Retirement, Intergenerational Time Transfers, and Fertility

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Abstract

Retired parents might invest time into their adult children by providing childcare. Such intergenerational time transfers can have important implications for family decisions. This paper estimates the effects of parental retirement on adult children's fertility. We use representative panel data from Germany to link observations on parents and adult children. We exploit eligibility ages for early retirement for identification in a regression discontinuity design. The results show that parent's early retirement significantly increases the probability of childbirth for adult children. However, parental retirement affects only the timing of adult children's fertility, without having an effect on total fertility.

Keywords: retirement, fertility, intergenerational transfer, time use

JEL Codes: J13, J14, J22, J26

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We would like to thank Ludovica Gambaro, Osea Giuntella, Mathilde Godard, Florence Jusot, Jan Marcus, Jesse Matheson, Fabrizio Mazzonna, Mathias Schumann and Nicolas Ziebarth for their very helpful comments and suggestions.

1 Introduction

Intergenerational time transfers can have important implications for health, human capital, and labour market outcomes. The literature has mainly focused on two types of transfers: time investments by parents into their young children, and time investments of adult children into their elderly parents for the provision of support and informal care. In the first case, parents might reduce their working hours or withdraw from the labour market entirely to provide care for their children in the hope that they might benefit from this investment. Adult children who provide care for their elderly parents reduce their working hours and consequently forego earnings (Bolin et al., 2008; Van Houtven et al., 2013). Moreover, there is evidence that informal care provision has detrimental effects on the caregiver's mental health (Schmitz and Westphal, 2015) and well-being (van den Berg et al., 2014).

These examples show that the direction of intergenerational time transfers varies across the life course. Another event in life that could affect intergenerational time transfers is retirement. The transition from employment to retirement enables the elderly to invest more time into other activities. The literature, for example, shows that retirees invest more time into home production (Stancanelli and Van Soest, 2012) and healthy behavior (Coe and Zamarro, 2011; Eibich, 2015; Insler, 2014; Kämpfen and Maurer, 2016). Given these findings, it seems plausible that retired parents might also invest some of their time into their adult children, by assisting them with childcare or housework. In fact, grandparent childcare has been shown to be an important part of intergenerational family support in the United States (Vandell et al., 2003; Wang and Marcotte, 2007; Lumsdaine and Vermeer, 2015) and Europe (Hank and Buber, 2009; Aassve et al., 2012; Garcia-Moran, and Kuehn, 2017). Formally, retirement reduces the opportunity costs of time investments by the retired parents, while, at the same time, their adult children's time out of work might come at a very high cost in terms of foregone lifetime earnings and wealth accumulation. Consequently, if children's and parents' utility are linked, retired parents might help with childcare, thereby potentially affecting fertility behavior of adult children.

The existing literature mostly focuses on the determinants of grandchild care and the effects on the parent generation. Cardia and Ng (2003) model time and monetary transfers in an overlapping generations model and find that time transfers of the elderly increase labour supply of the second generation. Moreover, they report that subsidizing time the elderly spend on grandchild care is the most effective form of childcare subsidy. Ho (2015) examines how grandchild care needs affect time and monetary transfers by grandparents and their labour supply. She finds that the birth of a new grandchild and geographical proximity between generations increase the time grandparents spend with their grandchildren. A comprehensive demographic and sociological literature also examines grandparents' engagement in childcare and its relationships with fertility and employment decisions by the second generation (Del Boca, 2002; Hank and Kreyenfeld, 2003; Gray, 2005; Hank and Buber, 2009; Thomese and Liefbroer, 2013; Garcia-Moran and Kuehn, 2017). These studies have in common that the employment status of the grandparents is either assumed to be constant (i.e., they are assumed to be retired), or that their labour supply is affected by the presence of grandchildren. This paper is also related to the literature aiming at estimating a causal impact of grandparental retirement on maternal employment. Exploiting pension reform-induced variation in retirement eligibility in Italy, Bratti et al., (2016) report a significant higher employment probability among women whose mothers are eligible for retirement than among women whose mothers are not eligible.

