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Abstract

To determine how wives' and husbands' retirement options affect their spouses' (and their own) labour supply decisions, we exploit (early) retirement cutoffs by way of a regression discontinuity design. Several German pension reforms since the early 1990s have gradually raised women's retirement age from 60 to 65, but also increased ages for several early retirement pathways affecting both sexes. We use German Socio-Economic Panel data for a sample of couples aged 50 to 69 whose retirement eligibility occurred (i) prior to the reforms, (ii) during the transition years, and (iii) after the major set of reforms. We find that, prior to the reforms, when several retirement options were available to both husbands and wives, both react almost symmetrically to their spouse reaching an early retirement age, that is both husband and wife decrease their labour supply by about 5 percentage points when the spouse reaches age 60. This speaks in favour of leisure complementarities. However, after the set of reforms, when retiring early was much more difficult, we find no more significant labour supply reaction to the spouse reaching a retirement age, whereas reaching one's own retirement age still triggers a significant reaction in labour supply. Our results may explain some of the diverse findings in the literature on asymmetric reactions between husbands and wives to their spouse reaching a retirement age: such reactions may in large parts depend on how flexibly workers are able to retire.

Keywords

Retirement Coordination; Labour Market Participation; Household Decisions; Regression Discontinuity Design

JEL Classification

J22, J26

1 Introduction

Increasing longevity and declining fertility have led many industrialised countries to increase normal retirement ages and make early retirement schemes less generous, thereby motivating individuals to retire later (see Section 4.4.4 in Blundell et al. 2016, for a survey). The literature also emphasises an important context: household-level coordination of labour market exits. Indeed, rising female labour force participation over the last few decades means that retirement decisions might increasingly involve labor market exits of both partners in heterosexual couples. As a result, in addition to directly affecting the targeted individuals, changes in retirement age may also indirectly affect spousal labour supply decisions.

Retirement eligibility of one spouse can affect the labour supply of other spouse through two main channels. First, retirement typically involves income loss to the household. It should increase the labour supply of other household members if leisure is a normal good, thus implying a negative correlation. Second, leisure complementarities may exist, which change the trade-offs between consumption and leisure once one of the spouses retires. It would imply a positive correlation due to coordinated joint retirement (Hurd 1990, Coile 2003). However, instances such adverse health shocks to one spouse may work in opposite directions, which may complicate the identification of the size of retirement coordination.

Our paper contributes to a small but burgeoning literature on couples' retirement coordination that uses exogenous variation in spousal retirement eligibility status (e.g. Lalive and Parrotta 2017, Selin 2017, Stancanelli 2017, Atalay et al. 2019, Bloemen et al. 2019, Kruse 2020, Carta and De Philippis 2021, Johnsen et al. 2022). There is no consensus in the literature, as far as symmetry of reactions of husbands and wives to their respective spouses' retirement is concerned. Early structural studies find a higher response of husbands' reacting to wives' retirement than vice versa (e.g. Zweimüller et al. 1996, Gustman and Steinmeier 2000, Coile 2003, Gustman and Steinmeier 2004, for Austria and for the United States, respectively). This result has been confirmed in some recent studies (e.g. Stancanelli 2017, Carta and De Philippis 2021, for France and for

Italy, respectively). For Australia, however, Atalay et al. (2019) find symmetric effects of two retirement reforms—one for men one for women—on the retirement decisions of the spouses. There are, however, also studies finding only wives reacting to husbands' retirement, but not vice versa (e.g. Lalive and Parrotta (2017), Hersche et al. (2018) for Switzerland, Sand and Lichtman-Sadot (2019) for Israel, and Kruse (2020) for Norway, but see Johnsen et al. (2022) as an exception for Norway when incomes of both spouses are similar). We add to this literature by studying a particularly interesting case of Germany. This case is interesting, because it allows us to isolate the context of early retirement eligibility. In Germany, in early periods of our sample, the costs of retirement coordination were lower than in other countries. Both disproportionately low cuts in benefits in case of early retirement and multiplicity of early retirement options compounded to this relatively low cost. In the subsequent periods of our sample, major reforms reduced the eligibility for early retirement programs.

Using this unique design, we show that the symmetry of spouses' reactions to the other spouses' reaching a retirement age may depend on how flexibly workers can retire. Our results lend support to the leisure complementarity hypothesis for both spouses. We further show that lower or no pension in case of early labour market exit effectively raised the cost of retirement coordination thus preventing joint retirement being an optimal decision. We demonstrate this by showing how spouses' reactions to their partner reaching a typical retirement age differ before and after major early retirement reforms in Germany. In particular, we use household panel data for Germany to estimate the effect of husbands' and wives' crossing key (early) retirement ages on both their own labour supply and the labour supply of their spouse.

In doing so, we exploit two types of natural experiments: first, we estimate multi-cut-off regression discontinuity designs, in that we examine how husbands and wives react when they or their spouses cross key retirement age thresholds, that is early retirement age of 60, 63, and normal retirement age 65. We include these retirement age thresholds for both wives and husbands in both labour supply equations. Based on German administrative data, Seibold (2021) also observes a spike in retirements around these three age thresholds. Bonsang and Van Soest (2020) also use German SOEP data and the same thresholds, but focus on home production. Second, we split the sample into groups of birth cohorts who were (i) not affected by early-retirement reform, (ii) affected by early retirement reforms mainly pertaining to men (because most women in these cohorts could still retire earlier than men) and (iii) affected by early-retirement reforms pertaining to both men and women. The reforms generally delayed the age at which a person could retire for a special reason and still receive a full pension. We control for time-invariant household-specific effects and for survey-year effects in a two-way fixed effects model, and thus take unobserved household and time heterogeneity into account.

We find that with lax early retirement eligibility husbands' and wives' reactions to their spouse reaching early retirement age are almost symmetric: depending on the sample and the specification, when the spouse reaches age 60, between 4.5 and 6.3 percent of husbands (both numbers statistically significant) and between 3.0 and 4.5 percent of wives (only the latter number statistically significant) leave the labour market. Raising the constraints on early retirement diminishes these effects: the estimated coefficients become insignificant except for one group of wives. Consistent with this finding, when early retirement eligibility is constrained, both husbands and wives respond strongly to reaching their own normal retirement eligibility age and less so to their spouses.

Our results thus suggest that there are preferences for joint retirement in couples and they may be roughly symmetric. However, joint retirement of couples is more likely to be observed if the pension system provides flexible early retirement schemes. Once Germany made early retirement more costly, neither husbands nor wives show a significant labour supply response to their partner reaching early retirement eligibility. Instead, their retirement seems to be driven more by their own crossing age thresholds of normal retirement eligibility, which—given age differences in couples—might make joint retirement when one partner crosses the threshold of 60 statistically rare.

The remainder of the paper is structured as follows: Section 2 briefly describes the German pension system and the retirement age reforms exploited in the study, after which Section 3 explains the endogeneity of a wife's labour supply to her husband's labour supply decision and vice versa. Section 4 then introduces the data, Section 5 outlines the regression discontinuity design, and Section 6 reports the empirical results. Section 7 concludes.

2 Institutional Background

Germany has a defined benefit pay-as-you-go pension system with an earnings point system. The point system makes benefits proportional to relative lifetime earnings. The replacement rate depends on the points accumulated throughout the working periods, the points in turn depend on annual earnings relative to the national average. The replacement rate generally does not depend on the life expectancy at retirement. For most of the cohorts studies here, normal retirement eligibility is reached at 65 for both men and women.

Early retirement is possible after age 63 for men and after age 60 if one fulfils certain conditions, which Riphahn and Schrader (2021) terms "retirement entry regimes" or "pathways to retirement". Table 1 exhibits some of the most important pathways to retiring before the "normal" retirement age of 65, which have experienced significant reforms during our study period: one could retire as early as age 60 "due to unemployment", or alternatively at age 63 if one had been "long-term insured" (for at least 35 years) in the public pension system.[1] In 2012, a new pathway to early retirement was introduced for the "very long-term insured" (for at least 45 years) and soon after made more generous, to partially counteract a reform of the pension for the "long-term insured".[2] For reasons of "severe disability", workers were able to retire at age 60. In addition, there exists an even more important programme under which one can retire at any age due to "reduced capacity to work", which we do not list in Table 1. Despite of some reforms concerning eligibility and determination of pension deductions, this pathway to retirement did not

[1] The reforms are described in Steffen (2022), for more detail, we consulted the laws published in BGB (1996), BGB (1997), BGB (2007), and BGB (2014).

[2] In 2014, the pathway to retirement for the "very long-term insured" was made more generous by lowering the early retirement age for some cohorts, such that cohorts born before 1953 could already retire at age 63 if they were eligible for this pathway. But for cohorts born between 1953 and 1964, the retirement age associated with this pathway was successively increased by two months each year to reach 65 again.

experience a change in age restriction for the cohorts we study. The mentioned pathways to retirement existed for both sexes. However, there was an additional retirement option at age 60 for women with at least 10 years of mandatory contributions (since age 40) and at least 15 years of active social security insurance. This option applied to about half of all women (Engels et al. 2017).[3]

Figures 1a and 1b show the shares of new pensions by pathways to retirement for men and women, respectively, during the period 1995 to 2020, using data every 5 years. The figures demonstrate that more than half of new pensions are due to pathways to retirement earlier than at the normal retirement age. This can be seen by comparing the orange area, which shows the share of new pensions due to retirement at the normal retirement age, to the other pathways. Furthermore, the share of the pathways changes over time, which is also due to several pension reforms, some of which we will discuss in the rest of this section.

A common feature of the pathways to early retirement was absence of actuarial discount for earlier retirement. In other words, early eligibility was equivalent to normal eligibility in terms of the replacement rate. The only downward adjustment in pension benefits was due to a lower number of "earnings points" accumulated in total during a shorter working period. In sum, the lack of actuarial pension adjustment made these pathways to early retirement particularly attractive in Germany.

As shown in Table 1, there have been reforms to all the pathways. Broadly, the pattern was to raise the age threshold at which the individuals were allowed to claim a title for a dedicated pathway. By the end of our sample, in most cases this age is equivalent to the normal retirement age. However, for many cohorts it was still possible to retire at the 60 or 63 years of age, but with a downward adjustment in pension benefits of 0.3 percent per month (3.6 percent per year). In particular, for "retirement due to unemployment" and "retirement for women", the age of retirement associated with these pathways has been successively raised from 60 to 65 for the 1937 to 1941 and the 1940 to

[3] For large parts of the sample, especially women who are not working any more, we cannot determine whether they belong(ed) to any of these groups, and so we do not split the sample based on these characteristics.

