	[0.09]	(0.588)	[0.09]	(0.330)
Age at claiming a disability pension	0.2	1.825	0.28	-0.470	0.09	-12.310	0.10	9.601
		(7.896)	[0.30]	(1.871)	[0.18]	(36.860)	[0.19]	(12.745)
Retirement rate (age 55-65)	0.2	0.051***	0.24	0.089***	0.02	-13.836	0.01	0.0053
		(0.010)	[0.34]	(0.008)	[0.034]	(8382)	[0.032]	(0.005)
Employment rate (age 55-65)	0.2	-0.283***	0.18	-0.175***	0.05	-0.1275**	0.002	0.0006
		(0.038)	[0.22]	(0.0226)	[0.04]	(0.0475)	[0.01]	(0.0008)

Notes: Standard errors are in parentheses †$p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The RKD estimates are the changes in outcome variable in response to an 100 €additional pension income from the subsidy. For each outcome variable I show results using three different bandwidth selection procedures: the FG bandwidth, the fuzzy IK bandwidth and the fuzzy CCT bandwidth. The estimated kinks, standard errors and different bandwidth selections are obtained following Card et al. (forthcoming). I show estimates from local linear models in Panel A and from local quadratic models in Panel B.

References

Richard Blundell, Eric French, and Gemma Tetlow. Retirement incentives and labor supply. *Handbook of the Economics of Population Aging*, 1:457–566, 2016.

Petri Böckerman, Ohto Kanninen, and Ilpo Suoniemi. A kink that makes you sick: The effect of sick pay on absence. *Journal of Applied Econometrics*, 33(4):568–579, 2018.

Axel Boersch-Supan and Christina B Wilke. The german public pension system: How it was, how it will be. Working Paper 10525, National Bureau of Economic Research, 2004.

Axel Börsch-Supan and Courtney Coile. Social security programs and retirement around the world: Reforms and retirement incentives - introduction and summary. Working Paper 25280, National Bureau of Economic Research, 2018.

Kristine M Brown. The link between pensions and retirement timing: Lessons from california teachers. *Journal of Public Economics*, 2013.

Sebastian Calonico, Matias D Cattaneo, and Rocio Titiunik. Robust nonparametric confidence intervals for regression-discontinuity designs. *Econometrica*, 82(6):2295–2326, 2014.

David Card, David S Lee, Zhuan Pei, and Andrea Weber. Inference on causal effects in a generalized regression kink design. *Econometrica*, 83(6):2453–2483, 2015.

David Card, David S Lee, Zhuan Pei, and Andrea Weber. Regression kink design: Theory and practice. *Advances in Econometrics*, 38, forthcoming.

Jonathan Cribb, Carl Emmerson, and Gemma Tetlow. Signals matter? large retirement responses to limited financial incentives. *Labour Economics*, 42:203–212, 2016.

Mathias Dolls, Philipp Doerrenberg, Andreas Peichl, and Holger Stichnoth. Do retirement savings increase in response to information about retirement and expected pensions? *Journal of Public Economics*, 158:168–179, 2018.

Barbara Engels, Johannes Geyer, and Peter Haan. Pension incentives and early retirement. *Labour Economics*, 2017. EALE conference issue 2016.

Jianqing Fan and Irene Gijbels. Variable bandwidth and local linear regression smoothers. *The Annals of Statistics*, pages 2008–2036, 1992.

Daniel K. Fetter and Lee M. Lockwood. Government old-age support and labor supply: Evidence from the old age assistance program. *American Economic Review*, 108(8):2174–2211, August 2018. doi: 10.1257/aer.20160921.

Leora Friedberg. The effect of old age assistance on retirement. *Journal of Public Economics*, 71 (2):213–232, 1999.

Peter Ganong and Simon Jäger. A permutation test for the regression kink design. *Journal of the American Statistical Association*, 113(522):494–504, 2018.

Alexander Gelber, Timothy J. Moore, and Alexander Strand. The effect of disability insurance payments on beneficiaries' earnings. *American Economic Journal: Economic Policy*, 9(3): 229–61, August 2017.

Alexander Gelber, Adam Isen, and Jae Song. The role of social security benefits in the initial increase of older women's employment. *Women Working Longer: Increased Employment at Older Ages*, page 239, 2018a.

Alexander Gelber, Timothy Moore, and Alexander Strand. Disability insurance income saves lives. Working paper, 2018b.

Andrew Gelman and Guido Imbens. Why high-order polynomials should not be used in regression discontinuity designs. *Journal of Business & Economic Statistics*, 37(3):447–456, 2019.

Matthew Gudgeon and Simon Trenkle. The speed of earnings responses to taxation and the role of firm labor demand. *Working Paper*, 2019.

Peter Haan, Daniel Kemptner, and Holger Lüthen. The rising longevity gap by lifetime earnings–distributional implications for the pension system. *The Journal of the Economics of Ageing*, page 100199, 2019.

Jean-Olivier Hairault, Thepthida Sopraseuth, and François Langot. Distance to retirement and older workers 'employment: The case for delaying the retirement age. *Journal of the European Economic association*, 8(5):1034–1076, 2010.

Barbara Hanel and Regina T. Riphahn. The timing of retirement - new evidence from swiss female workers. *Labour Economics*, 19(5):718–728, 2012.

Nathaniel Hendren. The policy elasticity. *Tax Policy and the Economy*, 30(1):51–89, 2016.

Guido Imbens and Karthik Kalyanaraman. Optimal bandwidth choice for the regression discontinuity estimator. *The Review of economic studies*, 79(3):933–959, 2012.

Lukas Inderbitzin, Stefan Staubli, and Josef Zweimüller. Extended unemployment benefits and early retirement: Program complementarity and program substitution. *American Economic Journal: Economic Policy*, 8(1):253–288, 2016.

Alan B Krueger and Jörn-Steffen Pischke. The effect of social security on labor supply: A cohort analysis of the notch generation. *Journal of labor economics*, 10(4):412–437, 1992.

Rafael Lalive and Stefan Staubli. How does raising women's full retirement age affect labor supply, income, and mortality? evidence from switzerland. *NBER Retirement Research Center Paper No. NB 14-09*, 2015.

Camille Landais. Assessing the welfare effects of unemployment benefits using the regression kink design. *American Economic Journal: Economic Policy*, 7(4):243–278, 2015.

Day Manoli and Nicholas Turner. Cash-on-hand and college enrollment: Evidence from population tax data and the earned income tax credit. *American Economic Journal: Economic Policy*, 10 (2):242–71, 2018.

Dayanand Manoli and Andrea Weber. Nonparametric evidence on the effects of financial incentives on retirement decisions. *American Economic Journal: Economic Policy*, 8(4):160–82, 2016.

Dayanand Manoli and Andrea Weber. The effects of the early retirement age on retirement decisions. Technical report, 2018.

Olivier Marie and Judit Vall Castello. Measuring the (income) effect of disability insurance generosity on labour market participation. *Journal of Public Economics*, 96(1):198–210, 2012.

Giovanni Mastrobuoni. Labor supply effects of the recent social security benefit cuts: Empirical estimates using cohort discontinuities. *Journal of public Economics*, 93(11-12):1224–1233, 2009.

David Neumark and Elizabeth Powers. Welfare for the elderly: the effects of ssi on pre-retirement labor supply. *Journal of Public Economics*, 78(1-2):51–80, 2000.

OECD. *Pensions at a Glance 2015: Germany*. OECD, 2015.

OECD. *Flexible retirement in OECD countries*. 2017.

Patrick A Puhani and Falko Tabbert. The effects of pension changes on age of first benefit receipt: Regression discontinuity evidence from repatriated ethnic germans. *Labour Economics*, 38: 12–23, 2016.

Deutsche Rentenversicherung. Zahlen und tabellen, der gesetzlichen rentenversicherung - werte west (ohne knappschaft), 1.1. - 30.6.2018. Technical report, 2018.

Philippe Ruh and Stefan Staubli. Financial incentives and earnings of disability insurance recipients: Evidence from a notch design. *American Economic Journal: Economic Policy*, 11(2):269–300, 2019.

Johannes F. Schmieder and Till von Wachter. A context-robust measure of the disincentive cost of unemployment insurance. *American Economic Review*, 107(5):343–48, May 2017.

Stephen E Snyder and William N Evans. The effect of income on mortality: evidence from the social security notch. *The Review of Economics and Statistics*, 88(3):482–495, 2006.

Stefan Staubli and Josef Zweimüller. Does raising the early retirement age increase employment of older workers? *Journal of public economics*, 108:17–32, 2013.

James H. Stock and David A. Wise. Pensions, the option value of work, and retirement. *Econometrica*, 58(5):1151–1180, 1990.

Songül Tolan. The effect of partial retirement on labor supply, public balances and the income distribution: Evidence from a structural analysis. Discussion Paper 1679, DIW Berlin, 2017.

Online Appendix

The Effect of Pension Subsidies on the Retirement Timing of Older Women

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Contents

A Additional Details on Institution

A.1 Details on pension-related periods

The total creditable/pension period (Wartezeit/Anrechenbare Zeiten) is approximately composed of the contribution period ((SGB VI § 55 Beitragszeiten) and the consideration period (SGB VI § 57 Berücksichtigungszeiten). The contribution periods consist of full value contribution periods (Vollwertigen Beiträgen) and reduced contribution periods (Beitragsgeminderte). Full value contribution periods are periods when compulsory contributions are paid in according to the social security regulation. Reduced contribution periods include periods of unemployment, sickness and vocational training. During those periods, EPs are accumulated even though no contributions have been made by the worker. The consideration periods include child-raising periods. The time of raising a child up to age 10 counts in the consideration period. The package is 10 years for one child, 15 years for two children and 20 years for more than two children.

A.2 Pension subsidy schedule

A.2.1 Examples of pension benefits and subsidies calculation

The de jure eligibility condition of the subsidy program requires only the average monthly EP of full-value contribution years at retirement (aep^t) to be less than 0.0625 (t is the year of retirement). Yet, because the average monthly EP of full-value contribution periods before 1992 (aep_i^{92}) cannot exceed 0.0625 after the subsidy, this implies that the de facto eligibility condition requires both aep^t and aep_i^{92} to be less than 0.0625. Following are three examples showing how the pension benefits and subsidies are calculated.

An example of a hypothetical pensioner Suppose Anja started to contribute to the pension system in 1982 and claimed a pension in 2015. Her contribution period is 34 years. For each year of work, some earnings points are accumulated. For incidence, in 1983, she earned 1000 euros per month, and the average monthly wage of all insured was also 1000 euros. Therefore, 1 EP was credited. In 1991, her wage income was half of the average, therefore, 0.5 EP was credited. The sum of EP between 1982 and 2015 was 18. The average annual EP at retirement was 0.529 (18 EPs/34). Pension value in 2015 was 30 euros, therefore her pension benefits before the subsidies were 540 euros per month.