There is no comprehensive information in the academic literature on the effects of elderly parents' labour supply on their (adult) children's fertility. Eibich (2015) reports that retirement increases the amount of time devoted to childcare, which likely reflects that grandparents provide care for their grandchildren once they are retired. The only studies that provide direct evidence for an effect of parents' labor force participation on their (adult) children are by Battistin et al. (2014) and Aparicio-Fenoll and Vidal-Fernandez (2015) with conflicting findings. Battistin et al. (2014) study a pension reform in Italy and find that an increase in the statutory retirement age has negative consequences for fertility. Aparicio-Fenoll and Vidal-Fernandez (2015) also exploit changes in minimum retirement age laws in Italy to study the role of grandmothers' labor force participation on daughters' fertility and employment. In contrast to Battistin et al. (2014), the study finds that daughters whose mothers are active in the labor force are more likely to have children compared to those whose mothers are no longer active.

The present paper uses a regression discontinuity design (RDD) to estimate the impact of parents' retirement on their adult children's fertility.[3] We use a representative household panel study from Germany (Socio-Economic Panel (SOEP) study) to link information on older parents to their adult children. We use discontinuous increases in the retirement probability at the early retirement age thresholds to identify the effect on the adult children's fertility. The RDD estimates suggest that retirement has a significant and positive impact on adult children's fertility, which is greater if families are geographically close. Moreover, the fertility effects are mainly driven by an increase for the second birth. Looking at the grandparent generation, we find that retired mothers spend more time on childcare compared to grandmothers who are active in the labor force. For example, retired mothers report one more hour on childcare activities per weekday upon retirement, on average. While retired fathers do not provide more childcare, their retirement increases childcare provision of mothers (i.e., their wives) significantly. These results suggest that retired parents support their adult children, which in turn leads their children to plan their fertility around their parents'

[3] Throughout the study, we mainly refer to the three-generational family in terms of elderly parents' (first generation), (adult) children (second generation), and grandchildren (third generation).

early retirement. Finally, our empirical findings indicate that early retirement does not lead to a considerable long-term increase in the number of grandchildren. Instead, adult children seem to postpone births that would have happened at an earlier age to coincide with their parents' retirement.

This study contributes to the literature by providing direct evidence on how parents' labour market decisions affect their adult children's fertility. Similar to Battistin et al. (2014), we address potential endogeneity of the parents' retirement decision. However, in contrast to Battistin et al., we include parents and their adult children in our dataset and can directly link the observations on both. This allows us to make use of more detailed information about the parental generation in terms of socio-economic characteristics and their time use behavior. Moreover, the pension reform studied by Battistin et al. increased the retirement age from 50 to 55. In contrast, we use a threshold for early retirement at age 60, which highlights that the fertility effects are present even for older parents. Finally, we use time use data for elderly parents to examine intergenerational time transfers directly.

The remainder of the paper is structured as follows. In Section 2, we discuss relevant theoretical approaches and provide a short overview of the German pension system. In Section 3, we describe the data used for the empirical analysis. Section 4 describes our empirical strategy. Section 5 presents the results, and, in Section 6, we provide a number of robustness checks and placebo analyses. Section 7 concludes.

2 Theoretical Considerations and Institutional Background

2.1 The potential impact of retirement on adult children's fertility

Several theoretical models of fertility are relevant for deriving predictions about a possible intergenerational effect of parental retirement on adult children's fertility. In this section, we briefly discuss these theories and review the related empirical literature.

Economic models of decision-making can be used to examine how retirement of elderly parents might affect the fertility of the second generation (Becker, 1993; Joseph Hotz et al., 1997; Ermisch, 2016, 2015). These theoretical contributions assume that fertility behavior follows a rational decision-making process: fertility decisions depend on expected benefits and costs, building on previous work by Becker and Lewis (1973) and Becker and Tomes (1976). Based on the predictions from static models of fertility behavior (Becker and Lewis, 1973; Willis, 1973), in the present context, we argue that parental retirement—together with a potential increase in family childcare support—implies a reduction in expected (monetary and non-monetary) costs of birth and childcare. Indeed, several empirical studies point out that grandparental childcare plays an important role.

Around 50 percent of grandparents in the U.S. and Europe provide some form of assistance with childcare (Hank and Buber, 2009; Thomese and Liefbroer, 2013). Consequently, lower expected costs in the form of (grand)parental support upon retirement might affect adult children's fertility behavior. Costs, in turn, are expected to be lower, the higher the probability and intensity of (grand)parental support. Intergenerational time transfers are likely to depend on the geographic proximity between parents and adult children (Hank and Buber, 2009; Chan and Ermisch, 2011; Compton, 2015; Compton and Pollak, 2014).