1944 birth cohorts, respectively, whereas for "retirement due to long-term insurance" the age of retirement associated with this pathway has been successively raised from 63 to 65 for the 1937 to 1938 birth cohorts. The age of retirement during the transition period was usually raised monthly, depending on the month of birth, and the discount on the pension level for retiring at the old early retirement age of 60 or 63 respectively was raised by the above-mentioned 0.3 percent usually each month during the transition period. From the birth cohort 1952 onwards, no early retirement options "due to unemployment" and "for women" exist. A reform in 1999, completely abolished the special early retirement option for women from birth cohorts 1952 and younger (see Geyer and Welteke 2021, Geyer et al. 2020, for an evaluation of the 1999 reform).

3 Theoretical Considerations

Coordinated (joint) retirement is an example of leisure complementarity within a household, one that is theoretically consistent with both unitary and collective household models (see Vermeulen 2002, Vermeulen et al. 2006, for and overview of the two theoretical approaches). Whereas in the unitary model, the household is the unit of analysis, with spouses acting as one unit to optimise their joint utility function; in the collective model, each household member maximises his or her own utility. In this section, therefore, we develop a static model in the spirit of Lalive and Parrotta (2017) to study the labour supply decisions of couples nearing retirement. In this collective model, which contains both cooperative and noncooperative components, each spouse has his or her own utility function (noncooperative element) but they both share joint household consumption (cooperative element), meaning that consumption decisions are not based on their individual incomes. This model is thus one of noncooperative bargaining by which each spouse maximises his or her own utility function subject to the constraint that family consumption does not exceed family income (cooperative element). Our outcome of interest is the effect of one spouse's retirement-relevant characteristics on the other spouse's labour supply decisions (i.e., when to retire), which cross-effect we express as a reduced-form representation.

First, following Gustman and Steinmeier (2000, 2004), we define the wife and husband's respective utility functions as

$$U_w = C + e^{\left(X^w \beta_w + \theta_w L^h + \xi_w\right)} L^w \quad \text{and} \quad U_h = C + e^{\left(X^h \beta_h + \theta_h L^w + \xi_h\right)} L^h. \tag{1}$$

Here, each spouse's utility function depends on the joint lifetime household consumption C, the leisure time of both wife L^w and husband L^h, and the characteristics of each spouse, $X\beta$, which includes age, educational level, and own and spouse's health status, with ξ denoting the individual fixed effect.

After marriage, the two spouses live for a finite T^w and T^h years, respectively, so that $l^w = T^w - L^w$ and $l^h = T^h - L^h$ denote their working years. Both maximize their utility separately subject to the lifetime household budget constraint given by

$$C = W_w(T^w - L^w) + W_h(T^h - L^h) + r(l_w)W_w L^w + r(l_h)W_h L^h + A \tag{2}$$

where W_w and W_h denote the compensation amounts for each spouse who works for l^w and l^h years, of which the pension replacement rate, $r(l)$, is a function. A denotes any joint family assets.

Family decision making proceeds as follows: both spouses first make a decision on lifetime consumption based on the family budget constraint, after which each selects his or her own labour supply taking the other's optimal labour supply as a given to maximize his or her own utility function. As regards labour supply decisions specifically, the wife maximizes (1) subject to (2) obtaining the following first-order condition:

$$e^{\left(X^w \beta_w + \theta_w L^h + \xi_w\right)} = W_w(1 - r(l_w)) - \frac{dr}{dL_w} W_w L^w$$

After an analogous derivation for the husband, we simplify our calculation by assuming that the derivative of r with respect to years of working is close to zero, which allows us to obtain the wife's and husband's optimal leisure time as follows:

$$L^w = T^w - r^{-1}\Big(1 - \frac{e^{\left(X^w\beta_w+\theta_w L^h+\xi_w\right)}}{W_w}\Big) \quad \text{and} \quad L^h = T^h - r^{-1}\Big(1 - \frac{e^{\left(X^h\beta_h+\theta_h L^w+\xi_h\right)}}{W_h}\Big) \tag{3}$$

Equation (3) describes the best response functions by showing that each spouse's labour supply depends on that of their partner, as well as their own characteristics and potentially some of their spouse's. Nonetheless, by demonstrating the interrelation of husbands' and wives' labour supply decisions, the model hints at the potential endogeneity of the wives' labour supply in regressions modelling the husbands' labour force participation. In particular, such endogeneity will cause bias if unobserved factors driving the two spouses' labour supply correlate with each other. We will therefore limit ourselves to estimating reduced-form equations by regressing our proxy for retirement on reaching typical retirement ages (of oneself as well as one's spouse). Because we have no information on number of years in retirement L_w and L_h but do have data on labour force participation, we estimate the effect of a spouse reaching typical retirement ages on the other spouse's labour supply decision.

4 Data and Descriptive Results

We use the German Socio-Economic Panel (SOEP) for 1984–2019 (Goebel et al. 2019).[4] In this data, we identify 27,234 observations for 4,687 couples in which the male partner is aged 55 to 69 and the female partner is aged 50 to 69. Because men are on average older than their wives, we also keep couples in the sample where women are as young as age 50 in order to stabilise our estimates. Our sample also contains cohabiting heterosexual couples, but, for simplicity, we refer to the partners throughout the discussion as husband and wife.[5]

[4] Although Engels et al. (2017) successfully used German pension insurance data to demonstrate that the raised female pension age (and/or early retirement penalties) motivated women to retire later, these data do not enable spousal identification.

[5] Observations where a man is not living with a woman in the same household are deleted from the sample, for example when a couple splits up. For 87 observations, we observe a change in the partner. We have checked that our main results are robust to excluding these 87 and 14 observations where the couple composition changes.

We use couples born within specific birth year intervals, defined on the state of the pension reforms discussed in Section 2. The “Pre-Reform Sample” comprises couples where both husband and wife are born up to the year 1936, as none of the pension reforms affected these cohorts, as shown in Table 2. The “Male Reform Sample” comprises couples where both husband and wife are born between 1937 and 1941. The labelling “Male Reform Sample” is somewhat imprecise, because wives of cohorts 1940 and 1941 are affected by the phasing in of the reform raising the pension age for women. Still, because wives are typically a few years younger than their husbands, we need to have a wide enough interval of birth years to obtain a reasonably representative sample of couples born in this period. Our final sample, the “Male-Female Reform Sample” uses couples from birth cohorts born in 1945 or later. We thus do not use birth cohorts 1942 to 1944 for whom the pension age for women was eventually raised to 65.

In the SOEP data, we observe age to the month, because both the month of interview and the month of birth are recorded in our data. This will be important for the regression discontinuity design below. Couples where one partner’s age is out of the stated ranges are irrelevant to our research design and are hence not included in the sample in the respective calendar years. Because our sample is collected during the years 1984 to 2019, birth cohorts 1915 to 1969 are in the stated age ranges at least some time during this period. For birth cohorts 1930 to 1955 (restricted such to save space), Table A1 of the Appendix reveals which cohorts experience which age during our observation period.

Sample means for these three subsamples are provided in Table 3. As expected, participation rates in the “Male-Female Reform Sample” are higher than in the “Pre-Reform Sample”, because the former cohorts are younger. The gap in participation rates between men and women is larger amongst the older “Pre-Reform Sample”, which also confirms expectations, given recent trends in female labour force participation rates. In all subsamples and for both husbands and wives, we have observations on both sides of the typical retirement age thresholds 60, 63, and 65, as the means of the corresponding dummy variables are always between 0 and 1. Wives on average are between one and two and a half years younger than their husbands.

For our further empirical analysis, we proxy retirement status by using an indicator for whether a person is participating in the labour force (employed or unemployed, a proxy for not being retired) or not (out of the labour force, proxy for being retired). Figure 2 plots labour force participation rates by age for husbands and wives for the three subsamples for our main sampling scheme. For both husbands and wives, labour market participation is higher at virtually every age for the "Male Reform Sample". This difference is larger for wives than for husbands. In addition, for both husbands and wives, we observe that the drop in labour force participation becomes weaker at age 60 and stronger at age 65.[6] A more formal investigation of how husbands and wives react to their own and their spouses' crossing typical retirement ages before and after the implementation of early retirement reforms is examined in the econometric analysis below.

5 Methodology

In examining how the two spouses' labour supply decisions interact, we apply a combined regression discontinuity and two-way fixed effects model. Our approach focuses on the three threshold ages of 60, 63, and 65 for both wives and husbands where retirement becomes increasingly likely.[7] We use these thresholds as the basis for a regression discontinuity design. Then, we estimate an equation that includes second-order polynomials for both husbands' and wives' ages. In our regressions, we thus include six binary indicators: equal to 1 when the wife is at least 60 (AGE^{60w}), 63 (AGE^{63w}), and 65 (AGE^{65w}) years of age; and the husband is at least 60 (AGE^{60h}), 63 (AGE^{63h}), and 65 (AGE^{65h}) years of age, respectively, and zero otherwise. The six discontinuities at the respective

[6]Male labour force participation in the age group 55 to 64 is comparatively high in Germany by OECD standards, with an increasing trend between 2010 and 2019 (OECD 2020). Male labour force participation in this age group was 77 percent according to this source in Germany in 2016, whereas it was 56 , 59, 66, 70, 72, 83, and 86 percent in France, Poland, Italy, USA, UK, Sweden, and Japan in the same year, respectively.