I also assume Anja has one child. Therefore, the condition of 35 years credible periods is satisfied. Additionally ,as her average annual EP at retirement was below 0.75, she was entitled to the subsidy program. The subsidy size is determined by aep_i^{92}. She has accumulated 5.5 EPs in

The calculation of an hypothetical pensioner's pension benefit and subsidy

	10 years				24 years			
Year	1982	1983	...	1991	1992	1993	...	2015
Monthly Wage	500	1000	500	500	750	750	500	600
Average Monthly Wage of All Insured	1000	1000	1000	1000	1000	1000	1000	1200
EP	0.5	1	3.5	0.5	0.75	0.75	10.5	0.5

Sum of EP	18	Sum of EP pre 92	5.5
Mean EP	0.529	Mean EP pre 92	0.55
PV in 2015	30	Subsidy in EP	2
Monthly Pension Benefit	**540**	**Monthly Subsidy**	**60**

Monthly Pension Benefit + Subsidy **= 600**

the 10 years before 1992. Therefore, her annual average EP before 1992 was 0.55. Because 0.55 is higher than 0.5, therefore, the subsidy size was (0.75-0.55)*10=2. After the increase, aep_i^{92} is at 0.75, the maximum value. 2 EPs was equivalent to 60 euros in 2015. Her total pension benefits were around 600 euros per month.

Two calculation examples provided by the German Pension Office

Following are two examples provided on the German Pension Office website :

Example 1: Calculation of the monthly average The total EPs for the contribution periods are 46.6909. Out of this total amount, 31.6900 earning points are attributed to the 517 months of full-value contribution period. Out of the 31.6900 earning points, 26.5000 earning points are attributed to 400 months of full-value contribution before 31.12.1991.

Example 1 Solution

- Dividing 31.6909 earning points by 517 months gives us 0.0613 earning points. The monthly average of all full-value contribution periods does not reach (is below) the value of 0.0625.

- Dividing 26.5000 earning points by 400 months gives us 0.0663 earning points. The monthly average of all full-value contribution periods until 31.12.1991 reaches/is above the value of 0.0625.
- Therefore, additional (extra/add-on) earning points do not have to be calculated.

Example 2: Calculation of additional (extra) earning points There were 228 months of full-value contributions before 1992. For these contribution periods, 10.3968 earning points were accumulated.

Example 2 Solution:

- Dividing 10.3968 earning points by 228 months gives us the average value of 0.0456 earning points. As this value is below 0.0625, it must be increased by a factor of 1.5. 0.0456 times 1.5 gives us 0.0684.
- However, after the increase, the average before 1992 can at most be 0.0625 earning points. The increased average value, which is in this case limited to 0.0625, is to be multiplied by the amount of months with full-value contributions before 1992. 0.0625 times 228 gives us 14.2500 earning points.
- This results in 3.8532 additional earning points (14.2500 − 10.3968)

A.2.2 Subsidy schedule with simulated T_i^{92} and actual T_i^{92}

According to the subsidy formula ($Subsidy_{it} = min\left(0.5 \times \sum_{t<92} EP_{it}\ , 0.75T_i^{92} - \sum_{t<92} EP_{it}\right)$), individuals who worked more years before 1992 and individuals with aep_i^{92} closer to 0.5 are granted more subsidies. In order to focus on changes in subsidy along aep_i^{92}, it is necessary to make some assumptions on the distribution of T_i^{92}. In Figure 1, I show the subsidy schedule when T_i^{92} are simulated according the following three distributions.

- T_i^{92} is set to 19 years, which is the average value for the baseline sample (Figure 1a); and
- T_i^{92} is generated from a normal distribution N(18.73,6.41), which is The distribution of T_i^{92} in the data. Number of observations is set to 25000, close to the sample size. Observations

are equally distribution across bins. There are 500 observations for each bin (50 bins)(Figure 1c).

- T_i^{92} is generated for six different segments along aep_i^{92}. Each segment follows a normal distribution. The number of observations per segment, parameters of the normal distribution are taken from the sample (Figure 1d).
  - When $aep_i^{92} < 0.19825$, $T_i^{92} \sim N(9.87674, 5.079995)$
  - When $0.19825 <= aep_i^{92} < 0.30500$, $T_i^{92} \sim N(13.96151, 6.001462)$
  - When $0.30500 <= aep_i^{92} < 0.38125$, $T_i^{92} \sim N(16.26061, 6.054799)$
  - When $0.38125 <= aep_i^{92} < 0.53375$, $T_i^{92} \sim N(18.7341, 6.215825)$
  - When $0.53375 <= aep_i^{92} < 0.65575$, $T_i^{92} \sim N(21.59123, 5.958086)$
  - When $0.65575 <= aep_i^{92} < 0.74725$, $T_i^{92} \sim N(24.38256, 6.202347)$

Figure 1d takes into account the variations in T_i^{92} as aep_i^{92} increases, as shown in Figure A9. This figure also shows that there is a linear positive relationship of $T92$ with aep_i^{92} for the recipients. Also $T92$ is more dispersed when aep_i^{92} is low.

A.2.3 Construction of average earning points before 1992 in the data

The assignment variable is average monthly pension points accumulated from full-value contributions. In the VSKT dataset, we observe 624 months of pension-related biographies. Respondents enter the data set in January of the year they turn age 14 until the December of the year they turn 65 years old. I use the birth year and birth month to back out the corresponding year and month when the contribution was made. Additionally, I also observe the socioeconomic status associated with the recorded pension contribution. To calculate average EP from full-value contribution before 1992, I sum up EP and number of months with "gainfully employment with pension contribution obligations." Because in the data, I observe the number of months before 1992 used to calculate the subsidy amount, I compare this variable with the constructed number of months contributed before 1992. This way I can test for the accuracy of the variable construction. I have estimated the regression kink estimates using the policy-defined cutoff 0.5 as the kink point (Table A6). I find that the impacts are not significant.

A.3 Pension pathways and pension reforms

Several alternate pathways make retiring before the regular retirement age 65 possible. There are four main early retirement pathways: old-age pensions for women, old-age pensions due to unemployment (and part-time work), old-age pensions for the long-term insured and old-age pensions for severely disabled persons. Each pathway has its own eligibility conditions. Each pathway has also its own full retirement age (FRA) and early retirement age (ERA). For example, to be eligible for the pension for women, the individual has to be female, born before 1952, have 15 years of contributions of which at least 10 years must have occurred after age 40.

Changes in pension parameters for cohorts 1935 to 1952

	1935	...	1941	1942	...	1945	1946	1947	...	1951	1952	Reform Year
Regular/statutory retirement age	65	...	65	65	...	65	65	$65\frac{1}{12}$	...	$65\frac{5}{12}$	$65\frac{6}{12}$	2007
Pension for women (ERA^w)	60	...	60	60	...	60	60	60	...	60	-	1999
Pension for women (FRA^w)	60	...	62	63	...	65	65	65	...	65	-	1992
Deductions at ERA^w	**0%**	...	7.2%	10.8%	...	18%	18%	18%	...	18%	-	
Pension for unemployed (ERA^u)	60	...	60	60	...	60	61	62	...	63	-	1999
Pension for unemployed (FRA^u)	60	..	65	65	...	65	65	65	...	65	-	1992
Deductions at ERA^u	0%	...	18%	18%	...	18%	14.4%	10.8%	...	7.2%	-	
Pension for long-term insured (ERA^l)	63	...	63	63	...	63	63	63	...	63	63	
Pension for long-term insured (FRA^l)	63	...	65	65	...	65	65	65	...	$65\frac{5}{12}$	$65\frac{6}{12}$	1992/2017
Deductions at ERA^l	0%	...	7.2%	7.2%	...	7.2%	7.2%	7.2%	...	8.7%	9.0%	
Pension for severely disabled (ERA^d)	60	...	60	60	...	60	60	60	...	60	$60\frac{6}{12}$	2007
Pension for severely disabled (FRA^d)	60	...	61	62	...	63	63	63	...	63	$63\frac{6}{12}$	1992/2007
Deductions at ERA^d	0%	...	3.6%	7.2%	...	10.8%	10.8%	10.8%	...	10.8%	10.8%	

Note: Author's own calculation according to the SBG VI. The ERA, FRA and deductions are those for cohorts born in December that year.

The pension reforms in the past decades typically reduce public pension generosity by raising the retirement age and penalize early claiming. An individual can claim earliest at the ERA, however each year of early claim before FRA renders a 3.6% benefit deduction. (See Engels et al. (2017) for more details). During my sample period, women can claim pension the earliest at age 60, either via the pension for women or via pension for severely disabled. The table below highlights the changes in ERA, FRA and the corresponding deductions when claim at the ERA for cohort 1935 to 1952. For example, the ERA via the pension for women stayed at 60 for cohorts born before 1951. The 1999 pension reform abolished the women pathway for cohorts born after 1951. In order to isolate this drastic change, in this paper I focus on women born before 1952. The financial incentives to claim a pension at age 60 has also changed for women. The 1992 pension reform has increased the FRA from 60 to 65 by monthly steps since the cohort of 1941. This entails a 3.6% benefit deduction for each year claimed before FRA. The penalty to retire at 60 was phased in gradually in monthly steps, up to 18%, and it stabilized at 18% for cohort younger than 1945.

In Table A5, I examine how the impact of the subsidies interacts with the financial penalties on the early claim. According to the pension reform schedule, I separate the sample into two groups:first, the no-penalty group and transitional group: cohort 1935 to 1945; and second, the maximum-penalty group: cohort 1945 to 1951. I expect that the subsidy impact is smaller for younger cohorts who face penalties, because one additional euro is discounted by 18% for workers who retire at age 60. Table A5 shows that the impact on age of claiming a pension and the hazard to claim at 60 are slightly larger for the maximum-penalty group. However, the difference is not statistically significant. I can not claim that financial penalties to claim early have offset the impact of the subsidy program.

A.4 Information revelation

The impact of the additional subsidy program works through the knowledge of the total expected pension benefits. In Germany, individuals know their expected pension benefits when they retire. This is because letters with detailed pension information are sent to insured individuals. The salience of this information helps individuals to plan and allows them to take into account the additional pension benefits when they make labor supply choices. In detail, the statement is a letter with a summary of the insurance record, including pension service year, full contribution year, accumulated pension points, and projected pension entitlement, conditional on future contributions. It also indicates warnings and risks, such as shifting of relative income position. Before 2005, the letters were sent every three years from age 55. Since 2005, letters have been sent annually to workers who are 27 years old and have contributed to the public pension for at least five years. Dolls et al. (2018) have shown that these letters inform workers of their pension entitlements in a salient fashion. Following is an example of a pension letter received by a hypothetical individual, Mr.Test. This letter is provided by the German Pension Insurance Office. I highlight the key information on the first page of the letter. In the appendix of the letter, there is also information about the entitlement of the minimum pension points.