The theoretical work by Cardia and Ng (2003) is also closely related to our study. The authors develop a two-period overlapping generation model with altruistic agents allowing for both time and monetary transfers. A key finding of their study is that a transfer from older parents to adult children has "two effects: it relieves the time constraint of the working generation by allowing them to devote more time to market work, and it relaxes the budget constraint by reducing the demand for purchased child inputs such as day cares and nannies" (Cardia and Ng, 2003, pp. 432–433).

To summarize, the related literature suggests that the intergenerational effect of parental retirement on adult children's fertility is likely to depend on the extent of grandparental capacities and support. To explore this, we analyse heterogeneous effects with respect to older parents' capacities and time constraints (i.e., geographic distance to adult children) and adult children's characteristics (i.e., household income and family size) as well as contextual factors (i.e., differences between East and West Germany). Thereafter, we study the timing of childbirth and explore longer-term fertility effects. We then examine whether grandparents provide more childcare after retirement, which constitutes an important intergenerational transfer mechanism from the old to the young.

2.2 Early and official retirement regulations in Germany

Germany's pension system is based on three pillars—*(i)* state pensions, *(ii)* employer-based pensions, and *(iii)* private pensions. State pensions are by far the most important source of retirement income, amounting to on average 64 percent of the total retirement income of the population aged 65 or over in 2011. "Other pension income" (i.e., mostly employer-based pensions) accounts for 21 percent of the total retirement income, and private pensions only 9 percent (DRV, 2015a).[6] Therefore, in this section, we focus on the state pension system. The pension system in Germany is a pay-as-you-go system with earnings-based contributions split between employers and employees. Certain episodes of non-employment are also recognized as pensionable by the German pension fund, such as, e.g., periods of unemployment, welfare receipt, childrearing, long-term care provision, or military service.[7]

[6] The remaining six percent consists of employment income, welfare benefits and other types of income (e.g., from capital or investments).

[7] In general, these episodes are considered to be insurance times without contributions, i.e., they count towards the "years of insurance" eligibility criterion without increasing the pension amount.

Individuals over 27 years and with at least five years of insurance (which are required for an old age pension) receive a yearly statement from the German pension fund (DRV), which provides information on the current value of their pension, the projected value of their pension[8] as well as their anticipated retirement date. The latter is based on the standard old age pension and does not take opportunities for early retirement into account.[9] Once an individual is eligible for a state pension they have to apply to the German pension fund (DRV) to claim their pension, i.e., payments are not made without a prior claim. Payments are made on a monthly basis,[10] and the amount paid is linked to lifetime earnings.[11] The first month the pension is paid is when all eligibility criteria are met on the first day of the month.

The German pension fund offers six different types of pensions. These pension types represent different routes into retirement rather than separate pension plans, i.e., individuals do not choose between these pension types during their working life and the type of pension they eventually claim does not directly affect the pension amount. Instead, these pension types offer certain individuals the option to retire early. A detailed description of the different pension types as well as relevant reforms of the eligibility ages are provided in the Appendix (section B). Here, we focus on the relevant pension ages for the sake of brevity. The standard old age pension was available from age 65 onward, i.e., almost everyone would be eligible

[8]The projection is based on the assumption that an individual continues to pay contributions based on their average income over the past five years until their anticipated retirement date.

[9] The German pension fund offers advice on eligibility for other pension types on an individual basis.

[10] Lump sum payments are not possible.

[11] The amount of an individual's pension depends on their earnings points. An employee earning the median wage (relative to all members of the pension fund) for one year would gain one earnings point. Thus, earnings points are a relative measure of lifetime earnings, taking into account both the amount of an individual's salary as well as the amount of time spent in the labor market. Earnings points are converted into a monetary value based on the pension formula, which takes other factors into account, such as a sustainability adjustment.

for a full pension at this age.[12] At age 63, individuals with more than 45 contribution years and people with severe disabilities were eligible for a full pension, while individuals with more than 35 contribution years had the option of retiring early. Finally, the threshold at age 60 offered an early retirement option for women, unemployed, or partially retired individuals[13] as well as people with severe disabilities.[14]There were several different reforms to these pension types over the period considered in this paper (1984 to 2015). For example, the age threshold for the standard old age pension increases stepwise from 65 to 67 for cohorts born from 1947 onwards. In line with this increase, age thresholds for other pension types were increased as well, while some pension types are also not available to cohorts born from 1952 onwards. These reforms are described in detail in Börsch-Supan and Jürges (2012) as well as in the appendix. We take these reforms into account and adjust the age thresholds in our analysis. Consequently, there are two sources of variation in the data–*(i)* pension eligibility varies by age, i.e., among individuals observed in the same year some will be above the age threshold and thus eligible for a pension, while others will be below the age threshold, and *(ii)* pension eligibility varies across cohorts, i.e., individuals observed at the same age might face different age thresholds.[15]

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[12] The standard old age pension only requires five years of pension contributions.