[7]See Bonsang and Van Soest (2020) who uses a similar specification by focusing on these three ages 60, 63, and 65, but does so in a different context of home production and retirement using SOEP data. Based on German administrative data, Seibold (2021) also observes a spike in retirements around these three age thresholds. A paper by Eibich (2015) also uses multiple discontinuities in the context of retirement's effect on health.

age thresholds combined with the continuous second-order polynomials for both spouses' ages constitute our regression discontinuity specification. Furthermore, we control for fixed household-specific effects to take unobserved household heterogeneity into account using SOEP longitudinal household survey data. The dependent variable $participating_{it}$ is a binary indicator for whether or not individual i at year t is participating in the labour force (working or unemployed). The reduced-form estimating equations are as follows:

$$\begin{aligned} participating^h_{it} = \\ & \alpha + \rho^h_1 AGE^{60h}_{it} + \rho^h_2 AGE^{63h}_{it} + \rho^h_3 AGE^{65h}_{it} + \beta^h_1 age^h_{it} + \beta^h_2 (age^h_{it})^2 \\ & + \rho^w_1 AGE^{60w}_{it} + \rho^w_2 AGE^{63w}_{it} + \rho^w_3 AGE^{65w}_{it} + \beta^w_1 age^w_{it} + \beta^w_2 (age^w_{it})^2 \\ & + \theta^h X^h + \theta^w X^w + \mu_i + \lambda_t + \epsilon_{it} \end{aligned} \tag{4}$$

$$\begin{aligned} participating^w_{it} = \\ & \tilde{\alpha} + \tilde{\rho}^w_1 AGE^{60w}_{it} + \tilde{\rho}^w_2 AGE^{63w}_{it} + \tilde{\rho}^w_3 AGE^{65w}_{it} + \tilde{\beta}^w_1 age^w_{it} + \tilde{\beta}^w_2 (age^w_{it})^2 \\ & + \tilde{\rho}^h_1 AGE^{60h}_{it} + \tilde{\rho}^h_2 AGE^{63h}_{it} + \tilde{\rho}^h_3 AGE^{65h}_{it} + \tilde{\beta}^h_1 age^h_{it} + \tilde{\beta}^h_2 (age^h_{it})^2 \\ & + \tilde{\theta}^h X^h + \tilde{\theta}^w X^w + \tilde{\mu}_i + \tilde{\lambda}_t + \tilde{\epsilon_{it}} \end{aligned} \tag{5}$$

where a tilde above a coefficient indicates that $\tilde{\alpha}$ and α are separate coefficients, with the superscripts w and h referring to wives and husbands, respectively. Under the model assumptions, the coefficients ρ^h_1 , ρ^h_2, and ρ^h_3 ($\tilde{\rho}^w_1$, $\tilde{\rho}^w_2$, and $\tilde{\rho}^w_3$) are the own effects of the husband (wife), and ρ^w_1, ρ^w_2, and ρ^w_3 ($\tilde{\rho}^h_1$, $\tilde{\rho}^h_2$, $\tilde{\rho}^h_3$) are the cross effects of the wife (husband) reaching the age thresholds of 60, 63, and 65 on the husband's (wife's) labour force participation probability, respectively. The β coefficients are those of the running variables (age^h and age^w) of the regression discontinuity design and their squares, while the θ coefficients refer to the other control variables. The additional vectors of control variables X^h and X^w include the survey year dummies and each spouse's years of education and satisfaction with personal health.

The main regressions will be accompanied by robustness checks, which will include estimates of the effects using dummy variables for each age in years for own effects, and regression discontinuity estimates for cross effects. This specification is as follows:

$$
\begin{aligned}
participating_{it}^{h} = \\
& \alpha + \sum_{k=56}^{69} \rho_k^h AGE_{it}^{kh} + \beta_1^h age_{it}^h \\
& + \rho_1^w AGE_{it}^{60w} + \rho_2^w AGE_{it}^{63w} + \rho_3^w AGE_{it}^{65w} + \beta_1^w age_{it}^w + \beta_2^w (age_{it}^w)^2 \\
& + \theta^h X^h + \theta^w X^w + \mu_i + \lambda_t + \epsilon_{it}
\end{aligned} \tag{6}
$$

$$
\begin{aligned}
participating_{it}^{w} = \\
& \tilde{\alpha} + \sum_{k=51}^{69} \tilde{\rho}_k^w AGE_{it}^{kw} + \tilde{\beta}_1^w age_{it}^w \\
& + \tilde{\rho}_1^h AGE_{it}^{60h} + \tilde{\rho}_2^h AGE_{it}^{63h} + \tilde{\rho}_3^h AGE_{it}^{65h} + \tilde{\beta}_1^h age_{it}^h + \tilde{\beta}_2^h (age_{it}^h)^2 \\
& + \tilde{\theta}^h X^h + \tilde{\theta}^w X^w + \tilde{\mu}_i + \tilde{\lambda}_t + \tilde{\epsilon_{it}}
\end{aligned} \tag{7}
$$

where $AGE_{it}^{kh}(AGE_{it}^{kw})$ denotes a binary indicator equal to 1 when the husband (wife) i is at least age k at year t. Note that age is measured in months, not in years, so that we still control linearly for age by including the variable age_{it}.

As an additional robustness check, we will perform an alternative specification with dummy variables for each age in years together with the additional control variables included in the main regressions as follows:

$$
\begin{aligned}
participating_{it}^{h} = \\
& \alpha + \sum_{k=56}^{69} \rho_k^h AGE_{it}^{kh} + \beta^h age_{it}^h + \sum_{l=51}^{69} \rho_l^w AGE_{it}^{lw} + \beta^w age_{it}^w \\
& + \theta^h X^h + \theta^w X^w + \mu_i + \lambda_t + \epsilon_{it}
\end{aligned} \tag{8}
$$

$$participating_{it}^{w} = \tilde{\alpha} + \sum_{k=51}^{69} \tilde{\rho}_k^w AGE_{it}^{kw} + \tilde{\beta}^w age_{it}^w + \sum_{l=56}^{69} \tilde{\rho}_l^h AGE_{it}^{lh} + \tilde{\beta}^h age_{it}^h + \tilde{\theta}^h X^h + \tilde{\theta}^w X^w + \tilde{\mu}_i + \tilde{\lambda}_t + \tilde{\epsilon}_{it} \quad (9)$$

All specifications allow for couple fixed effects μ_i and $\tilde{\mu}_i$, calendar year fixed effects λ_t and $\tilde{\lambda}_t$. Standard errors are also clustered at the couple level.

Finally, we will also carry out robustness checks estimating the effects by non-parametric regression discontinuity design with local polynomial regressions. Calonico et al. (2014b) suggest corresponding bias-corrected estimates with mean-square-error-optimal bandwidths and confidence intervals which take into account the additional variability generated by the estimation of the bias correction. These results have been extended to the inclusion of covariates in the local polynomial regressions in Calonico et al. (2019). We will carry out these estimates using the Stata package *rdrobust* provided by the same authors and documented in Calonico et al. (2014a) and Calonico et al. (2017). The estimation strategy employs weighted least squares with kernel weights. With a triangular kernel which we use, the weights decrease towards zero the further away an observation is off the cutoff (see Calonico et al. 2017, p. 376). In our application, we specify a local linear regression for the point estimator and a local quadratic regression for the bias correction. "BW est." in Table A1 in Appendix A refers to the optimal bandwidth of the triangular kernel used in the local polynomial regression. For example, a "BW est." of 2.1 at the cutoff age of 60 means that observations outside of the age interval of 57.9 and 62.1 years will be ignored in the non-parametric local polynomial regressions.

6 Results

Tables 4 shows the reduced-form regression coefficients for the age discontinuities at the typical retirement ages 60, 63 and 65. The first three columns show the labour force participation estimates for husbands, the last three columns the labour force participation for wives. As we are mainly interested in the "cross effects", that is how husbands react to their wives' reaching typical retirement ages and vice-versa, we highlight the cross-effects which are reported in the lower left and upper right parts of the tables. In addition, we graphically display the estimation results by displaying all estimated coefficients (whether statistically significant or not) in Figures 3a and 3b.

As shown in Table 4, in the "Pre-Reform" sample, when the generosity of early retirement schemes still allows workers of both sexes to retire flexibly, both husbands and wives significantly reduce their labour supply when the spouse reaches age 60: wives reduce their labour supply by 4.5 percentage points (significant at the 10 percent level) when the husband reaches age 60, whereas husbands reduce their labour supply by 6.3 percentage points (significant at the 5 percent level), when the wife reaches age 60. Hence, in this setting, the cross effects between husbands and wives are almost symmetric, as found by Atalay et al. (2019) for Australia. As might be expected—as husbands are more than a year older than their wives in the "Pre-Reform" sample —wives also reduce their labour supply by 6.5 percentage points (significant at the 5 percent) level when their husbands reach age 63. The corresponding estimate for husbands when their wives reach age 63 is smaller at statistically insignificant 2.7 percentage points.

How do these almost symmetric cross effects in labour supply (when the spouse reaches age 60) change for the cohorts affected by reforms to the early retirement schemes? As shown in Table 4, the cross effects become much smaller and mostly statistically insignificant, most notably for husbands, but also for wives: for the "Male Reform" and "Male-Female Reform" sample, the coefficients for the wives crossing age 60 are close to zero in the labour supply regression for husbands and not statistically significant. In the regression for wives, the coefficients for the husband crossing age 60 are an insignificant minus 2.2 percentage points in the "Male Reform" and minus 1.7 percentage points (significant at the 10 percent level) in the "Male-Female Reform" sample. Still, the point estimate of minus 1.7 percentage points for the "Male-Female Reform" sample is only slightly more than a third of the point estimate of minus 4.5 percentage points for the

"Pre-Reform" sample. Note that the wives' labour supply reaction to the husbands' crossing the age 63 threshold also becomes close to zero and statistically insignificant in the "Male-Female Reform" sample. These findings confirm that the reforms making early retirement more costly to workers decreased or even eliminated the cross-effects of one spouse reacting to the other crossing an age threshold for an early retirement scheme. It might also have made these cross effects less symmetric by eliminating the husbands' reactions to their wives' crossing age 60, whilst there is still a small reaction of the wives' labour supply to their husbands' crossing the age 60 threshold.

Figures 3a and 3b illustrate these results graphically: they exhibit, for husbands and wives, respectively, the own effects on the left and the cross effects on the right. Whereas the cross effects at age 60 are smaller in the "Male-Female Reform" sample (grey bars) than in the "Pre-Reform" sample (blue bars), the own effects for crossing age 65, that is the normal retirement age, become larger (the bars left of the vertical line in the red box). Table 4 shows that only in the "Male-Female Reform" sample are the own effects for crossing age 65 statistically significant at the 1 percent level. The estimates in Table 4, displayed in Figures 3a and 3b, also show that both husbands and wives react more strongly to their own crossing age 65 than crossing age 60 in the "Male-Female Reform" sample, whereas the reverse is true in the "Pre-Reform" sample. Taken together, this shows that the cohorts in the "Male-Female Reform" sample retired later and reacted more to their own retirement incentives and less to their spouses' crossing early retirement ages.