An example letter of a hypothetical individual

Versicherungsnummer 28 040158 L 166   Abtl. 4926

Deutsche Rentenversicherung
Braunschweig-Hannover

Deutsche Rentenversicherung Braunschweig-Hannover, 30875 Laatzen

Herrn
RTAC TEST
LEAT 16
30880 LAATZEN

Lange Weihe 6
30880 Laatzen
Postanschrift: 30875 Laatzen
Telefon 0511 829-0
Telefax 0511 829-2635
www.deutsche-rentenversicherung-braunschweig-hannover.de
info@drv-bsh.de

Kostenloses Servicetelefon:
0800 100048010

27. Oktober 2016

Pension information of Mr.Test

Rentenauskunft - kein Rentenbescheid

Sehr geehrter Herr TEST,

mit dieser Auskunft unterrichten wir Sie
- über die Höhe einer Rente wegen voller Erwerbsminderung
- über die Höhe der Regelaltersrente
- inwieweit die Voraussetzungen für verschiedene Rentenleistungen erfüllt sind
- über die gespeicherten rentenrechtlichen Zeiten (siehe Anlage "Versicherungsverlauf")
- über die persönlichen Entgeltpunkte (siehe Anlage "Berechnung der persönlichen Entgeltpunkte")

nach jetzigem Stand.

Die **Rente wegen voller Erwerbsminderung** würde **1.031,32 EUR** monatlich betragen, wenn von einem am **27.10.2016** eingetretenen Leistungsfall ausgegangen würde.

Pension benefits in case of immediate full disability : 1031.32 Euro per month

Hierbei ist zusätzlich die Zeit bis zur Vollendung des 62. Lebensjahres berücksichtigt worden (Zurechnungszeit).
Die Rente wegen teilweiser Erwerbsminderung würde die Hälfte des errechneten Betrages ergeben.
Wir haben nicht geprüft, ob eine Erwerbsminderung vorliegt.

Die **Regelaltersrente**, die **ab 01.02.2024** gezahlt werden kann, würde **1.326,35 EUR** monatlich betragen, wenn der Berechnung ausschließlich die bisher gespeicherten rentenrechtlichen Zeiten sowie der derzeit maßgebende aktuelle Rentenwert zugrunde gelegt werden.

Pension benefits at statutory retirement age, available on 2024 February 1st, if no more contributions were to be paid between now and retirement: 1326.35 Euro per month.

Die Berechnung der Monatsrente ergibt sich aus der Anlage "Berechnung der Rente".

Zukünftige Anpassungen
Aufgrund zukünftiger Rentenanpassungen kann die errechnete Rente in Höhe von 1.326,35 EUR tatsächlich höher ausfallen. Allerdings können auch wir die Entwicklung nicht vorhersehen. Deshalb haben wir - ohne Berücksichtigung des Kaufkraftverlustes - zwei mögliche Varianten für Sie gerechnet. Beträgt der jährliche Anpassungssatz 1 Prozent, so ergäbe sich eine monatliche Rente von etwa 1.420 EUR. Bei einem jährlichen Anpassungssatz von 2 Prozent ergäbe sich eine monatliche Rente von etwa 1.520 EUR.

Pension benefits at statutory retirement age if pension value increases by 1 % in the future is 1420 Euro; with 2% is 1520 Euro.

An example letter of a hypothetical individual (continued)

Deutsche Rentenversicherung

Versicherungsnummer	Abtl.		Seite	Datum
28 040158 L 166	4926	(000-00)	02	27.10.2016

Hinweise zur Rente, den Anspruchsvoraussetzungen und ob Sie diese bereits erfüllen oder noch erfüllen können, erfahren Sie in den einzelnen Abschnitten dieser Auskunft:

A Rentenhöhe und Beiträge zur Kranken-/Pflegeversicherung
B Rentenantragstellung und Rentenbeginn
C Monate für die Wartezeit
D Rente wegen Erwerbsminderung
E Altersrenten
F Regelaltersrente
G Altersrente für schwerbehinderte Menschen
H Altersrente für langjährig Versicherte
I Altersrente für besonders langjährig Versicherte
J Hinterbliebenenrenten
K Hinweise zum Versicherungsverlauf
L Private Altersvorsorge
M Besteuerung der Alterssicherung
N Auskunft und Beratung
O Bestandteile der Rentenauskunft

Here are some other information provided in the letter, including months of waiting period, old age pension for long-term insured, taxation,etc.

A Rentenhöhe und Beiträge zur Kranken-/Pflegeversicherung

Die Rentenanwartschaft ist nach den aktuellen Bestimmungen errechnet worden. Minderungen des errechneten Betrages kommen insbesondere in Betracht, wenn Sie eine Unfallrente beziehen. Außerdem können Änderungen bei Wechsel der derzeitigen Staatsangehörigkeit eintreten oder wenn Sie in einen anderen Staat umziehen. Aus künftig wirksam werdenden neuen Rechtsvorschriften oder durch die Anwendung von Vorschriften des über- und zwischenstaatlichen Rechts können sich ebenfalls Abweichungen ergeben.
Die Rentenauskunft ist deshalb nicht rechtsverbindlich.

Deutsche Rentenversicherung

Versicherungsnummer	Abtl.		Anlage	Seite	Datum
28 040158 L 166	4926	(000-00)		03	27.10.2016

Entgeltpunkte für Beitragszeiten

Mindestentgeltpunkte bei geringem Arbeitsentgelt

Die Entgeltpunkte für Pflichtbeitragszeiten bis 31.12.1991, die nicht als beitragsgeminderte Zeiten gekennzeichnet sind und nicht während des Bezuges einer Rente aus eigener Versicherung liegen (vollwertige Pflichtbeitragszeiten), sind auf das 1,5fache des tatsächlichen Durchschnittswertes, höchstens jedoch auf 0,0625 monatlich anzuheben, wenn sich aus allen vollwertigen Pflichtbeitragszeiten ein Durchschnitt von weniger als 0,0625 Entgeltpunkten ergibt.

43,6502 Entgeltpunkte : 588 Monate = 0,0742 Punkte

Der Monatsdurchschnitt aus allen vollwertigen Pflichtbeitragszeiten erreicht den Wert 0,0625.
Zusätzliche Entgeltpunkte sind nicht zu ermitteln.

Summe der Entgeltpunkte für 588 Monate Beitragszeit 43,6502

Für Zeiten im Beitrittsgebiet und für reichsgesetzliche Zeiten außerhalb der Bundesrepublik Deutschland sind die Entgeltpunkte als Entgeltpunkte (Ost) zu berücksichtigen.

Das sind	1,5633 Entgeltpunkte (Ost) für 12 Monate
Damit verbleiben	42,0869 Entgeltpunkte für 576 Monate

In the appendix of the letter, there is information of the minimum pension points. Here we can see a detailed calculation of the entitled additional EPs from the subsidy program for Mr. Test.

A.5 Unemployment insurance and the early retirement pathway via UI

The German unemployment insurance (UI) system provides an approximately 60% income replacement to eligible unemployed workers. The replacement rates for UI were relatively stable over my sample period, and were 67-68% for individuals with children and 63-60% for individuals without children.

During my sample period, the maximum benefit duration for older workers ranged from 18 months to 32 months, depending on age and previous working history. Time spend on UI also increases future pension benefits. Workers who exhaust UI benefits are eligible for unemployment assistance (UA) benefits with an effective average replacement rate of around 30%. Eligible workers can stay in UA until they reach the full retirement age of 65. From 2005 on, UA was replaced by unemployment insurance benefits 2 (UIB 2), a completely means-tested program. Both UA and UIB 2 provide unlimited benefit duration.Time spent on UA does not increase pension benefits.

Moreover, workers aged 58 and older could receive unemployment benefits without actively looking for a job or other obligations. This "58er-Regelung" was formally introduced at the end of 1985 and was in place until end of 2007. The generosity of the unemployment insurance benefits and the lenient job search requirement for older workers made UI an attractive pathway to bridge to retirement.

A.6 Lifetime labor market activities by gender

There has been a sharp increase in the level of employment among 55 to 64-year-olds in Germany. In 2005, the employment rate among this age group totaled 46%, but increased to 66% by 2014 (OECD). However, there is still a significant gender gap in terms of lifetime employment. The figure below shows the share of different activities from age 14 to age 63 for people in West Germany. It shows that women in West Germany spend 55% of the time in regular employment on average, while this number is 73% for men. A female subsidy recipient has a similar lifetime as an average woman, while a male subsidy recipient spends much more time in unemployment than an average man. This suggests that female recipients are not much different from an average woman. This pattern is consistent with the density of all workers in West Germany, as shown in Figure 4d, and also with the fact that 80% of the recipients are female.

Share of activities over lifetime (before age 63), workers and subsidy recipients in West Germany

Note: Own calculation based on Scientific Use File of VSKT2014 for individuals who are at least 63 years old.

B Lifetime Budget Constraint

In this section, I describe a simple life budget constraint model in the spirit of Brown (2013) to illustrate the main incentives of the subsidy program. For simplicity, bequests and savings are not modeled, and retirement is an absorbing state. I assume workers start work from period 0. Let C be total consumption, Y be lifetime income, T be the last period of life, T^E be the year of exit from regular employment, T^R be the year of claiming a pension. I assume no discounting and that T is known with certainty. Retirement is an absorbing state. I assume an individual earns a constant (after tax and pension contribution) annual wage w and receives annual pension benefits pb at retirement. If an individual leaves the labor force before the earliest pension claiming age, I assume she gets an annual income of v. v can be interpreted as wage income from marginal employment or unemployment insurance benefits.

B.1 Lifetime Budget Constraint

The lifetime budget constraint with pension subsidies is $C = Y = w \times T^E + v \times (T^R - T^E) + pb \times (T - T^R)$, where pb is the pension benefit per year and $pb = w/\bar{w} \times T^E \times PV + b$. b is the additional pension benefits provided by the subsidy program. I denote the pension replacement rate per year of contribution as p, where $p = PV/\bar{w}$. Therefore, $pb = p \times w \times T^E + b$. The financial penalties due to early claiming are not modeled.

An individual's utility in each period is assumed to be additively and separable in consumption and leisure as in Brown (2013). $u_t(c_t, l) = v(c_t) - \phi_t l$, where ϕ_t is the disutility from working in period t and l takes the value one if the individual works in period $v(.)$ is increasing and concave in consumption. The individual will maximize utility by perfectly smoothing consumption over the lifecycle. Therefore, the lifetime utility function is $U(C) = T \times v(C/T) - \sum_{t=0}^{T^E} \phi_t$. The optimal age of exiting employment T^{E^*} is characterized by $v'/\phi_t = dC/dT^E$.