[13] Partial retirement contracts are agreements between an employer and an employee. The version most relevant in this context would entail two phases: in the first phase, the employee continues working full-time with a reduced salary. In the second phase, the employee would stop working while still receiving the (reduced) salary.

[14] These include people with severe disabilities or occupational disabilities. Severe disability is defined with respect to a person's usual activities. In contrast, occupational disability only refers to the capability to work in a specific occupation or perform any job for more than three hours per day under normal employment conditions.

[15] In our sample, the largest increase in the threshold is by eight months.

3 Data

3.1 Description of the dataset and sample construction

We use data from the German Socio-Economic Panel (SOEP), a large representative panel study of private households in Germany. Starting in 1984, respondents answer questions covering a broad range of topics, including fertility, labour market participation, and time use, annually. For further information, see Wagner et al. (2007).

The SOEP surveys all members of participating households aged 17 or over. Moreover, if members of participating households move out (e.g., children leaving their parents' home), they are followed over time and their new household also becomes part of the panel. This allows us to directly link comprehensive data on adult children to the employment status of their elderly parents. While it limits our analysis to child-parent dyads that lived in the same household at some point, the long duration of the panel ensures that our sample is not restricted to adult children living with their parents.

Our sample spans the period from 1984 to 2015. In a first step, we link respondents in the sample (i.e., "adult children") to their biological father and mother. Then, we link adult children to their father- and mother-in-law by using their partner's identification number.[16] We only use data on their parents-in-law in cases where the parents could not be linked to their children's information. For the remainder of this paper, we refer to parents as well as parents-in-law simply as "parents". Finally, we restrict our estimation sample to observations (i.e., person-years) for which both the father and the mother of the respondent are observed

[16] It should be noted that, in most cases, we observe either only the parents or only the parents-in-law. While this introduces random measurement error into the analysis, it should not meaningfully affect our results. We prefer to use information on the adult children's parents if possible.

and the person identifier of the mother is the same as the partner identifier of the father (and vice versa).

3.2 Outcomes

The main focus of our analysis is on adult children's fertility. Our primary outcome is a binary indicator of whether a child was born in the following year *(t+1)* or not. We choose to focus on childbirth in the following year since it takes at least nine months to conceive a child and carry it to term. Therefore, if the decision to have a child is made around the time of the parent's retirement, the child would likely be born in the year following the parent's retirement. However, retirement can often be anticipated (especially if the timing is based on pension eligibility). Thus, it is possible that adult children anticipate their parent's retirement and plan their fertility accordingly. In these cases, we might find that parent's retirement affects the probability of childbirth in the same year or even the previous year. Conversely, pregnancy cannot be perfectly planned. Some couples will need to try longer to conceive while some might conceive faster than expected. This implies that if parental retirement affects their children's fertility, we could expect increases in the probability of childbirth both shortly before the parent's retirement and in the first few years following the parent's retirement. To test this hypothesis, we examine the effect of parent's retirement on the timing of fertility.

Since we hypothesize that parental retirement affects children's fertility through an intergenerational transfer of time, we also examine the effects of retirement on elderly parents' time use, in particular their childcare provision. In the SOEP, respondents are asked how many hours they spend on a set of activities on a normal weekday, on a Saturday, and on a Sunday, e.g., paid work, running errands, housework, childcare, education,[18] repairs and gardening, and leisure.

3.3 Retirement, pension eligibility, and age

The treatment variable is parents' self-reported retirement status. Parents are defined as retired at the time of the interview, if *(a)* they report being retired and they are not working full-time, or *(b)* if they are not working and, in the following year, report a retirement date (i.e., year and month of retirement) prior to the interview date in the current year.[19] We assume that retirement is an absorbing state, i.e., we assume that once respondents retire, they will remain in retirement. Age is measured in months (based on the year and month of the interview and the year and month of birth).