How robust are our results to a more flexible specification of the age-labour supply profile? In Table 4, we report results of the specifications with dummy variables for each age for own effects, but regression discontinuity estimates for cross effects, which we are most interested in. The estimates are displayed graphically in Figures A1a and A1b in the Appendix. Whereas the point estimates are lower for the own effects (now modelled by dummy variables for each age), the point estimates for the cross effects as well as their statistical significance, are rather similar in Table 4 to our main estimates in Table 3. In particular, point estimates for the cross effects at age 60 in Table 4 are almost identical to the ones in Table 3 for both husbands and wives, at minus 5.2 and minus 4.6 percent, respectively (both significant at the 1 percent level). For the "Male-Female Reform" sample, only the cross effect for wives remains significant, albeit at a low level of minus 1.5 percent.

The results are also robust to modelling the age-labour supply profile by age dummy variables for both own and cross-effects. These results are shown in Table 5. Although most of the own effects are still smaller than our main estimates, the general tendency to retire later after the reforms still prevails for both husbands and wives. Moreover, the cross-effects when the spouse crosses the age 60 threshold are larger than in our main estimates and statistically significant in the "Pre-Reform" samples. In the "Male-Female Reform" and "Post-Reform" samples, however, they become statistically insignificant with almost all estimates close to zero.

6.1 Robustness Analysis: Nonparametric Estimates

As a robustness check, we also estimate the non-parametric local polynomial regression discontinuity estimator without covariate adjustment, as discussed in Section 5.[8] Note that these estimate also do not include fixed effects, as the parametric estimates do. Table A2 in Appendix A summarises the results. As expected, the standard errors of the nonparametric estimates are larger then those of the parametric estimates. The local polynomial estimates partially confirm our results based on a parametric specification, in that the cross effects for the"Pre-Reform" sample are negative and statistically significant for both husbands and wives when the spouse crosses the age 60 threshold, whereas the corresponding estimates move closer to zero and become statistically insignificant in the"Male-Reform" and "Male-Female Reform" samples. The own effects at age 60 are smaller in the "Male-Female Reform" than in the "Pre-Reform" sample, whereas the own effects at age 65, albeit negative, are mostly insignificant, even in the "Male-Female Reform sample".

[8]We obtain a similar result using covariates. The results are available upon request.

6.2 Robustness Analysis: Alternative Sampling Scheme

Only allowing couples in the sample where both spouses are born within a rather short birth year interval raises the question of the representativeness of our sampling procedure. As a robustness check and to take account of the fact that wives tend to be younger than their husbands, we use a second sampling scheme, where we shift the birth year intervals of wives forward by three years. In our second sampling scheme, we observe 14,899 observations for 1,868 couples. Table B1 in Appendix B illustrates the second sampling scheme in connection with the pension age reforms. The "Pre-Reform Sample" thus contains husbands born up to 1936, whereas their wives may be born up to 1939. In such defined couples, neither husbands and wives are affected by any of the discussed pension reforms. The "Transition Sample" contains husbands born between 1937 and 1941 with wives born between 1940 and 1944. Both husbands and wives experienced reforms of early retirement schemes that made retirement at age 60 costlier through discounts in the pension received. The "Post-Reform Sample" consists of husbands born between 1949 and 1953 and wives born between 1952 and 1956. For these couples, the pension reforms discussed here have mostly been completed: women born in 1952 or later could not retire under the "retirement for women" scheme at the age of 60 any more, not even with a discount. For these cohorts, therefore, the available retirement schemes were identical to the ones for men.[9]

The sample means for the subsamples under this alternative sampling scheme are displayed in Table B2: the age gaps between husbands and wives are slightly larger than for the subsamples of the main sampling scheme, namely between about 2 and 3 years.[10] Table B3 shows results analogous to Table 4, estimated on this alternative sampling scheme. Both the qualitative conclusions and the point estimates are similar.

[9]Note that there were still some reforms playing out, such as a very gradual increase of the regular retirement age as well as of the age of retirement under the "retirement due to invalidity" scheme. There were also gradual shifts in the retirement due to "long-term insurance" and "very long-term insurance".

[10]Another fact worth mentioning is that the "Post-Reform Sample" under sampling scheme 2 is of similar size as the first two subsamples of this sampling scheme, whereas the "Male-Female Reform Sample" in our preferred sampling scheme contains many more observations than the first two subsamples under this sampling scheme. The reason is that the "Male-Female Reform Sample" only has an age, but not a year of birth restriction for the younger cohorts, whereas the "Post-Reform Sample" starts with comparatively young birth cohorts and only contains five birth year cohorts for each sex.

While fewer of the cross effects are statistically significant (Table B3), the point estimates largely show similarities to the ones in our main specification (Table 4). The results are confirmed in Tables B4 and B5, which—in analogy to Tables 5 and 6— present estimates of the effects using dummy variables for each age in years for own effects only (Table B4) and dummy variables for each age in both own and cross effects (Table B5), respectively. In Table B5, we observe significant cross effects which are almost symmetric at age 60 in the "Pre-Reform Sample", which become statistically insignificant (and smaller) in the "Transition" and "Post-Reform" samples.

7 Discussion and Conclusions

This paper uses German SOEP data to investigate how husbands and wives react not only to their own reaching a typical (early) retirement age, but also to their spouse's reaching a typical (early) retirement age before and after a period of several early retirement reforms. It is these cross effects that we are mostly interested in. We find evidence for leisure complementarities between husbands and wives in that during the "Pre-Reform" period, when several pathways to early retirement were still relatively accessible, husbands and wives react almost symmetrically to their spouses' reaching age 60 ("cross effects"). The point estimates for a labour market participation indicator regressed on—amongst others—an indicator for the spouse being 60 years of age is around minus 5 percentage points for the "Pre-Reform" period cohorts. This implies that about one in 20 spouses retires when the other spouse reaches age 60. This effect becomes smaller or disappears for the cohorts affected by the early retirement reforms, which have made early retirement costlier. In addition, we observe that wives but even more so husbands increasingly react to the later earlier retirement age 63 and the normal retirement age of 65 ("own effects") during and after the course of the retirement reforms.

Our results suggest that some findings in the literature on the asymmetry of cross effects, in that husbands might react to wives' reaching a retirement age differently than vice versa, cannot simply be interpreted as evidence of asymmetric leisure complementarities, as observed labour supply choices depend both on preferences and constraints. The contribution of our paper is to show that the observed symmetry of these cross effects during a period of very flexible and generous early retirement disappears after early retirement reforms in Germany, which made early retirement costlier and less flexible. As the slight variation of the results between sampling schemes shows, age differences between spouses, which we implicitly control for in our regressions, may also play a role. Our main results are robust to different functional form specifications and an alternative sampling scheme.

References

Atalay, K., Barrett, G. F. and Siminski, P.: 2019, Pension incentives and the joint retirement of couples: Evidence from two natural experiments, *Journal of Population Economics* **32**(3), 735–767.

BGB: 1996, Gesetz zur Umsetzung des Programms für mehr Wachstum und Beschäftigung in den Bereichen der Rentenversicherung und Arbeitsförderung (Wachstums- und Beschäftigungsförderungsgesetz - WFG), Bundesgesetzblatt, Teil I Nr. 48, Bonn, 27. September 1996.

BGB: 1997, Gesetz zur Reform der Arbeitsförderung (Arbeitsförderungs-Reformgesetz - AFRG), Bundesgesetzblatt, Teil I Nr. 20, Bonn, 27. März 1997.

BGB: 2007, Gesetz zur Anpassung der Regelaltersgrenze an die demografische Entwicklung und zur Stärkung der Finanzierungsgrundlagen der gesetzlichen Rentenversicherung (RV-Altersgrenzenanpssungsgesetz), Bundesgesetzblatt, Teil I Nr. 16, Bonn, 20. April 2007.

BGB: 2014, Gesetz über Leistungsverbesserungen in der gesetzlichen Rentenversicherung (RV-Leistungsverbesserungsgesetz), Bundesgesetzblatt, Teil I Nr. 27, Bonn, 20. April 2014.

Bloemen, H., Hochguertel, S. and Zweerink, J.: 2019, The effect of incentive-induced retirement on spousal retirement rates: Evidence from a natural experiment, *Economic Inquiry* **57**(2), 910–930.

Blundell, R., French, E. and Tetlow, G.: 2016, Retirement incentives and labor supply, *in* J. Piggott and A. Woodland (eds), *Handbook of the Economics of Population Aging*, Vol. 1, Elsevier, pp. 457–566.

Bonsang, E. and Van Soest, A.: 2020, Time devoted to home production and retirement in couples: a panel data analysis, *Labour Economics* **65**, 101810.

Calonico, S., Cattaneo, M. D., Farrell, M. H. and Titiunik, R.: 2017, rdrobust: Software for regression-discontinuity designs, *The Stata Journal* **17**(2), 372–404.

Calonico, S., Cattaneo, M. D., Farrell, M. H. and Titiunik, R.: 2019, Regression discontinuity designs using covariates, *Review of Economics and Statistics* **101**(3), 442–451.

Calonico, S., Cattaneo, M. D. and Titiunik, R.: 2014a, Robust data-driven inference in the regression-discontinuity design, *The Stata Journal* **14**(4), 909–946.

Calonico, S., Cattaneo, M. D. and Titiunik, R.: 2014b, Robust nonparametric confidence intervals for regression-discontinuity designs, *Econometrica* **82**(6), 2295–2326.

Carta, F. and De Philippis, M.: 2021, Working horizon and labour supply: the effect of raising minimum retirement age on middle-aged individuals, *Bank of Italy, Discussion Paper* (1314).

Coile, C.: 2003, Retirement incentives and couples' retirement decisions, *Technical report*, National Bureau of Economic Research.

Eibich, P.: 2015, Understanding the effect of retirement on health: Mechanisms and heterogeneity, *Journal of Health Economics* **43**, 1–12.

Engels, B., Geyer, J. and Haan, P.: 2017, Pension incentives and early retirement, *Labour Economics* **47**, 216–231.

Geyer, J., Haan, P., Hammerschmid, A. and Peters, M.: 2020, Labor market and distributional effects of an increase in the retirement age, *Labour Economics* **65**, 101817.

Geyer, J. and Welteke, C.: 2021, Closing routes to retirement for women: How do they respond?, *Journal of Human Resources* **56**(1), 311–341.

Goebel, J., Grabka, M. M., Liebig, S., Kroh, M., Richter, D., Schröder, C. and Schupp, J.: 2019, The German Socio-Economic Panel (SOEP), *Jahrbücher für Nationalökonomie und Statistik* **239**(2), 345–360.