For simplicity, I make two assumptions: first, if an individual leaves a job before early retirement age at age 60 ($T^E < 60$), then claims pension at age 60 ($T^R = 60$); that is, the worker claims pension immediately as their pension becomes available at early retirement age. In the sample, among the individuals who leave employment before 60, half retire at 60; second, if an individual leaves a job after early retirement at age 60, then the worker claims a pension immediately ($T^E = T^R$). In the sample, among the individuals who exit employment after age 60, 70% claim immediately. Then, the lifetime budget constraint is the following:

$$Y = \begin{cases} w \times T^E + v(60 - T^E) + (p \times w \times T^E + b)(T - 60) & T^E < 60 \\ w \times T^E + (p \times w \times T^E + b)(T - T^E) & T^E \geq 60 \end{cases}$$

$$\frac{dY}{dT^E} = \begin{cases} w - v + p \times w(T - 60) & T^E < 60 \\ w + p \times w(T - T^E) - (p \times w \times T^E + b) & T^E \geq 60 \end{cases}$$

The slope of the budget constraint dY/dT^E is the total financial return to work. For ages of exiting T^E before the pension eligibility age 60, the gain of one additional year of work has three components: first, one year of wage income w; second, one year of forgone "bridge wage" v; and third an increase of total pension income due to one more year of contribution $p \times w(T - 60)$. The return to work is independent of pension subsidy b if age of exiting is younger than 60. For ages of exiting T^E older than 60, the gain of one additional year of work comes from annual wage income w, an increase in total pension income $p \times w(T - T^E)$ and one year of foregone pension benefits $p \times w \times T^E + b$. The change in the return to work due to pension subsidy b is -1 if an individual exits employment after age 60 and claims a pension immediately.

B.2 Parameters in the illustrated budget constraint

The taxable wage income is after the social security contribution (SCC) and child allowance. Healthcare insurance is almost always 100% deductible during the sample period. Before 2005, pension contributions were 100% tax-free. As of 2005, to balance the changes in pension income tax, 60% of pension contributions were tax-free, and this increased by 2% each year. In 2025, 100% of contributions will be taxed. For simplicity, I assume all SCC are tax deductible. The social security contribution (SSC) includes contributions to healthcare insurance, long-term care insurance, unemployment insurance and pension insurance. The average SSC is around 20% of gross wage income. The baseline budget set is constructed for the sample of the married female without dependent children. Given that in the sample, around 90% have non-dependent children, it is representative to construct the lifetime budget constraint for the married couple without children. According to the online tax calculator [35], the average tax rate of the married individual with an average wage income and whose spouse makes zero income is 0.12.

The public pension benefits are calculated on a complex formula of individual career earnings, average pay, revaluation, and insurance periods. The main determinant of pension payments is the sum of individual accumulated earnings points. Some periods without contribution also count as insurance periods after the age of 17, such as years of further education, time spent in military service, and time spent in raising children. The annual pension wealth of a worker who claims old age pension without financial adjustment and is insured for $T^E - s$ years is the following:

$$PB_{gross} = \sum_{t=T^R}^{T} AR_t \times \sum_{\tau=s}^{T^E} \frac{w_\tau}{\bar{w}}$$

, where AR_t is aggregate pension base of year t, w is gross annual individual income τ , $\bar{w}$ is the

[35]The tax rates are obtained from https://www.bmf-steuerrechner.de/ekst

average income of all insured people in the pension system. If we assume constant wage and take the mean of AR_t, the total pension wealth is

$$TotalPB_{gross} = (T - T^R)\frac{AR}{\bar{w}}(T^E - s) = pw(T^E - s)(T - T^R)$$

, where p is the gross pension replacement rate per year of the pension contribution. The interest portion (Ertragsanteil) of pension is subject to income tax. The taxable portion depends on retirement age. It is 27% if an individual retires at full retirement age 65. The taxable rate of pension is around 30%. Because the taxable portion of pension on average falls into the zero tax bracket, we assume the pension is not subject to income tax.

B.3 Construct lifetime pension wealth

I calculate the discounted pension wealth at age 60 using the following equation.

$$\mathbb{E}(PW_i) = \sum_{a=60}^{100} \frac{PB_{ia} \times LE_{c,60}}{(1 + r_i)^{a-60}}$$

The discounted subsidies at age 60 is:

$$\mathbb{E}(SUBSIDY_i) = \sum_{a=60}^{100} \frac{SB_{ia} \times LE_{c,60}}{(1 + r_i)^{a-60}}$$

where PB_{ia} denotes the pension benefits received by individual i at age a, SB_{ia} denotes the subsidized benefits received by individual i at age a, $LF_{c,60}$ is the life expectancy of cohort c conditional on reaching age 60, r_i is individual rate of return(IRR). The IRR is the interest rate equalizes lifetime pension contribution and the expect lifetime pension benefits. Haan et al. (2019) shows that the IRR for a West German male born between 1935 and 1949 who are in the lower 20% percentile of lifetime earnings is 1%. Another standard value for discounting is 3%, which has been used in many studies, such as Gelber et al. (2018a). I take three values as the discounting factor 1%, 2% and 3% to show a range of possible value of lifetime discounted subsidies. $LF_{c,60}$ is the life expectancy of cohort c conditional on reaching age 60 and is obtained from three different statistics: first, the life expectancy of female born between 1935 and 1951 at birth is 68.86 years old; second, the life expectancy of female conditional on reaching age 60 between year 2002 and

2014 is 24.73 years;[36] and third, Haan et al. (2019) shows the average life expectancy at age 65 of West German workers born between 1935 and 1949 who are in the lower 20% percentile is around 15 years. Using these numbers, I calculate a range of discounted lifetime subsidies in the table below:

Discounted lifetime pension subsidies

Monthly subsidy amount	Discount rate	Life expectancy	Discounted lifetime subsidies
€100	1%	24 years	€26692.06
€100	2%	24 years	€23896.71
€100	3%	24 years	€21522.65
€100	1%	15 years	€17838.06
€100	2%	15 years	€16619.12
€100	3%	15 years	€15525.52
€100	1%	9 years	€11479.22
€100	2%	9 years	€10994.68
€100	3%	9 years	€10543.33
Average			€17234.59

Note: Author's own calculation according to the statistics from German Statistic Office and Haan et al. (2019).

Note that I muted the impact of additional subsidies on mortality. If additional subsidies reduced mortality, we will expect 100 €additional monthly benefits translate to a higher lifetime pension wealth.

C The Mechanical Cost and Behavioral Cost

The mechanical costs (MC) represents the increase in government spending if there were no behavioral responses. If I assume the average duration of pension claim is 16 years, which is the average of the three life expectancy statistics used in Appendix B.3, which represents the length of the period between pension claim and death, then the mechanical cost of a 1 euro increase in monthly pension benefit equates to approximately a 190 euros increase in lifetime pension benefits per each infra-marginal worker.

The behavior cost (BC) is the additional costs imposed on the government budget by the fact that people claim pensions earlier, leave regular jobs earlier, and are more likely to take unemployment

[36] They are from the life tables from the German Statistic Office.

insurance prior to taking an early retirement pathway.[37] The BC comes from the increase in total pension benefits paid (€36), the increase in UI benefits paid((€9), and the decrease in the revenues due to lower levels of contribution to the public pension system (€1.6). The total behavioral cost for one additional euro of pension benefit per month is around 47 euros per worker. [38]

The resulting BC/MC ratio is approximately 0.25. This implies that in order to increase the lifetime income of the low-income pensioners by 1 euro, 1.25 euros have to be raised by the government, either via taxes or pension contribution. The BC/MC ratio helps me to compare the distinctive effect of the pension subsidy program with other welfare programs. For instance, the average BC/MC ratio of UI benefit extensions is 1.35 (Schmieder and von Wachter (2017));[39] the average BC/MC ratio of increasing the Earned Income Tax Credit is 1.15; and BC/MC of "food stamps"(subsidies to help low-income people purchase food) ranges from 0.53 to 0.64 (Hendren (2016)).[40] The BC/MC ratio suggests that, compared to other income support programs, the pension subsidy program has a relatively less distortionary effect.

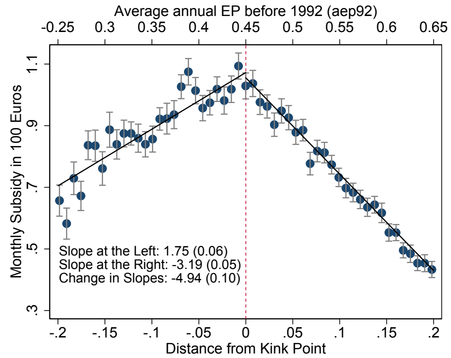
D Additional Figures and Tables

[37]In this paper, I did not look at the "enrollment" responses. Potentially, workers may lower their average earnings point at retirement in order to meet the eligibility threshold for the pension subsidy program. Therefore, I do not consider the fiscal externalities from the marginal workers.

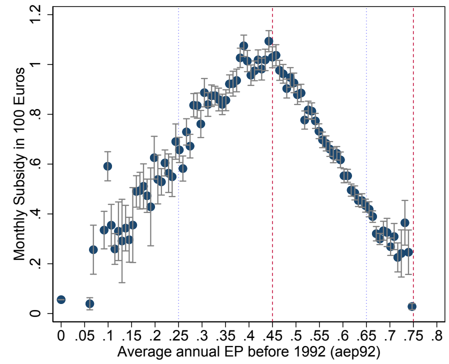
[38]The three parts of BC are calculated as the following: first, I find that a €1 increase in monthly pension benefit induces worker to claim early by 1.8 days. This translates to €36 additional spending per worker (the average monthly pension €600); second, I also learn that a €1 additional monthly pension benefit increases the duration spent in unemployment after exiting regular employment job by around 1.5 days. This incurs an additional €30 of government spending (the UI benefit is roughly 67 percent of the average wage and monthly wage up to €900). Additionally, on average, 30% of the recipients bridge to retirement via unemployment. Therefore, the expected value of the second part of the behavioral cost is €9; and third, the decrease in pension contributions comes from two sources: first, a change in the age of exiting regular employment; and second, a change in time spent in UI. The magnitude of the first part is around zero, as the estimated distortion on age of exiting employment is not significant. The change in contribution due to change in time spent in UI is €9 multiplied by the pension contribution rate of 18%. This sums up to around €1.6. The behavioral costs can also come from lost in tax revenue. This can again be attributed to the impact on the age at exiting regular job. However, mostly of the recipients face zero income tax rates; therefore, I do not count this channel.

[39]This is obtained under the assumption that nonemployment affects the social planner's budget by both income tax and UI payroll tax. If only the UI payroll tax is considered, BC/MC ratio of UI benefit extensions is on average around 0.35.

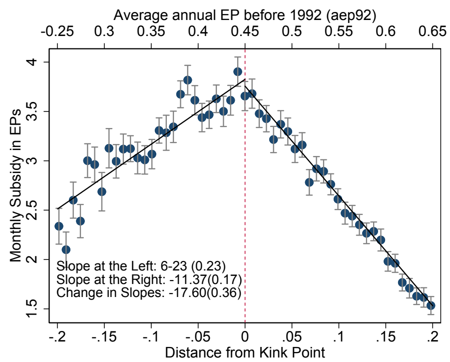
[40]The BC/MC ratio of a public policy is conceptually the same as the "fiscal externality" in Hendren (2016). The FE measures the impact on government budget due to behavioral response to the policy change, per dollar of government expenditure.