We focus on age, gender, and year of birth when determining eligibility for a state pension, since we do not have reliable data on the other criteria. Therefore, we apply the following definitions: the age threshold for early retirement is the earliest age at which an individual could be eligible for a pension. Similarly, the threshold for official retirement is the age at which an individual is definitely eligible for a pension. Since the eligibility criteria need to be met on the first day of the month, individuals will only receive a pension one month after reaching the relevant age threshold unless they were born on the first of the month. Since we lack information on the exact date of birth, we assume that for all observations the first pension will be received one month after reaching the age threshold. Thus, the relevant age threshold for early retirement is 60 years and one month for the majority of the sample.[22]

[18] This includes school and university attendance as well as further training and learning.

[19] The question on retirement status refers to the previous survey year.

[22] Since age, gender, and year of birth do not allow us to distinguish between individuals eligible for early retirement at age 63 but not at age 60, the age threshold at age 63 is irrelevant for our analysis. Moreover, the

However, respondents born from 1952 onwards will be affected by several reforms, which gradually increase the pension age. These increases (based on birth cohort) are taken into account in our pension eligibility variable. Consequently, the age threshold for early retirement differs in our sample between 60 years and one month and 60 years and nine months. Similarly, the age threshold for official retirement is 65 years and one month for the majority of the sample, and it varies between that and 65 years and five months in the sample.

3.4 Summary statistics

The upper left panel in Figure 1 shows the probability of childbirth by age for the second generation. For women, birth is most common between the ages of 25 and 35, and the probability of childbirth is lower than four percent for women under 23 or over 38. Similarly, for men, the probability of childbirth is highest between the ages of 26 and 35. Compared with women, men have lower probabilities at younger ages, and higher rates of childbirth over the age of 34. The upper right and lower left panel in Figure 1 show the share of fathers and mothers above the retirement age thresholds of 60 and 65 by adult children's age, respectively. We note that less than 20 percent of the parents have reached the relevant age thresholds before their child's 25th birthday and that, by the time the adult child is 40, almost all parents have passed the age threshold for early retirement. Therefore, we limit the sample to adult children aged 25 to 40, since outside of this age range both childbirth and parental retirement are rare events. In the robustness section, we also present estimates for samples of adult children aged 17-40 and 20-40. These alternative sample selections yield very similar results. Table A1 in the Appendix presents summary statistics.

4 Empirical Methodology

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empirical analysis in section 4.2.3 also shows that the discontinuity at age 63 is considerably less pronounced than at the other two thresholds.

4. Fuzzy regression discontinuity design

4.1 General model

Parental retirement is likely to be endogenous with respect to adult children's fertility, since older parents might retire voluntarily to assist their children with childcare or household chores (Lumsdaine and Vermeer, 2015). We address this problem by using the age threshold for early retirement (at age 60) as exogenous variation for parental retirement. This identification strategy is based on the assumption that older parents prefer to retire once they are eligible for a state pension, which is likely to be the most important source of their retirement income. Since state pension eligibility is tied to passing the relevant age threshold, being above the age threshold should be linked to a considerable increase in the retirement probability. We provide evidence on this in section 4.2.

Two further assumptions are needed for a causal interpretation of the effect. First, being above or below the age threshold should not have a direct effect on the probability of child birth. While parental age might be related to adult children's fertility, it appears unlikely that there should be a discontinuous increase in the probability of child birth at age 60. Thus, this assumption is likely to hold conditional on a continuous trend in parental age. Second, individuals should not be able to manipulate whether they are above or below the threshold. With age as the assignment variable for the threshold this should hold by construction.

Under these assumptions we can estimate a causal effect of parental retirement on the probability of child birth in a fuzzy regression discontinuity design.

Our empirical model can be written as follows:

(1) First stage:

$$pr_{it} = \zeta + f(age_{it}) + g(page_{it}) + \pi D_{it} + \omega_i + \kappa_t + \nu_{it}$$

(2) Second stage:

$$y_{it} = \beta + f(age_{it}) + g(page_{it}) + \lambda pr_{it} + \alpha_i + \tau_t + \varepsilon_{it}$$

where y_{it} is the outcome of adult child *i* at time *t*, age_{it} is the age of child *i*, $page_{it}$ the age of the parent of child *i*, and pr_{it} indicates the retirement status of child *i*'s parent. α_i and ω_i are child-fixed effects, and τ_t and κ_t are a set of month- and year-fixed effects to control for secular and seasonal trends, respectively. ε_{it} and ν_{it} are the idiosyncratic errors of the second and first stage. $f(age_{it})$ and $g(page_{it})$ are parametric functions of child's and parental age. The variables age_{it} and $page_{it}$ are both measured in months. D_{it} is a dummy variable indicating whether the parent of child *i* in year *t* is above or below the age threshold for early retirement. In the first stage, the parameter π measures the effect of crossing the age threshold on the retirement probability of the parent. In the second stage, λ is the treatment effect of parent's early retirement on their children's fertility.