Gustman, A. L. and Steinmeier, T. L.: 2000, Retirement in dual-career families: A structural model, *Journal of Labor Economics* **18**(3), 503–545.

Gustman, A. L. and Steinmeier, T. L.: 2004, Social security, pensions and retirement behaviour within the family, *Journal of Applied Econometrics* **19**(6), 723–737.

Hersche, M., Moor, E. and Bloemen, H.: 2018, Labor or leisure? Labor supply of older couples and the role of full retirement age, *Technical report*, Tilburg University, Netspar.

Hurd, M. D.: 1990, The joint retirement decision of husbands and wives, *Issues in the Economics of Aging*, University of Chicago Press, 1990, pp. 231–258.

Johnsen, J. V., Vaage, K. and Willén, A.: 2022, Interactions in public policies: Spousal responses and program spillovers of welfare reforms, *The Economic Journal* **132**(642), 834–864.

Kruse, H.: 2020, Joint retirement in couples: Evidence of complementarity in leisure, *The Scandinavian Journal of Economics* .
URL: *http://doi.org/10.1111/sjoe.12427*

Lalive, R. and Parrotta, P.: 2017, How does pension eligibility affect labor supply in couples?, *Labour Economics* **46**, 177–188.

OECD: 2020, *OECD Labour Force Statistics 2020*, OECD Publishing, Paris.
URL: *https://www.oecd-ilibrary.org/content/publication/5842cc7f-en*

Riphahn, R. T. and Schrader, R.: 2021, Reforms of an early retirement pathway in germany and their labor market effects, *Journal of Pension Economics & Finance* pp. 1–27.

Sand, E. and Lichtman-Sadot, S.: 2019, The effects of a retirement age reform on couples' labor supply decisions, *Bank of Israel Discussion Paper* **2019**(13).

Seibold, A.: 2021, Reference points for retirement behavior: Evidence from german pension discontinuities, *American Economic Review* **111**(4), 1126–65.

Selin, H.: 2017, What happens to the husband's retirement decision when the wife's retirement incentives change?, *International Tax and Public Finance* **24**(3), 432–458.

Stancanelli, E.: 2017, Couples' retirement under individual pension design: A regression discontinuity study for France, *Labour Economics* **49**, 14–26.

Steffen, J.: 2022, Sozialpolitische Chronik, Berlin.
URL: *http://www.portal-sozialpolitik.de*

Vermeulen, F.: 2002, Collective household models: Principles and main results, *Journal of Economic Surveys* **16**(4), 533–564.

Vermeulen, F., Bargain, O., Beblo, M., Beninger, D., Blundell, R., Carrasco, R., Chiuri, M.-C., Laisney, F., Lechene, V., Moreau, N. et al.: 2006, Collective models of labor supply with nonconvex budget sets and nonparticipation: A calibration approach, *Review of Economics of the Household* **4**(2), 113–127.

Zweimüller, J., Winter-Ebmer, R. and Falkinger, J.: 1996, Retirement of spouses and social security reform, *European Economic Review* **40**(2), 449–472.

Table 1
Sketch of Reforms of (Early) Retirement Schemes

Born	**1934**	**1935**	**1936**	**1937**	**1938**	**1939**	**1940**	**1941**	**1942**	**1943**	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
60 in	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
65 in	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Ret. due to unemployment	60	60	60	61	62	63	64	65	65										x
Early retirement with a discount				60	60	60	60	60	60	60	60	60	61	62	63	63	63	63	x
Ret. due to long-term insurance	63	63	63	64	65	65	65	65	65	65	65	65	65	65	65	65.25	65.33	65.42	65.50
Early retirement with a discount				63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Ret. due to very long-term insurance																65	64	63	63
Early retirement with a discount																			
Ret. due to invalidity	60	60	60	60	60	60	60	61	62	63	63	63	63	63	63	63	63	63	63.5
Early retirement with a discount								60	60	60	60	60	60	60	60	60	60	60	60.5
Ret. for women	60	60	60	60	60	60	61	62	63	64	65	65	65	65	65	65	65	65	x
Early retirement with a discount							60	60	60	60	60	60	60	60	60	60	60	60	x
Normal retirement age	65	65	65	65	65	65	65	65	65	65	65	65	65	65.08	65.17	65.25	65.33	65.42	65.50

Source: Table created on the basis of information taken from Steffen (2022) and the following laws: BGB (1996), BGB (1997), BGB(2007), and BGB (2014).

Table 2
Graphical Illustration of Sampling Scheme 1 Based on Sketch of Reforms of (Early) Retirement Schemes

	Pre-Reform Sample			Male Reform Sample					Not in Sample			Male-Female Reform Sample							
Born	**1934**	**1935**	**1936**	**1937**	**1938**	**1939**	**1940**	**1941**	**1942**	**1943**	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
60 in	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
65 in	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Ret. due to unemployment	60	60	60	61	62	63	64	65	65										x
Early retirement with a discount				60	60	60	60	60	60	60	60	60	61	62	63	63	63	63	x
Ret. due to long-term insurance	63	63	63	64	65	65	65	65	65	65	65	65	65	65	65	65.25	65.33	65.42	65.50
Early retirement with a discount				63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Ret. due to very long-term insurance																65	64	63	63
Early retirement with a discount																			
Ret. due to invalidity	60	60	60	60	60	60	60	61	62	63	63	63	63	63	63	63	63	63	63.5
Early retirement with a discount								60	60	60	60	60	60	60	60	60	60	60	60.5
Ret. for women	60	60	60	60	60	60	61	62	63	64	65	65	65	65	65	65	65	65	x
Early retirement with a discount							60	60	60	60	60	60	60	60	60	60	60	60	x
Normal retirement age	65	65	65	65	65	65	65	65	65	65	65	65	65	65.08	65.17	65.25	65.33	65.42	65.50

Source: Table created on the basis of information taken from Steffen, Johannes (2022): Sozialpolitische Chronik, Berlin, http://www.portal-sozialpolitik.de and the laws cited therein.

Table 3
Sample Means – Sampling Scheme 1 (Same Birth Cohorts Limits)

	Pre-Reform	Male-Reform	Male-Female Reform
husband participating	0.31	0.34	0.66
wife participating	0.18	0.25	0.64
age husband	63.84	63.21	60.91
age wife	62.37	62.33	58.14
husband older than 60	0.79	0.77	0.52
husband older than 63	0.60	0.54	0.30
husband older than 65	0.45	0.36	0.19
wife older than 60	0.68	0.71	0.33
wife older than 63	0.49	0.46	0.16
wife older than 65	0.34	0.29	0.09
years of education husband	11.23	11.87	12.73
years of education wife	10.16	10.98	12.21
health husband	6.07	6.11	6.22
health wife	5.92	5.99	6.28
calendar year	19.94	20.02	20.13
Observations	4,577	3,813	18,844
Number of households	536	427	3,724

Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Table 4
Sampling Scheme 1 - Regression Coefficients of the Age Thresholds

	Regressions for Husbands			Regressions for Wives		
	Pre-Reform	Male-Reform	Male-Female Reform	Pre-Reform	Male-Reform	Male-Female Reform
Age60_h	-0.222***	-0.241***	-0.061***	-0.045*	-0.022	-0.017*
	(.031)	(.035)	(.01)	(.026)	(.032)	(.009)
Age63_h	-0.164***	-0.103***	-0.179***	-0.065***	-0.058*	-0.012
	(.026)	(.029)	(.014)	(.019)	(.026)	(.012)
Age65_h	-0.041**	-0.025	-0.147***	-0.005	0.003	-0.008
	(.018)	(.025)	(.017)	(.014)	(.017)	(.013)
Age60_w	-0.063**	-0.007	-0.005	-0.226***	-0.334***	-0.076***
	(.029)	(.033)	(.013)	(.03)	(.038)	(.012)
Age63_w	-0.027	-0.017	-0.015	-0.009	0.003	-0.144***
	(.023)	(.027)	(.017)	(.016)	(.023)	(.016)
Age65_w	-0.013	0.021	0.016	0.009	0.002	-0.064***
	(.018)	(.02)	(.018)	(.013)	(.019)	(.018)
Observations	4,577	3,813	18,844	4,577	3,813	18,844

Notes: The table shows regression discontinuity estimates for the age 60, 63, and 65 thresholds for both husbands ("_h") and wives ("_w"). The regressions also contain a second-order polynomial for both husbands' and wives' age, couple and calendar year fixed effects, as well as husbands' and wives' years of education and subjective health indicators. Standard errors are in parentheses and clustered by person identifier. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Table 5
Sampling Scheme 1 – Specification with Dummy Variables for Each Age in Years for Own Effects and Regression Discontinuity Estimates for Cross Effects – Only Coefficients of Key Own and Spouse's Age Threshold Effects Reported

	Regressions for Husbands			Regressions for Wives		
	Pre-Reform	Male-Reform	Male-Female Reform	Pre-Reform	Male-Reform	Male-Female Reform
Age60_h	-0.182***	-0.213***	-0.009	-0.046*	-0.023	-0.015*
	(0.039)	(0.039)	(0.014)	(0.027)	(0.032)	(0.009)
Age63_h	-0.118***	-0.086**	-0.107***	-0.064***	-0.048*	-0.003
	(0.034)	(0.034)	(0.018)	(0.019)	(0.026)	(0.012)
Age65_h	-0.030	-0.055	-0.101***	-0.003	0.003	0.001
	(0.028)	(0.035)	(0.020)	(0.014)	(0.017)	(0.014)
Age60_w	-0.052*	0.007	0.005	-0.260***	-0.314***	-0.041**
	(0.030)	(0.033)	(0.013)	(0.038)	(0.041)	(0.016)
Age63_w	-0.022	-0.013	-0.009	-0.034	0.016	-0.107***
	(0.023)	(0.027)	(0.017)	(0.026)	(0.031)	(0.020)
Age65_w	-0.015	0.016	0.008	-0.011	-0.012	-0.075***
	(0.018)	(0.020)	(0.018)	(0.026)	(0.030)	(0.020)
Observations	4,577	3,813	18,844	4,577	3,813	18,844

Notes: Standard errors are in parentheses and clustered by person identifier. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Table 6
Sampling Scheme 1 – Specification with Dummy Variables for Each Age in Years – Only Coefficients of Key Own and Spouse's Age Threshold Effects Reported