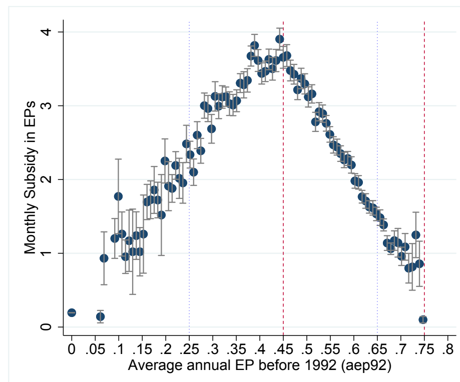
(a) Total subsidy, baseline



(b) Total subsidy, full support



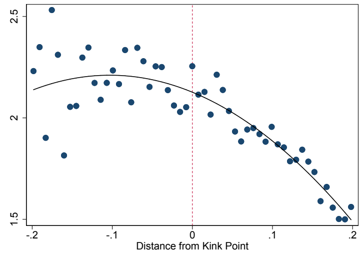
(c) Total subsidy in EPs, baseline



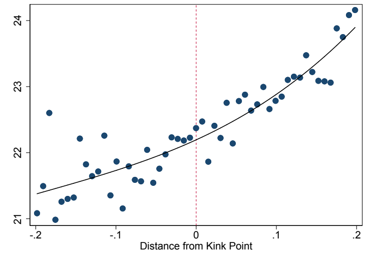
(d) Total subsidy in EPs, full support

Figure A1: Subsidy before 1992 as a function of average monthly earnings points before 1992

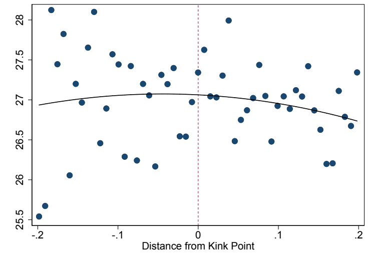
Note: Figure A1 (a) and (b) show the observed monthly subsidy size measured in euro for the recipients within the bandwidth of 0.2 EP and the full support, respectively. Figure A1 (c) and (d) show the observed monthly subsidy size measured in earnings points for the recipients within the bandwidth of 0.2 EP and the full support, respectively.



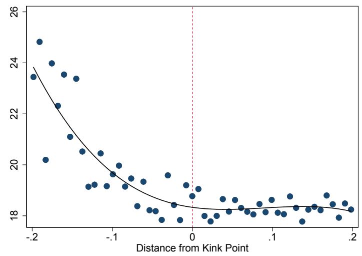
(a) Number of children



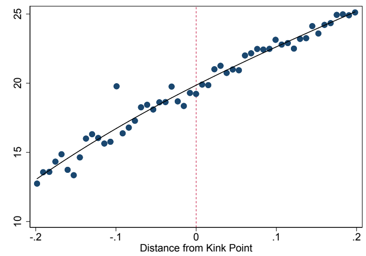
(b) Age at first birth



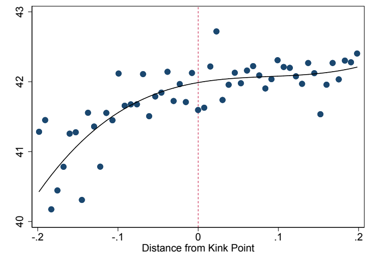
(c) Age at last birth



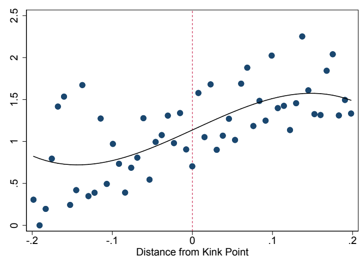
(d) Age at first employment



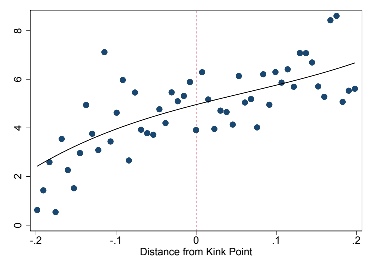
(e) Total pension without subsidies



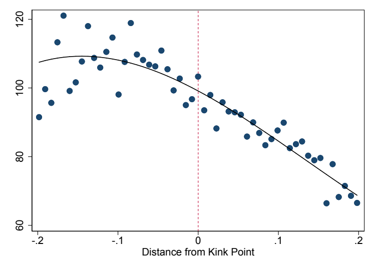
(f) Total pension years



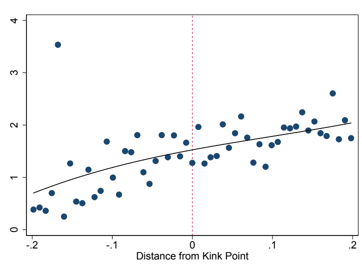
(g) Months of UI before 92



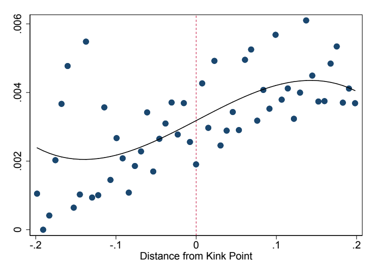
(h) Months of UA before 92



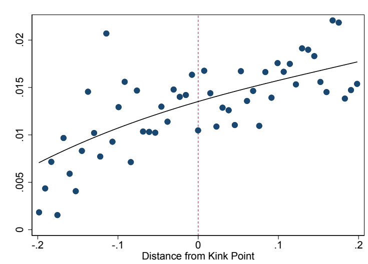
(i) Months of childcare before 92



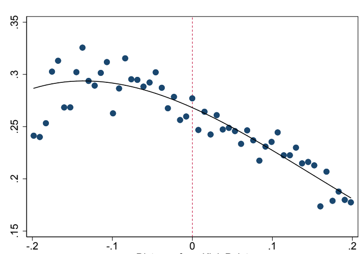
(j) Months of sickness before 92



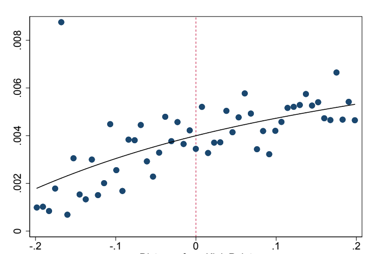
(k) Share of UI before 92



(l) Share of UA before 92



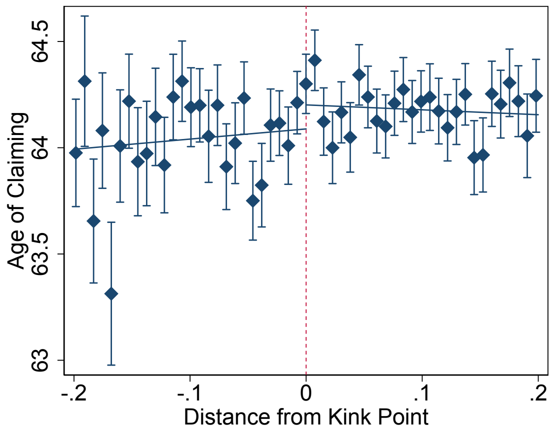
(m) Share of childcare before 92



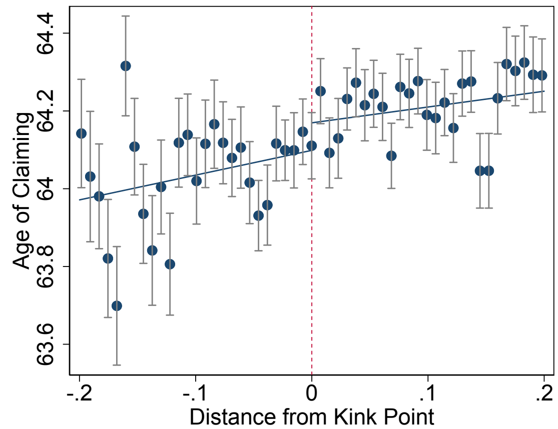
(n) Share of sickness before 92

Figure A2 : Predetermined covariates around the Kink

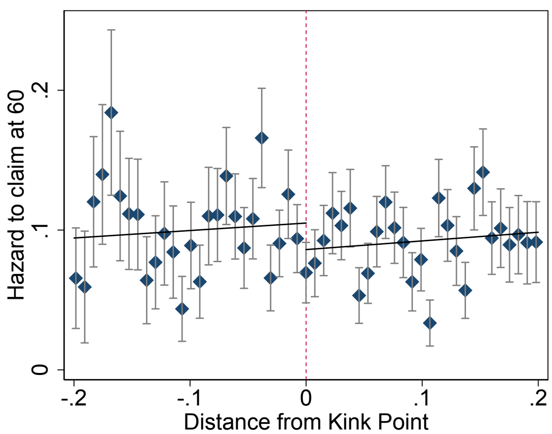
Note: Figure A2 shows the scatter bin plots of aep_i^{92} in 0.05125 ($\sim$ 40 €in 2010) bins as a function of distance to the observed kink point for the predetermined covariates. These distributions are smooth around the kink. Table A1 has listed the p-values for changes in slopes of covariates around the kink.



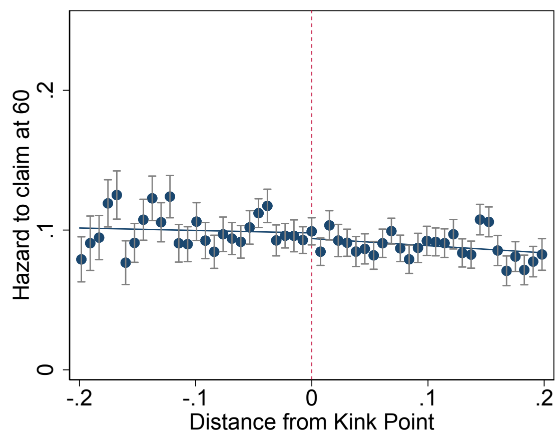
(a) Bin plots: Age at claiming pension



(b) Bin plots: Age at claiming pension(w. ctrl.)