We estimate the model using two-stage least squares (2SLS) methods to derive a causal estimate of the parameter. We use a bandwidth of ten years (i.e., we only include observations where parents are aged between 50 and 70) and a quadratic trend for parental age as our main specification. The choice of the bandwidth and the functional form for parental age are discussed in detail in the Appendix and we explore the robustness of our results to higher age polynomials and smaller bandwidths in section 6.2. For children's age, we include a quadratic trend based on plots of the parental retirement probability against their children's age (see Figure A1 in the Appendix).

4.2 Graphical evidence

Figure 2 shows the share of retired parents in the sample by parental age. The dots show averages over bins of six months, and the vertical lines mark the thresholds for early and official retirement. Fathers are shown on the left-hand side, and mothers on the right-hand side. The graphs clearly show that the share of retirees increases sharply at age 60 and age 65 for both fathers and mothers. The graph for fathers also seems to suggest the presence of a discontinuity at age 63, which is in line with the discussion in Section 2.2. However, this discontinuity is less pronounced than the changes at age 60, and we will therefore focus on this age (i.e., 60) threshold in our analysis.

5 Results

5.1 First-stage results

The first-stage regression in equation (1) allows us to derive precise estimates for the increase in the retirement probability at the age 60 threshold. Comparing a parent who is slightly younger than age 60 to a parent who is slightly older, we find that crossing the age threshold for early retirement increases the parent's propensity to be retired by 20 percentage points for fathers, and 15 percentage points for mothers, respectively.[25] This indicates that the age thresholds are sufficiently strong instruments for parental retirement status, with F-statistics of 211 and 84 (see Table 1), respectively, which are considerably larger than the rule of thumb F-statistic of ten to 12 (Staiger and Stock, 1997).

5.2 Parental retirement and short-term fertility

Table 1 provides the main estimates of the effect of early parental retirement on their adult children's fertility. We present findings for a quadratic age trend for adult children's fertility for a bandwidth of ten years. Panel A shows the effects of the father's retirement, and the effects of the mother's retirement are shown in panel B. First, we find that the father's retirement significantly increases the probability of a childbirth for both daughters and sons.

[25] The results for the official retirement age threshold are quite similar—fathers (mothers) who are slightly older than 65 have a 15.9 (26.9) percentage points higher propensity to be retired.

The estimates in the first row of Table 1 suggest that early retirement of the father increases the probability of a grandchild birth by 16 percentage points. Second, the magnitude of early paternal retirement on the fertility of the second generation is larger for daughters than for sons. The point estimate of paternal retirement on childbirth for daughters is 18 percentage points. The corresponding figure for sons suggests an increase of about 15 percentage points. Third, we also find a positive and statistically significant effect of maternal retirement on the probability of a grandchild birth. Note, however, that the estimates of maternal retirement are less precisely estimated.[26] Early maternal retirement increases the likelihood of a grandchild birth by 11 percentage points, being significant at the five percent level. This impact is stronger in magnitude and more precisely estimated for daughters (14 percentage points; significant at the ten-percent level) than for sons (9 percentage points; not significantly different from zero at conventional levels). Overall, the first RDD results in Table 1 show a positive effect of mothers' and fathers' early retirement on their adult children's fertility behavior. [27]

5.3 Heterogeneous effects

Older parents' retirement and involvement in grandchild care is likely to depend on their own capacities and time constraints as well as the children's characteristics. We now analyse whether the effect differs according to the geographic distance It is important to point out that the following findings should be interpreted with caution as location and retirement

[26] This might be the result of a lower bite of the early retirement age threshold for women (first-stage F-statistic for mothers is 84 compared to 211 for elderly fathers) and/or more measurement error in measuring retirement for women compared to men. We address the issue of potential measurement error in the robustness section below by presenting results for alternative retirement measures.