	Regressions for Husbands			Regressions for Wives		
	Pre-Reform	Male-Reform	Male-Female Reform	Pre-Reform	Male-Reform	Male-Female Reform
Age60_h	-0.186***	-0.214***	-0.011	-0.093***	-0.001	-0.006
	(0.039)	(0.039)	(0.014)	(0.032)	(0.042)	(0.014)
Age63_h	-0.117***	-0.082**	-0.108***	-0.106***	-0.022	0.004
	(0.035)	(0.035)	(0.018)	(0.027)	(0.031)	(0.015)
Age65_h	-0.029	-0.054	-0.101***	-0.053*	0.005	0.002
	(0.028)	(0.035)	(0.020)	(0.027)	(0.030)	(0.017)
Age60_w	-0.075**	-0.020	0.019	-0.261***	-0.309***	-0.040**
	(0.033)	(0.037)	(0.016)	(0.038)	(0.041)	(0.016)
Age63_w	-0.043	-0.023	0.011	-0.035	0.020	-0.108***
	(0.031)	(0.035)	(0.019)	(0.026)	(0.031)	(0.020)
Age65_w	-0.053*	0.001	0.016	-0.012	-0.013	-0.076***
	(0.028)	(0.033)	(0.020)	(0.026)	(0.030)	(0.020)
Observations	4,577	3,813	18,844	4,577	3,813	18,844

Notes: Standard errors are in parentheses and clustered by person identifier. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

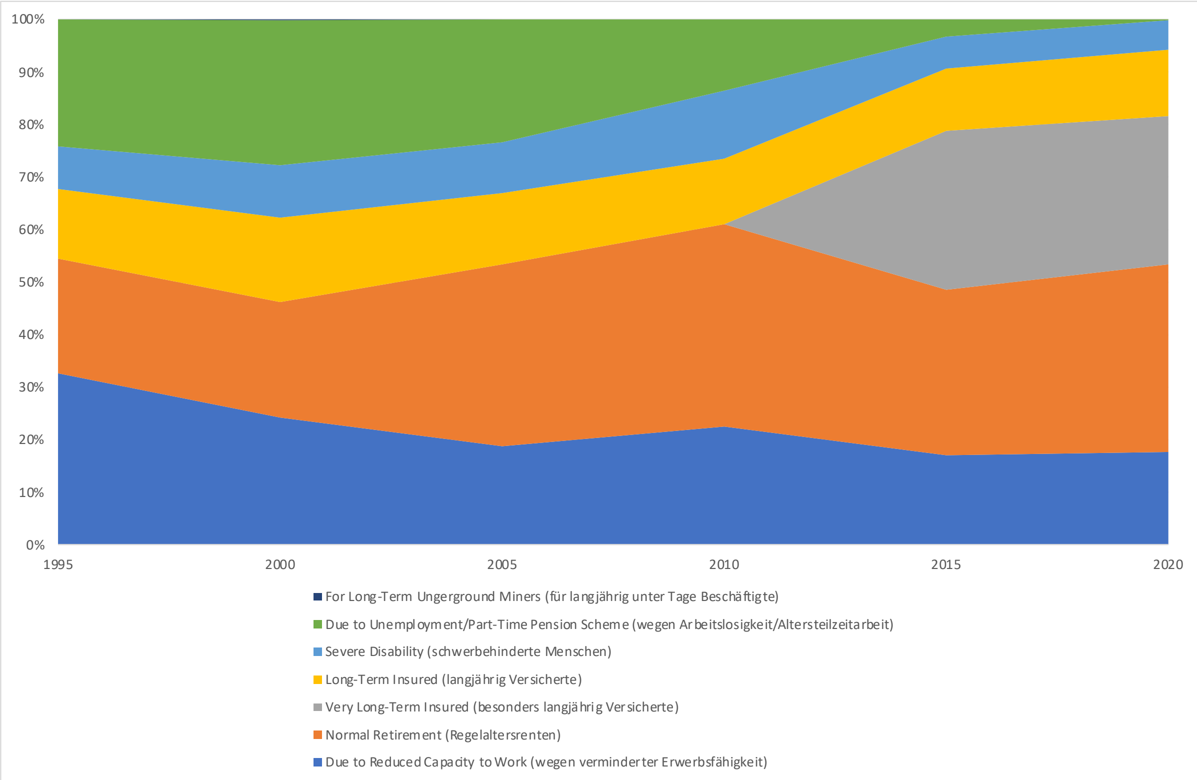

Fig. 1a. New Pensions by Pension Type/Pathway to Retirement – Men

Source: Deutsche Rentenversicherung (2021), p.63; own illustration based on data every five years.

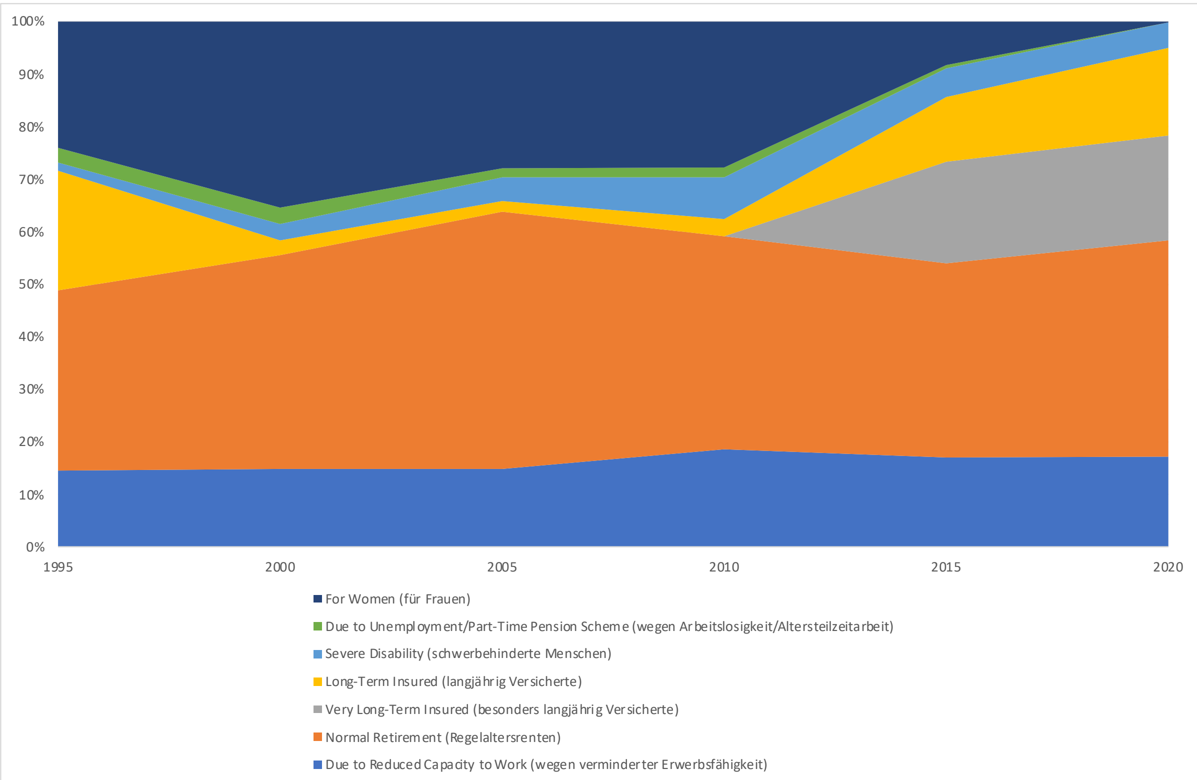

Fig. 1b. New Pensions by Pension Type/Pathway to Retirement – Women
Source: Deutsche Rentenversicherung (2021) , p.64; own illustration based on data every five years.

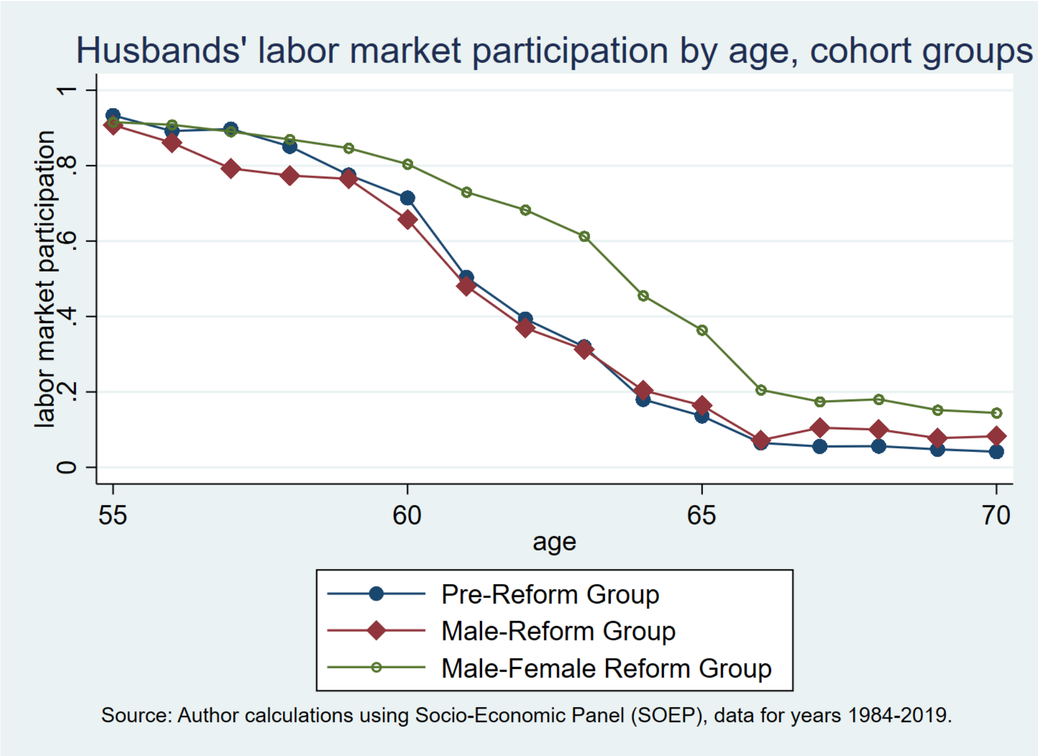

Fig. 2a. Sampling Scheme 1 – Husbands' Labor Force Participation by Age
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