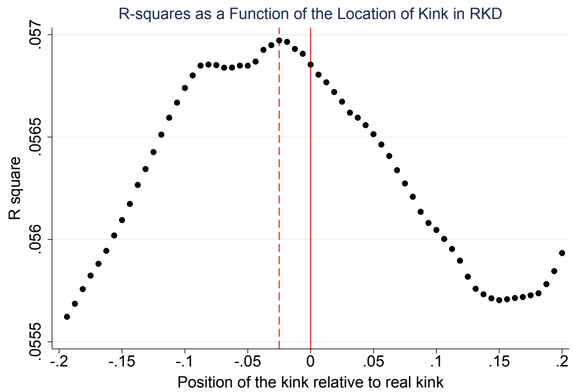
(c) Bin plots: hazard to claim pension at age 60



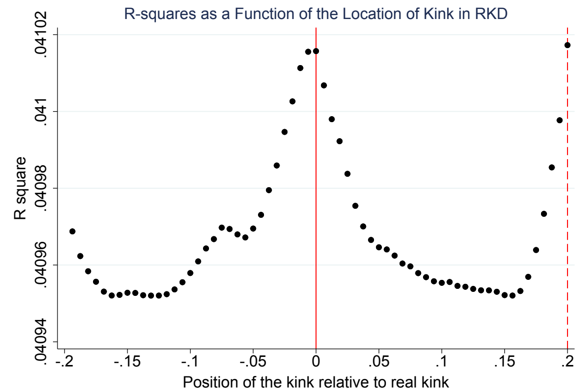
(d) Bin plots: hazard to claim pension at age 60(w. ctrl.)

Figure A3: Scatter plots around the kink for workers with less than 35 credible years (non-recipients)

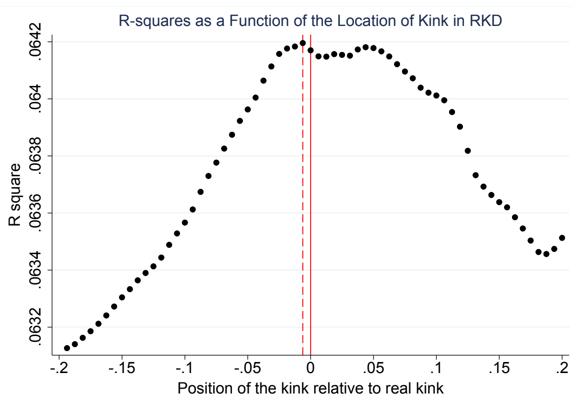
Note: Figure A3 provides evidence that the estimated impact on age at claiming pension, hazard to claim at age 60, age at exiting employment and hazard to exit at age 60 are not caused by the quadratic functional form. The figures show the relationship of the outcome variables with average earnings points before 1992 for a placebo group of West German women with less than 35 creditable periods (non-recipients). All four panels show that there are no visible changes in slope at the kink. The diamond bins are bins from raw data and the dots are the predicted outcome variables with controls and cohort fixed effects. The regression results are presented in Table A4.



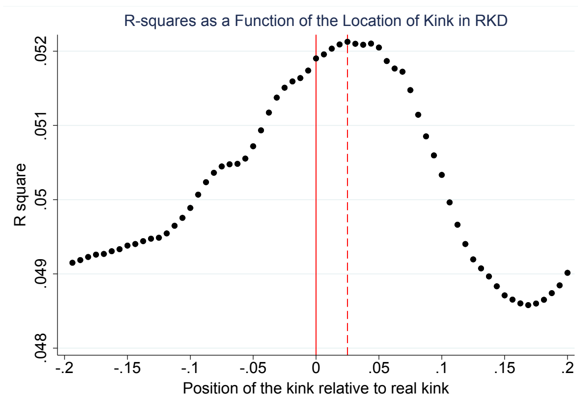
(a) Age at claiming pension



(b) Age at exiting employment



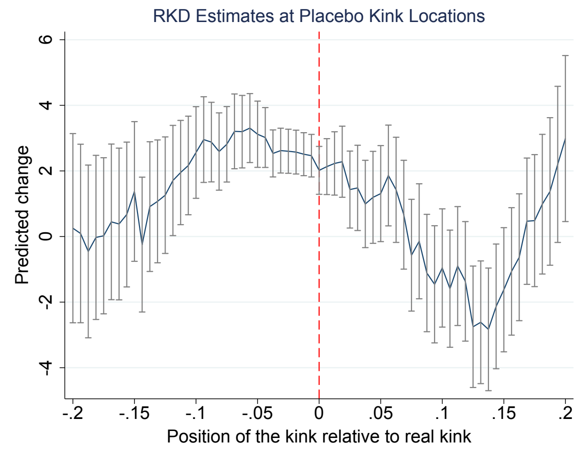
(c) Hazard to claim a pension at 60



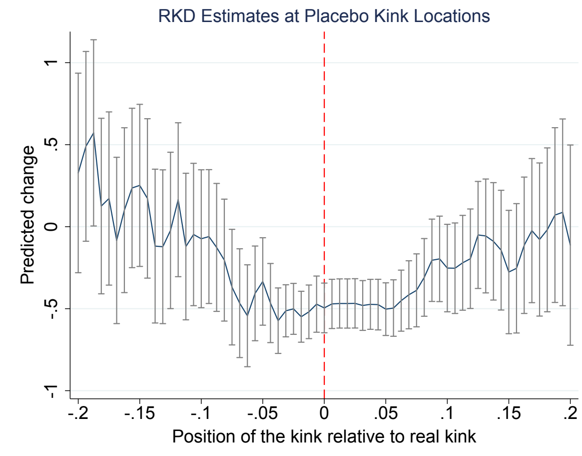
(d) Hazard to exit employment at 63

Figure A4 : R-squares as a function of placebo kinks

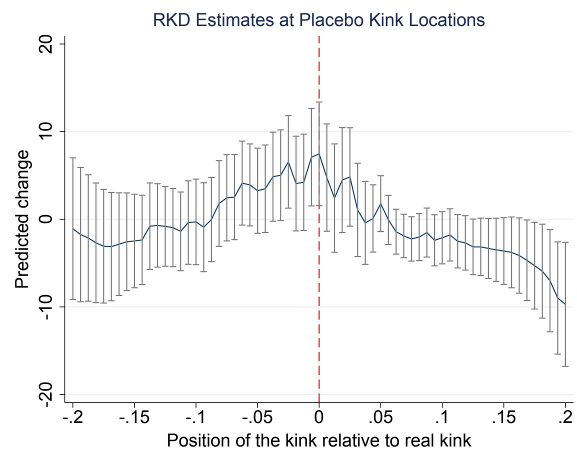
Note: Figure A4 shows the R-squares of the baseline model when the kink is placed at "placebo" locations around the kink. Following Landais (2015), I run regressions of Equation 4 for a series of virtual kink points. I estimate the RKD with placebo kinks range from 0.25 to 0.65. This process produces 65 placebo estimates. This method follows Landais (2015). The solid red line is the true kink and the dashed red line is where R-squares are maximized.



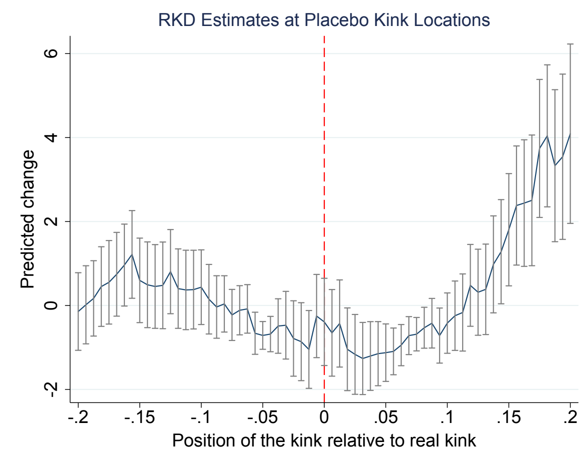
(a) claiming pension



(b) Hazard to claim at 60



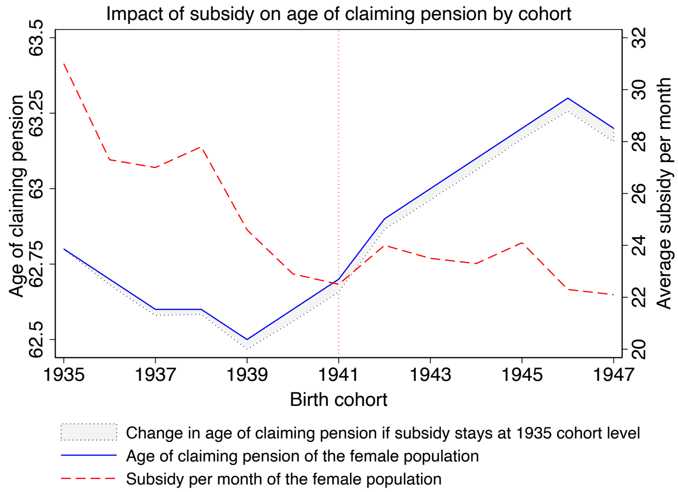
(c) Age at exiting employment



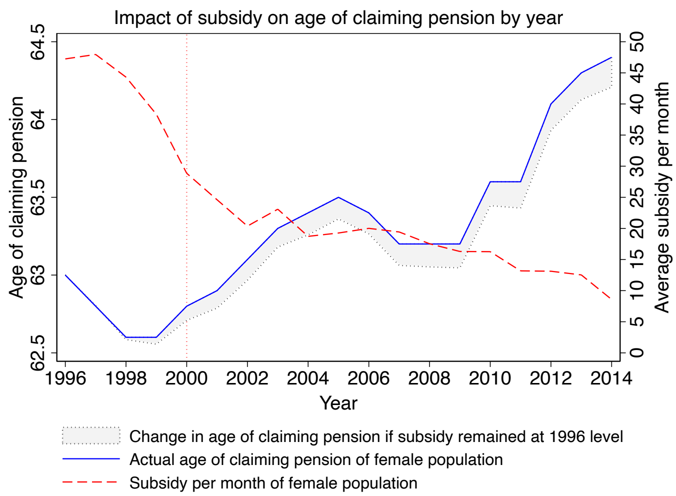
(d) Hazard to exit at 63

Figure A5 : Reduced form estimates at placebo kinks

Note: Figure A5 plots reduced-form estimates and 95 percent confidence intervals by replacing the true kink (normalized to zero) with "placebo" kink locations at other locations of aep_i^{92}. The estimates and standard errors are obtained followingGanong and Jäger (2018). The red dashed line indicates the actual kink. I estimate the RKD with placebo kinks ranging from 0.25 to 0.65. This process produces 65 placebo estimates.



(a) Change in age at claiming pension by cohort



(b) Change in age at claiming pension by year

Figure A6: Policy implication

Note: Figure A6 shows the counter-factual retirement age for female workers if subsidy size remained at the same level as the 1935 cohort and in 1996, respectively. The red dashed lines show that the average subsidy size decreased over time and by cohort. In the meantime, the average age at claiming pension has increased by 1.5 years since the 1990s. The blue dash-dot lines display the profile of age at claiming pension for female cohorts between 1935 and 1948, and for female workers from year 1996 to 2014. Based on the estimate in the paper, I extrapolate age at claiming pension if the subsidy level remained at the average level of the 1935 cohort in Figure A6a; and if the subsidy level remained at the average level of year 1996 in Figure A6b. The corresponding changes in retirement age are shown as the grey area between the black solid line and blue dash-dot line.