[27] We consider whether the estimated effects are caused by joint retirement of both father and mother in appendix D. In short, our findings suggest that joint retirement does not play an important role.

choices might be made simultaneously with adult children's fertility choices (Compton and Pollak, 2014). If time transfers from parents to adult children are the mechanism through which parental retirement affects adult children's fertility, we would expect the effect of parental retirement to be stronger if both generations live in close geographic proximity. Chan and Ermisch (2011), for example, report a decline in intergenerational exchange with traveling distance in the United Kingdom. Similarly, Hank and Buber (2009: 65) study the role of grandparents in providing childcare in ten European countries and point out that the likelihood of caring decreases with an increase in the geographic distance between generations.

Columns 1 and 2 in Table 2 show the heterogeneous effects.[31] We report estimates for the specification with a quadratic age trend and a bandwidth of ten years (as in Table 1). The table distinguishes between whether or not parents and adult children live in close geographic proximity, which is defined as a travel time of less than one hour.[32] Overall, around 83 percent of adult children and their parents live less than one hour away from each other. We estimate separate models for each of these groups. The results show that the positive effect of early paternal retirement on grandchild birth is stronger if both generations live close to each other. For example, the intergenerational point estimate of father's retirement on adult children's fertility is 22 percentage points if both live in close geographic proximity, compared to 8 percentage point if both generations live more than an hour away from each other. The first point estimate is statistically significant at the one-percent level, whereas the latter is not statistically different from zero at conventional significance levels. The effect of

[31] Separate estimates by the gender of the adult child are reported in Tables A.3 and A.4 in the Appendix.

[32] In selected years, SOEP respondents are asked about the residential distance to their relatives. See Rainer and Siedler (2009) for further information. To minimize the loss of statistical power, we imputed missing values in years where the question was not asked with the closest observed value in either recent or later years.

maternal retirement on adult children's fertility also shows a positive and statistically significant effect of around 14 percentage points if both generations live close to each other.

One might expect a stronger effect of early parental retirement on adult children's fertility behavior if the latter have lower levels of household income, as paid childcare services might be less affordable for them (Gray, 2005). The altruism model by Becker (1974) hypothesizes that individuals care about the well-being of the potential recipient. We would therefore expect adult children's income to be negatively related to parents' time transfers, with elderly parents mainly supporting less affluent children. Alternatively, according to the exchange model, the amount of time transfers could be positively or negatively related to adult children's income, depending on the elasticity of supply and demand of services (Cox, 1987). Adult children's household income might also relate to fertility decisions as, for example, unforeseen changes or shocks to family income may result in families revising their fertility intentions. We therefore distinguish by whether adult children's household income in the year prior to parents' early retirement age is below the 25th percentile, or above the 75th percentile. The results in columns 3 and 4 in Table 2 show that the intergenerational effects are strongest for adult children with a high household income.

Are the intergenerational effects stronger at the extensive (i.e., entry into parenthood) or the intensive margin (i.e., the number of children)? Columns 5 to 7 in Table 2 report the impact of parental retirement on the probability of adult children's first, second, or higher-order birth. The estimates point to important heterogeneous effects. The fertility effects are strongest in magnitude for the second birth (column 6 in Table 2). This applies to both paternal and maternal retirement.

Taken together, these findings suggest that the main estimates in Table 1 are mostly driven by a positive intergenerational effect at the second birth, rather than at the extensive margin.

These results are to be expected, given the average age of adult children at the time of parental retirement. Figure 1 shows that when adult children are aged 30, on average, around 40 percent of their fathers are above the early retirement age threshold. At age 35, almost 80 percent of the fathers are over 60. In Germany, the mother's average age at first birth is 29.5 years, and 31.8 years at the second birth. At the third birth, mothers are 33 years old on average (Destatis, 2016).[34] Hence, the strongest positive intergenerational effect on the incidence of second birth is in line with these statistics, since the majority of adult children had already entered parenthood at the time of their parents' retirement.

More than 25 years after German reunification, there are still pronounced differences between former East and West Germany in terms of fertility, public childcare, and the labour market (Hank et al., 2004; Hunt, 2008; Felfe and Lalive, 2012; Bauernschuster et al., 2016). Moreover, Chevalier and Marie (2017) document a significant drop in fertility in East Germany after the fall of the Berlin Wall. Recent studies also document that eastern and western Germans differ in terms of preferences and gender-role attitudes (Alesina and Fuchs-Schündeln, 2007; Bauernschuster and Rainer, 2011). We therefore present separate RDD estimations for East and West Germany. We also examine differences over time, by presenting results for the period 1984-1999 as well as 2000-2015, since differences in public childcare infrastructures in both parts of Germany were particularly pronounced during the 1980s and 1990s (Wrohlich, 2008; Schober and Stahl, 2014).