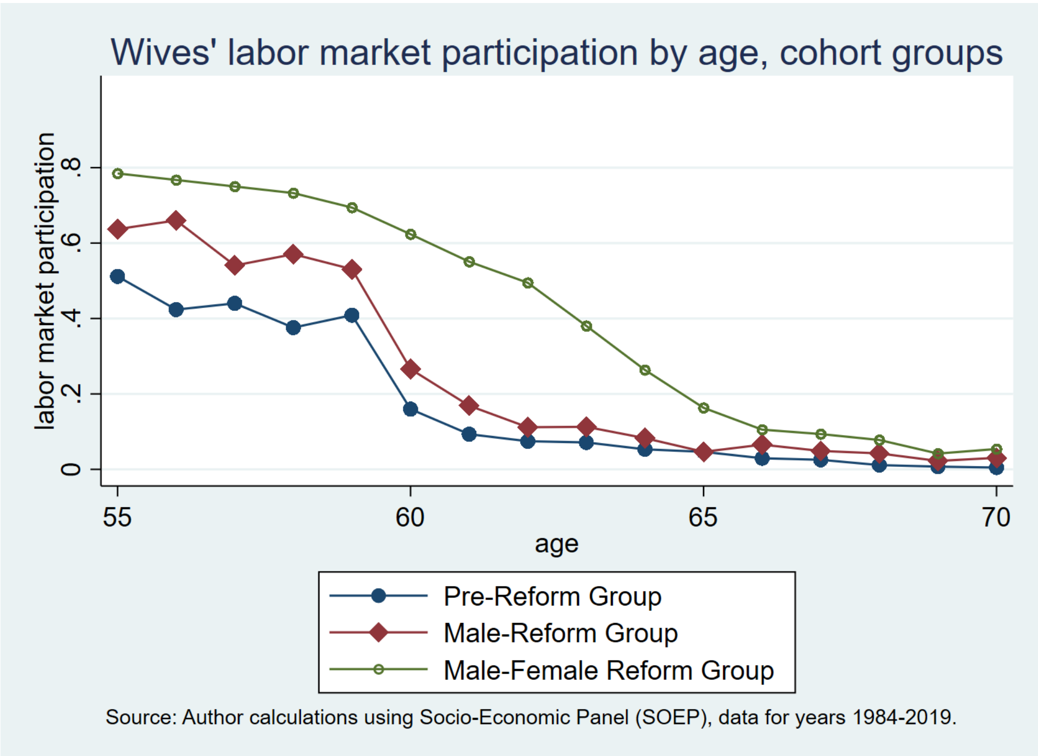

Fig. 2b. Sampling Scheme 1 – Wives' Labor Force Participation by Age
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

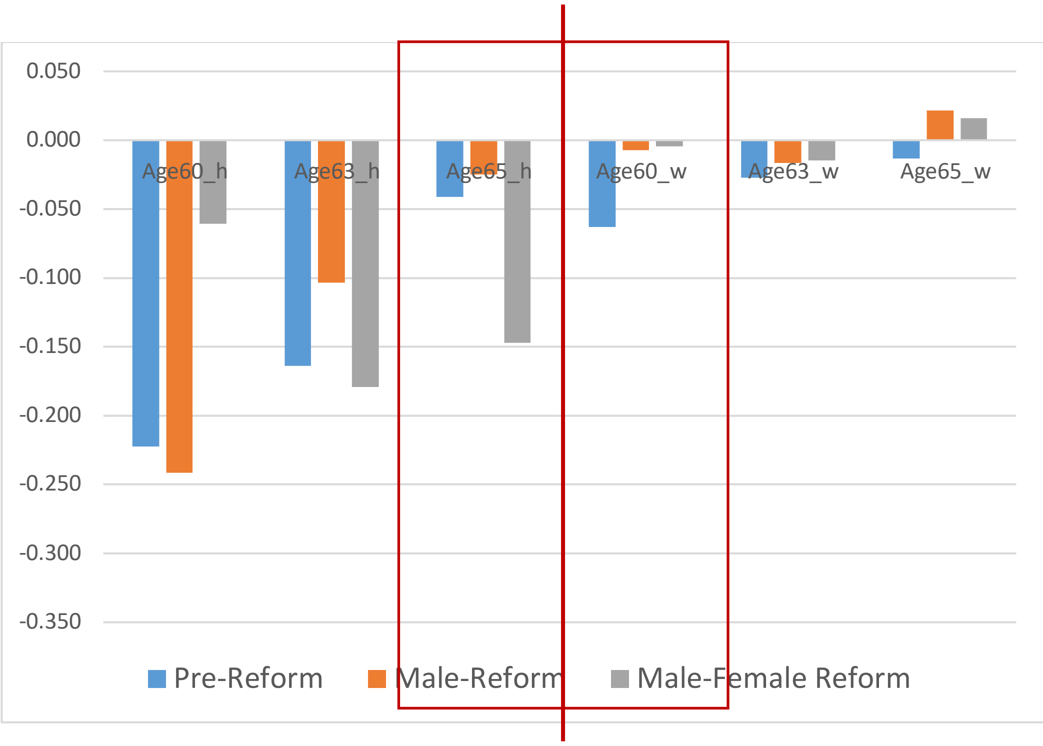

Fig. 3a. Sampling Scheme 1 - Husbands' Own Effects on the Left – Wives' Effects on Husband on the Right – Fixed Effects estimates
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Fig. 3b. Sampling Scheme 1 - Wives' Own Effects on the Left – Husbands' Effects on Wives on the Right – Fixed Effects estimates
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Online Appendix A – Additional Material
Table A1
Age by Year of Birth and Calendar Year for Selected Cohorts

calendar year/ year of birth	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
1984	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29
1985	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30
1986	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31
1987	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
1988	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
1989	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34
1990	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35
1991	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36
1992	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37
1993	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38
1994	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39
1995	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40
1996	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41
1997	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42
1998	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43
1999	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44
2000	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45
2001	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46

continued on the next page.

Table A1 (continued)
Age by Year of Birth and Calendar Year for Selected Cohorts

calendar year/ year of birth	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
2002	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47
2003	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
2004	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
2005	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50
2006	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51
2007	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52
2008	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53
2009	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54
2010	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55
2011	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56
2012	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57
2013	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58
2014	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59
2015	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60
2016	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61
2017	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62
2018	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63
2019	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64

Notes: Husbands' age range is marked in blue; wives' age range is marked in blue and red.

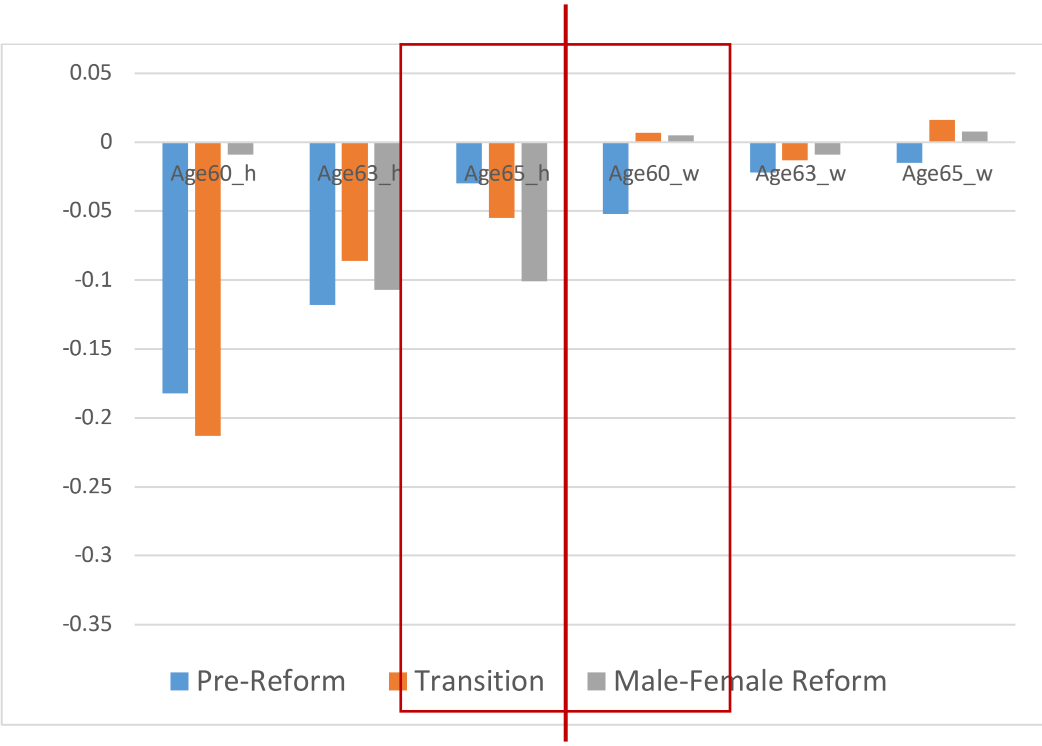

Fig. A1a. Sampling Scheme 1 - Husbands' Own Effects on the Left – Wives' Effects on Husband on the Right – Fixed Effects estimates – Specification with Annual Dummy Variables for Each Age
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

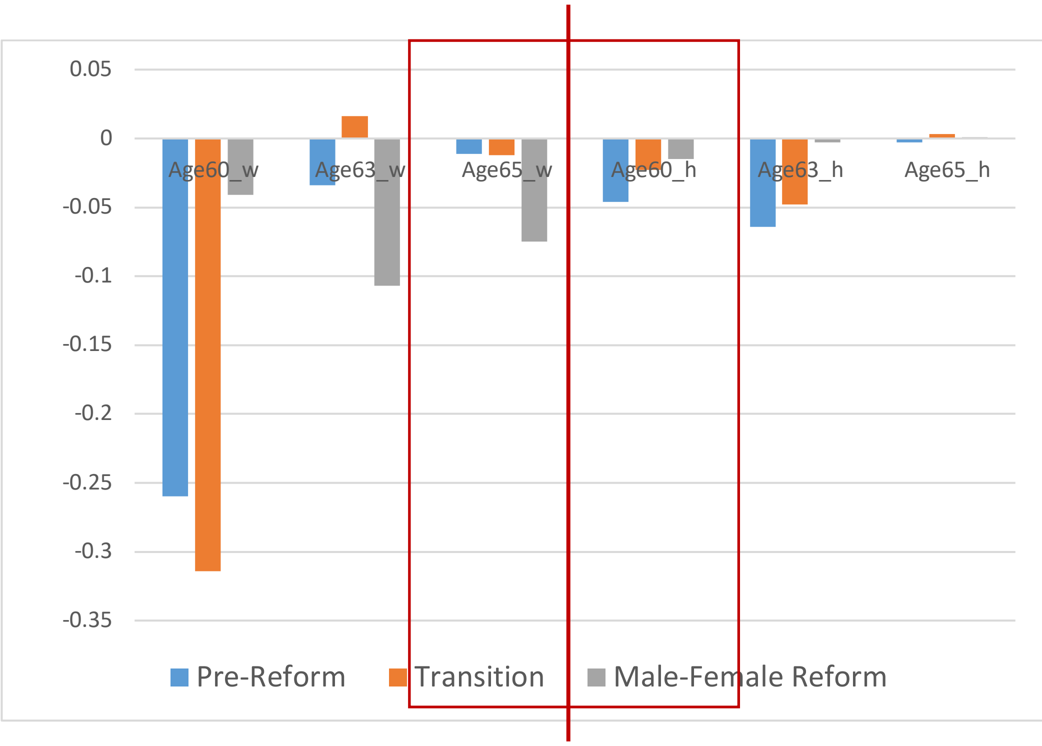

Fig. A1b. Sampling Scheme 1 - Wives' Own Effects on the Left – Husbands' Effects on Wives on the Right – Fixed Effects estimates – Specification with Annual Dummy Variables for Each Age
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Table A2
Robustness Checks Using Nonparametric Local Polynomial Regression