Source: The pension claim ages for female workers in West Germany by cohort and by year are obtained from the report "Rentenversicherung in Zeitreihen (Pension insurance in time series)"

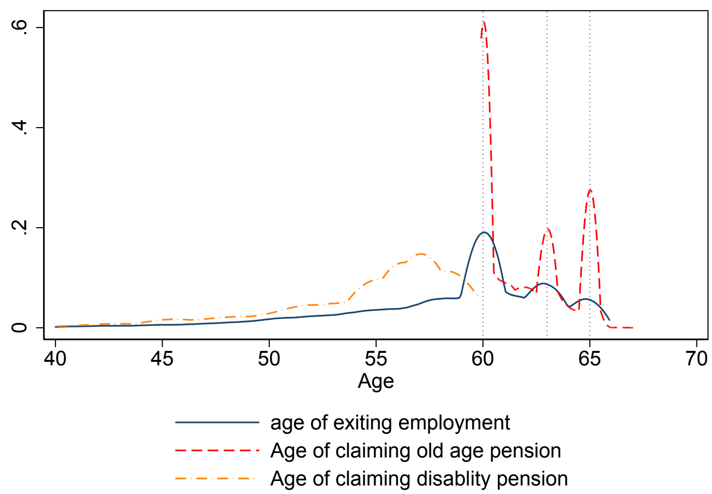


Figure A7: Density of age at exiting and age at claiming of the recipients

Note: Figure A7 plots the recipients' distributions of age at claiming pension (red dashed line), age at exiting employment (blue solid line) and age at claiming disability pension (orange dash dotted line).

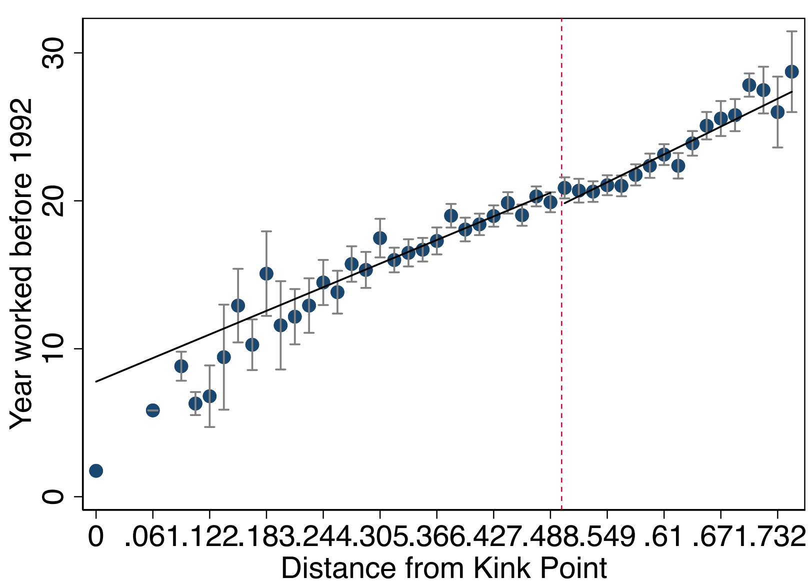
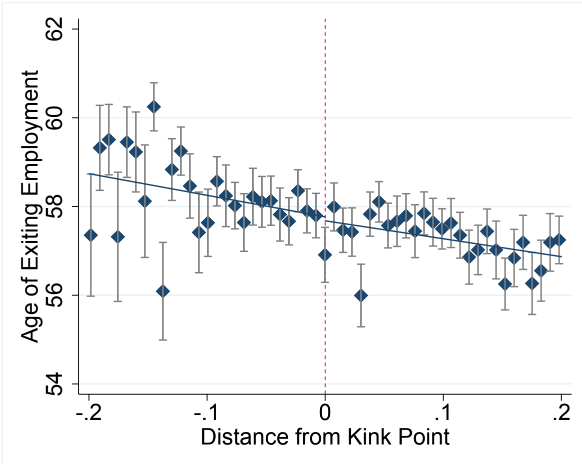
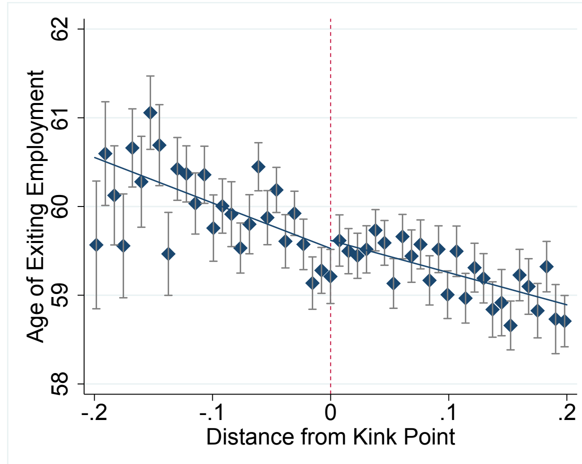


Figure A8: Relationship of $T92$ with aep_i^{92}

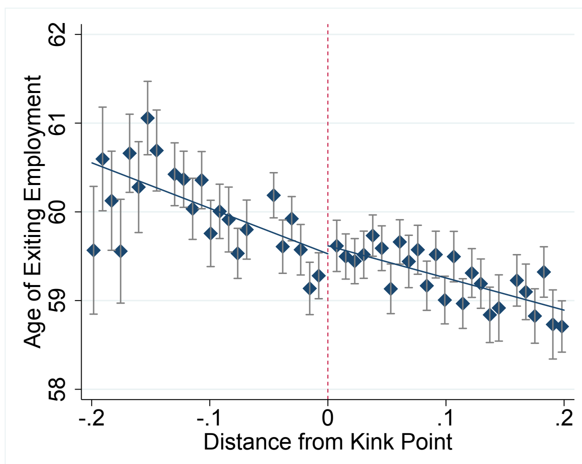
Note: Figure A8 plots the relationship of years worked before 1992 and aep_i^{92}. There is a linear positive relationship of T_i^{92} with aep_i^{92} for the recipients. Also T_i^{92} is more dispersed when aep_i^{92} is low.



(a) Bin plots: age at exiting employment



(b) Bin plots: age at exiting employment (set to missing when less than 50)



(c) Bin plots: age at exiting employment (drop when less than 50)

Figure A9: Scatter Plots of Age at Exiting Employment around the Kink

Note: Figure A9 shows the scatter bin plots of aep_i^{92} in 0.05125 (∼ 40 €in 2010) bins as a function of distance to the observed kink point for three main outcome variables: age at exiting employment (without restrictions), adjusted age at exiting employment (age at exiting employment when set the value to missing for everyone who exits before age 50) and the censored age at exiting employment (age at exiting employment when dropping everyone who exits before age 50). The solid lines are the linear fitted lines.

Table A1: Estimated impacts on labor supply (reduced-form)

	Estimated changes in slope (1)	(2)	(3)	Means at the kink	Sample means	Obs.
First-stage $\Delta\frac{dB}{dr}$						
Monthly subsidies (€100)	-4.943***	-4.893***	-4.623***	98.64	83.27	24796
	(0.197)	(0.187)	(0.100)	(53.79)	(48.59)	
Reduced-Form $\Delta\frac{dY}{dr}$						
Age at claiming old-age pension	2.724***	2.596***	2.291***	61.90	61.92	24796
	(0.856)	(0.842)	(0.838)	(1.97)	(1.98)	
Hazard to claim at age 60	-0.640**	-0.623**	-0.578**	0.36	0.36	24834
	(0.212)	(0.208)	(0.208)	(0.48)	(0.48)	
Hazard to claim at age 63	-0.487†	-0.520†	-0.509†	0.25	0.22	24834
	(0.297)	(0.294)	(0.303)	(0.43)	(0.42)	
Age at claiming disability pension	6.322	6.636	3.460	53.42	53.64	24802
	(6.555)	(6.439)	(5.436)	(6.75)	(6.40)	
Age at exiting employment	0.952	0.750	2.449	57.65	57.63	24834
	(3.168)	(3.171)	(2.966)	(7.20)	(7.16)	
Adjusted/Censored Age at exiting employment	1.382	1.012	0.844	59.56	59.54	24781
	(1.666)	(1.649)	(1.554)	(3.568)	(3.595)	
Hazard to exit at age 60	-0.232	-0.274	-0.313	0.28	0.28	24704
	(0.269)	(0.261)	(0.257)	(0.45)	(0.45)	
Hazard to exit at age 63	-1.026*	-1.017*	-0.951*	0.30	0.26	24690
	(0.444)	(0.435)	(0.453)	(0.46)	(0.44)	
Controls	No	No	Yes			
Cohort Fixed Effect	No	Yes	Yes			

Notes: Standard errors in parentheses † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Subsidies are measured in €100. The results are from local linear regressions with a bandwidth of 0.2 EP around the kink. The adjusted age at exiting employment 50 is the age at exiting employment when setting the value to missing for everyone who exits before age 50. The censored age at exiting employment is the age at exiting employment when dropping individuals who exit before age 50.

Table A2: Estimated impacts on labor supply (additional outcomes)

	Change per €100 more subsidy $\Delta\frac{dY}{dB}$ (1)	(2)	(3)	Means at the kink	Sample means	Obs.
Hazard to claim at age 60	0.129**	0.127**	0.125**	0.36	0.36	24834
	(0.042)	(0.042)	(0.045)	(0.48)	(0.48)	
Hazard to claim at age 63	0.099	0.106†	0.110†	0.25	0.22	24834
	(0.060)	(0.060)	(0.066)	(0.43)	(0.42)	
Hazard to claim at age 65	-0.220	0.022	0.108	0.803	0.803	24826
	(0.322)	(0.243)	(0.256)	(0.398)	(0.398)	
Hazard to exit at age 60	0.047	0.056	0.068	0.28	0.28	24704
	(0.054)	(0.053)	(0.056)	(0.45)	(0.45)	
Hazard to exit at age 63	0.207*	0.208*	0.206*	0.30	0.26	24690
	(0.090)	(0.089)	(0.098)	(0.46)	(0.44)	
Hazard to exit at age 65	-0.327	0.349	0.438	0.709	0.717	24641
	(0.644)	(0.534)	(0.555)	(0.455)	(0.452)	
Retirement rate (age 60-63)	0.156***	0.158***	0.168***	0.537	0.531	24649
	(0.007)	(0.007)	(0.005)	(0.026)	(0.050)	
Retirement rate (age 64-65)	0.061***	0.061***	0.065***	0.878	0.873	24649
	(0.003)	(0.003)	(0.003)	(0.016)	(0.027)	
Retirement rate (age 60-65)	0.098***	0.099***	0.105***	0.651	0.645	24649
	(0.005)	(0.005)	(0.003)	(0.022)	(0.041)	
Employment rate (age 55-59)	-0.035***	-0.036***	-0.0371***	0.701	0.697	24649
	(0.003)	(0.003)	(0.003)	(0.024)	(0.044)	
Employment rate (age 60-65)	-0.041***	-0.042***	-0.045***	0.235	0.235	24649
	(0.003)	(0.003)	(0.003)	(0.017)	(0.043)	
Controls	No	No	Yes			
Cohort Fixed Effect	No	Yes	Yes			

Notes: Standard errors in parentheses † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Subsidies are measured in €100. The results are from local linear regressions with a bandwidth of 0.2 EP around the kink. The adjusted age at exiting employment 50 is the age at exiting employment when setting the value to missing for everyone who exits before age 50. The censored age at exiting employment is the age at exiting employment when dropping individuals who exit before age 50. I drop individuals who exit before age 50 because they are most likely exiting due to sickness rather than financial incentives.

Table A3: Placebo tests using workers with less than 35 credible years (non-recipients)

	Estimated changes in slope (1)	(2)	(3)	Means at the kink	Sample means	Obs.
Reduce form $\Delta\frac{dY}{dr}$						
Age at claiming old-age pension	-0.850	-0.694	-0.558	64.12	64.13	20028
	(0.886)	(0.883)	(0.752)	(1.81)	(1.81)	
Retirement rate (age 55-65)	6.784	6.631	-9.735	0.149	0.148	19993
	(15.014)	(14.453)	(25.705)	(0.016)	(0.015)	
Hazard to claim at age 60	0.032	0.014	0.070	0.10	0.10	20040
	(0.148)	(0.147)	(0.140)	(0.30)	(0.29)	
Hazard to claim at age 63	-0.050	-0.028	-0.053	0.022	0.022	20040
	(0.077)	(0.076)	(0.075)	(0.15)	(0.15)	
Age at claiming disability pension	7.102	6.922	10.914	53.79	53.98	19911
	(8.115)	(7.892)	(6.244)	(5.94)	(5.68)	
Age at exiting employment	-8.550	-8.567	-9.475	49.27	48.68	20040
	(6.346)	(6.324)	(5.970)	(15.14)	(15.46)	
Employment rate (age 55-65)	0.952	0.914	-1.421	0.331	0.325	19993
	(2.278)	(2.166)	(4.000)	(0.027)	(0.039)	
Hazard to exit at age 60	-0.197	-0.228	-0.165	0.107	0.101	19930
	(0.249)	(0.248)	(0.240)	(0.31)	(0.30)	
Hazard to exit at age 63	-0.043	-0.003	-0.048	0.04	0.05	19916
	(0.205)	(0.202)	(0.192)	(0.19)	(0.21)	
Controls	No	No	Yes			
Cohort Fixed Effect	No	Yes	Yes			

Notes: Standard errors in parentheses † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Table A3 provides evidence that the estimated impacts on the main outcome variables are not significant for a placebo group of West Germans women with less than 35 creditable periods (non-recipients). The table shows that there are no significant changes in slope at the kink.

Table A4: Placebo tests using average EP five years after exiting employment as the forcing variable

	Average EP				
	1 year	2 years	3 years	4 years	5 years
	after employment				
	(1)	(2)	(3)	(4)	(5)
First-stage $\Delta\frac{dB}{dr}$					
Monthly subsidies (€100)	-4.820***	-4.804***	-4.800***	-4.794***	-4.781***
	(0.130)	(0.129)	(0.128)	(0.129)	(0.128)
Change per €100 more subsidy $\Delta\frac{dY}{dB}$					
Age at claiming old-age pension	-0.116	-0.103	-0.094	-0.088	-0.101
	(0.212)	(0.210)	(0.209)	(0.210)	(0.210)
Hazard to claim at age 60	0.021	0.016	0.013	0.013	0.018
	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)
Hazard to claim at age 63	0.051	0.049	0.048	0.046	0.038
	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)
Age at claiming disability pension	1.715	0.128	0.049	-1.852	-4.316
	(4.386)	(4.607)	(4.710)	(4.716)	(4.511)
Age at exiting employment	0.469	0.448	0.483	0.453	0.513
	(0.702)	(0.700)	(0.698)	(0.700)	(0.703)
Adjusted Age at exiting employment	0.308	0.290	0.292	0.219	0.220
	(0.367)	(0.364)	(0.363)	(0.361)	(0.361)
Hazard to exit at age 60	-0.051	-0.054	-0.056	-0.058	-0.057
	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)
Hazard to exit at age 63	0.151	0.150	0.148	0.147	0.147
	(0.095)	(0.094)	(0.094)	(0.094)	(0.095)
Controls	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effect	Yes	Yes	Yes	Yes	Yes
Obs	24065	24084	24104	24102	24112

Notes: Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The results show the estimated impacts of 100 euro additional subsidies on labor supply using placebo forcing variables — average annual earnings points post-employment. The estimates are results from local linear regressions with a bandwidth of 0.2 EP around the kink. The standard error is obtained from delta method. Average EPs years after exiting employment are correlated with lifetime income but are not correlated to aep_{92}. The results show that there are no effect in these placebo specifications.

Table A5: The effect of pension subsidies by cohort groups

	Pension claiming age		Hazard rate at age 60	
	(1)	(2)	(3)	(4)
	< 1945	≥ 1945	< 1945	≥ 1945
Change per €100 more subsidy				
$\frac{dY}{dB}$	-0.353†	-0.803*	0.123 *	0.137†
	(0.210)	(0.333)	(0.053)	(0.082)
Controls	Yes	Yes	Yes	Yes
Cohort Fixed Effect	Yes	Yes	Yes	Yes
Obs.	13211	11585	13221	11613

Notes: Standard errors in parentheses $^{\dagger}p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Table A5 examines the impact of the subsidies by two cohort groups: first, no-penalty group and transitional group: cohort 1935 to 1945; and second, the maximum-penalty group: cohort 1945 to 1951. The estimates are obtained from local linear regressions with a bandwidth of 0.2 EP around the kink. I do not find a statistically significant difference between the two groups.

Table A6: Estimated impacts on labor supply using the legal kink

	Change per €100 more subsidy $\Delta\frac{dY}{dB}$			Obs.
	(1)	(2)	(3)	
Age at claiming old-age pension	-0.200	-0.185	-0.147	25005
	(0.210)	(0.209)	(0.199)	
Hazard to claim at age 60	0.098 †	0.094	0.076	24834
	(0.212)	(0.208)	(0.208)	
Hazard to claim at age 63	0.083	0.125	0.099	25039
	(0.079)	(0.078)	(0.078)	
Age at claiming disability pension	1.822	1.074	0.988	25005
	(1.595)	(1.590)	(1.332)	
Adjusted Age at exiting employment	-0.397	-0.413	-0.668	24781
	(0.776)	(0.784)	(0.678)	
Hazard to exit at age 60	-0.028	-0.019	0.019	24909
	(0.071)	(0.070)	(0.065)	
Hazard to exit at age 63	0.296 †	0.322	0.302	24894
	(0.118)	(0.118)	(0.116)	
Controls	No	No	Yes	
Cohort Fixed Effect	No	Yes	Yes	

Notes: Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The results show the estimated impacts of 100 euro additional subsidies on labor supply. The estimates are results from local linear regressions with a bandwidth of 0.2 EP around the legal kink point ($aep_{92} = 0.5$). The standard error is obtained from the delta method.

Table A7: RKD estimates by polynomial orders

	Linear (1)	Quadratic (2)	Cubic (3)
First-stage $\Delta \frac{dB}{dr}$			
Monthly subsidies (€100)	-4,623***	-2,862 ***	-1,822 *
	(0,100)	(0,350)	(0,818)
Change per €100 more subsidy $\Delta \frac{dY}{dB}$			
Age at claiming pension	-0.496 ***	-0.018	0.375
	(0.181)	(1.057)	(4.055)
AIC	100944	100944	100945
BIC	101244	101260	101278
AICc	100944	100944	100946
Hazard to claim at age 60	0.125 **	-0.126	0.091
	(0.045)	(0.266)	(1.019)
AIC	30003	30000	30001
BIC	30303	30316	30334
AICc	30003	30000	30002
Age at exiting employment	-0.530	-7.286 †	-3.920
	(0.643)	(3.977)	(14.572)
AIC	161892	161884	161886
BIC	162192	162200	162219
AICc	161892	161884	161886
Hazard to exit at age 63	0.206 *	0.508	-0.662
	(0.098)	(0.573)	(2.212)
AIC	5146	5143	5144
BIC	5384	5394	5408
AICc	5147	5143	5145
Retirement rate (age 55-65)	0.063***	0.051***	0.190*
	(0.002)	(0.010)	(0.087)
AIC	-143994	-144720	-145067
BIC	-143735	-144444	-144775
AICc	-143994	-144720	-145067
Employment rate (age 55-65)	-0.030***	-0.283***	-0.551*
	(0.003)	(0.038)	(0.248)
AIC	-117964	-119552	-120116
BIC	-117705	-119276	-119824
AICc	-117964	-119552	-120116
Controls	Yes	Yes	Yes
Cohort Fixed Effect	Yes	Yes	Yes
Obs.	24834	24834	24834
Bandwidth	0.2	0.2	0.2

Notes: Standard errors in parentheses † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The results show the estimated impacts of 100 euro additional subsidies on labor supply. The results are estimation results of Equation 4 with a bandwidth of 0.2 EP for a linear, a quadratic and a cubic specification. AIC is Aikake Information Criterion, BIC is Bayesian information criterion and AICc is AIC with a correction for sample sizes.

Table A8: RKD estimates by bandwidth

Change per €100 more subsidy $\Delta\frac{dY}{dB}$	Bandwidth 0.3BW	0.25 BW	0.2BW	0.15BW	0.10BW	0.05BW
Age at claiming pension	-0.336*	-0.338*	-0.496**	-0.503†	-0.449	-1.554
	(0.135)	(0.143)	(0.181)	(0.274)	(0.520)	(2.245)
Hazard to claim at age 60	0.074*	0.068†	0.125**	0.105	0.185	0.117
	(0.034)	(0.035)	(0.045)	(0.069)	(0.134)	(0.580)
Age at exiting employment	0.109	-0.479	-0.530	-1.428	-3.029	-4.107
	(0.486)	(0.490)	(0.643)	(0.967)	(1.870)	(7.854)
Hazard to exit at age 63	0.135†	0.180*	0.206*	0.298*	0.142	-0.680
	(0.075)	(0.076)	(0.098)	(0.145)	(0.292)	(1.253)
Retirement rate (age 55-65)	0.050***	0.048***	0.063***	0.067***	0.079***	0.223***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.045)
Employment rate (age 55-65)	-0.014***	-0.028***	-0.030***	-0.066***	-0.117***	-0.485***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.008)	(0.096)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Cohort Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	27220	26651	24834	21084	15363	8311
Specification	Linear	Linear	Linear	Linear	Linear	Linear

Notes: Standard errors in parentheses † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The results show the estimated impacts of 100 euro additional subsidies on labor supply. The results are estimation results from linear specifications for a bandwidth of 0.3, 0.25, 0.2 , 0.15, 0.10 and 0.05 EP.