	Regressions for Husbands			Regressions for Wives		
	Pre-Reform	Male-Reform	Male-Female-Reform	Pre-Reform	Male-Reform	Male-Female-Reform
Age60_h	-0.167***	-0.200***	0.004	-0.134**	-0.053	0.001
	(.059)	(.063)	(.022)	(.063)	(.087)	(.023)
BW est.	2.1	2.2	1.9	1.8	1.3	2.1
Age63_h	-0.213***	-0.024	-0.049*	-0.095**	0.018	0.022
	(.065)	(.048)	(.029)	(.041)	(.041)	(.026)
BW est.	1.4	2.2	2.1	2.4	2.5	2.8
Age65_h	-0.064*	-0.058	-0.011	0.030	0.059*	0.053
	(.037)	(.046)	(.041)	(.032)	(0.032)	(.039)
BW est.	1.7	1.5	1.3	2.1	1.8	1.5
Age60_w	-0.088*	0.046	0.003	-0.249***	-0.267***	-0.066**
	(.051)	(.055)	(.024)	(.044)	(.049)	(.028)
BW est.	3.6	3.1	3.1	3.4	3.6	2.1
Age63_w	-0.036	-0.003	0.000	-0.002	0.014	-0.081**
	(.042)	(.044)	(.033)	(.031)	(.042)	(.038)
BW est.	3.0	2.8	2.3	1.6	1.5	1.7
Age65_w	-0.013	0.028	0.043	-0.002	-0.034	-0.031
	(.042)	(.043)	(.041)	(.024)	(.029)	(.037)
BW est.	1.5	1.8	1.6	1.8	1.9	1.7

Notes: BW est. is an optimal bandwidth estimate on both sides of the cutoff using the mean square error-optimal bandwidth selector for the regression discontinuity treatment effect estimator method. Standard errors are in parentheses and clustered by person identifier. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively. *Source*: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Online Appendix B – Robustness Checks – Sampling Scheme 2

Table B1

Graphical Illustration of Sampling Scheme 2 Based on Sketch of Reforms of (Early) Retirement Schemes

	Pre-Reform Sample						Transition Sample					Not in Sample				Post-Reform Sample			
Born	**1934**	**1935**	**1936**	**1937**	**1938**	**1939**	**1940**	**1941**	**1942**	**1943**	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
60 in	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
65 in	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Ret. due to unemployment	60	60	60	61	62	63	64	65	65										x
Early retirement with a discount				60	60	60	60	60	60	60	60	60	61	62	63	63	63	63	x
Ret. due to long-term insurance	63	63	63	64	65	65	65	65	65	65	65	65	65	65	65	65.25	65.33	65.42	65.50
Early retirement with a discount				63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Ret. due to very long-term insurance																65	64	63	63
Early retirement with a discount																			
Ret. due to invalidity	60	60	60	60	60	60	60	61	62	63	63	63	63	63	63	63	63	63	63.5
Early retirement with a discount								60	60	60	60	60	60	60	60	60	60	60	60.5
Ret. for women	60	60	60	60	60	60	61	62	63	64	65	65	65	65	65	65	65	65	x
Early retirement with a discount							60	60	60	60	60	60	60	60	60	60	60	60	x

Source: Table created on the basis of information taken from Steffen (2021) and the following laws: BGB (1996), BGB (1997), BGB(2007), and BGB (2014).

Table B2
Sample Means – Sampling Scheme 2 (Wives Younger Birth Cohorts than Husbands)

	Pre-Reform	Transition	Post-Reform
husband participating	0.30	0.35	0.61
wife participating	0.21	0.34	0.65
age husband	63.96	63.20	61.52
age wife	61.78	60.84	58.66
husband older than 60	0.79	0.77	0.61
husband older than 63	0.62	0.53	0.38
husband older than 65	0.47	0.36	0.23
wife older than 60	0.65	0.58	0.40
wife older than 63	0.45	0.33	0.18
wife older than 65	0.28	0.18	0.06
years of education husband	11.35	11.98	12.93
years of education wife	10.32	11.20	12.30
health husband	6.05	6.02	6.13
health wife	5.89	6.04	6.32
calendar year	19.95	20.03	20.13
Observations	6,390	4,435	4,074
Number of households	756	479	633

Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Table B3
Sampling Scheme 2 - Regression Coefficients of the Age Thresholds

	Regressions for Husbands			Regressions for Wives		
	Pre-Reform	Transition	Post-Reform	Pre-Reform	Transition	Post-Reform
Age60_h	-0.214***	-0.212***	-0.069***	-0.030	-0.010	0.016
	(.027)	(.032)	(.024)	(.022)	(.028)	(.018)
Age63_h	-0.157***	-0.103***	-0.164***	-0.067***	-0.037	-0.015
	(.022)	(.026)	(.034)	(.018)	(.025)	(.025)
Age65_h	-0.046***	-0.069***	-0.128***	-0.004	-0.011	-0.038
	(.016)	(.024)	(.032)	(.013)	(.021)	(.027)
Age60_w	-0.045**	-0.022	0.031	-0.255***	-0.276***	-0.025
	(.025)	(.027)	(.03)	(.025)	(.03)	(.024)
Age63_w	-0.018	0.001	0.007	-0.007	-0.048**	-0.166***
	(.017)	(.021)	(.036)	(.013)	(.022)	(.034)
Age65_w	-0.008	-0.014	0.055	0.003	-0.007	-0.008
	(.015)	(.019)	(.039)	(.011)	(.023)	(.04)
Observations	6,390	4,435	4,074	6,390	4,435	4,074

Notes: The table shows regression discontinuity estimates for the age 60, 63, and 65 thresholds for both husbands ("_h") and wives ("_w"). The regressions also contain a second-order polynomial for both husbands' and wives' age, couple and calendar year fixed effects, as well as husbands' and wives' years of education and subjective health indicators. Standard errors are in parentheses and clustered by person identifier. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Table B4
Sampling Scheme 2 – Specification With Dummy Variables for Each Age in Years for Own Effects and Regression Discontinuity Estimates for Cross Effects – Only Coefficients of Key Own and Spouse's Age Threshold Effects Reported

	Regressions for Husbands			Regressions for Wives		
	Pre-Reform	Transition	Post-Reform	Pre-Reform	Transition	Post-Reform
Age60_h	-0.148***	-0.179***	-0.023	-0.032	-0.016	0.007
	(0.034)	(0.040)	(0.034)	(0.022)	(0.028)	(0.019)
Age63_h	-0.088***	-0.064*	-0.125***	-0.067***	-0.023	-0.017
	(0.030)	(0.035)	(0.039)	(0.019)	(0.025)	(0.026)
Age65_h	-0.013	-0.059*	-0.078*	-0.003	0.001	-0.039
	(0.025)	(0.035)	(0.040)	(0.012)	(0.020)	(0.027)
Age60_w	-0.035	-0.011	0.032	-0.286***	-0.222***	-0.050
	(0.025)	(0.027)	(0.031)	(0.033)	(0.034)	(0.036)
Age63_w	-0.016	-0.002	0.007	-0.030	0.016	-0.177***
	(0.017)	(0.021)	(0.036)	(0.023)	(0.032)	(0.040)
Age65_w	-0.013	-0.059*	-0.078*	-0.003	0.001	-0.039
	(0.025)	(0.035)	(0.040)	(0.012)	(0.020)	(0.027)
Observations	6,390	4,435	4,074	6,390	4,435	4,074

Notes: Standard errors are in parentheses and clustered by person identifier. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.

Table B5
Sampling Scheme 2 – Specification With Dummy Variables for Each Age in Years – Only Coefficients of Key Own and Spouse's Age Threshold Effects Reported

	Regressions for Husbands			Regressions for Wives		
	Pre-Reform	Transition	Post-Reform	Pre-Reform	Transition	Post-Reform
Age60_h	-0.153***	-0.178***	-0.023	-0.047*	-0.033	0.042
	(0.034)	(0.040)	(0.034)	(0.026)	(0.039)	(0.031)
Age63_h	-0.088***	-0.063*	-0.127***	-0.073***	-0.050	0.026
	(0.030)	(0.035)	(0.039)	(0.024)	(0.034)	(0.033)
Age65_h	-0.013	-0.057	-0.077*	-0.018	-0.031	-0.007
	(0.025)	(0.035)	(0.040)	(0.022)	(0.033)	(0.035)
Age60_w	-0.059**	-0.003	0.011	-0.287***	-0.220***	-0.049
	(0.028)	(0.034)	(0.040)	(0.033)	(0.034)	(0.036)
Age63_w	-0.033	0.031	-0.001	-0.031	0.017	-0.178***
	(0.026)	(0.032)	(0.041)	(0.022)	(0.032)	(0.040)
Age65_w	-0.032	0.003	0.028	-0.013	-0.001	-0.030
	(0.024)	(0.029)	(0.042)	(0.023)	(0.031)	(0.045)
Observations	6,390	4,435	4,074	6,390	4,435	4,074

Notes: Standard errors are in parentheses and clustered by person identifier. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.
Source: Socio-Economic Panel (SOEP), data for years 1984-2019, SOEP-Core v36, 2021, doi:10.5684/soep.core.v36; own calculations.