For fathers, the estimated effects in Table 3 are quite similar across all specifications. The estimates are slightly larger for fathers who live in East Germany, however, the differences in magnitude are relatively small and both point estimates are statistically significant. While the estimated effect for father's retirement between 1984 and 1999 is not statistically significant,

[34] The figures refer to the average age for biological mothers who gave (a living) birth in Germany in 2014.

the point estimate is also considerably larger than the estimate for the more recent time period, 2000 to 2015 (22 percentage points compared to 13 percentage points). This suggests that the difference in statistical precision is driven by the difference in sample sizes.

For mothers, we find that the effect of retirement on child birth is only significant for mothers in West Germany (30 percentage points and significant at the 5 percent level). Similarly, the estimated effect is large and significant for the period 1984 to 1999 (i.e., at a time with low levels of public child care infrastructure in West Germany), while the estimate for the later time period is considerably smaller (10 percentage points compared to 30 percentage points) and not statistically significant. Taken together, these results suggest that the availability of public childcare plays an important role for the intergenerational effects for mothers and adult children, since public childcare was more widely available in East than in West Germany, and childcare availability considerably improved since the early 2000s.

5.4 Parents' retirement, timing of fertility, and longer-term fertility

The immediate increase in fertility in response to parental retirement does not necessarily imply that the second generation has more children overall. Adult children could simply decide to either bring forward or delay births that would occur regardless of parental retirement. If the births that did occur in the treatment group would have happened at an earlier or later age in the control group, family support through grandparental childcare would not result in a net increase in completed fertility. Is the increase in short-run fertility permanent or are births rather timed earlier or later? Moreover, while children might anticipate their parents' retirement, it is unlikely that they are able to plan their fertility perfectly.

Therefore, we explore whether parental retirement affects childbirth in a 15-year window around retirement, i.e. in the seven years before retirement, in the year of retirement itself, and in the seven years after retirement. This allows us to examine potential anticipation effects and longer-term fertility behavior. Figure 3 displays the results. Panel A reports the point estimates together with 95-percent-confidence intervals of paternal retirement on the probability of childbirth for adult daughters and sons, and panel B shows the corresponding estimates for maternal retirement. Panel A displays an inverted U-shaped relationship in the probability of a grandchild birth over time. The effect is negative and significant four to six years prior to the father's early retirement. The probability of child birth becomes positive and statistically significant one year before the father's retirement, and remains positive and precisely estimated up to two years following paternal retirement.[36] The estimates for mother's early retirement in panel B show a quite similar development over time (inverted U-shaped). However, the estimates are only significant for adult children's fertility at the 95-percent level one year after the mother's retirement. These results indicate that early retirement does not lead to a considerable long-term increase in the number of grandchildren, on average. Instead, adult children seem to postpone births that would have happened at an earlier age to coincide with their parents' retirement.[37]

Taken together, the results suggest that paternal retirement leads to a significant and large increase in their adult children's fertility in the short run, which is somehow offset by a lower birth probability in the years before paternal retirement. While the average effects of maternal retirement are also positive, but less precisely estimated, the heterogeneous effects in Table 2 point toward positive intergenerational effects of maternal retirement on grandchild birth if

[36] Figure A2 in the Appendix shows that the point estimates of parental retirement are very similar for daughters and sons.

[37] Figures A3-A5 in the Appendix show whether there are heterogeneous effects in the development of childbirth in a 15-year window around retirement by child-parent geographic distance, adult children's household income, and family size.

elderly parents already have at least one grandchild. Since retirement typically leads to a decrease in parental income, but increases their leisure time, it seems plausible that these fertility effects might partly result from intergenerational time transfer from retired parents to their adult children. This might help the second generation to cope better with the time costs of raising another child. We now study these potential mechanisms.

5.5 Elderly parents' time use

Retired parents might choose to invest some of their leisure time into their adult children by providing childcare, which might partly explain the positive intergenerational relationship between early retirement and grandchild birth. Indeed, grandparent-provided childcare constitutes an important type of family support and intergenerational exchange. Both in the U.S. and Europe, around 50 percent of grandparents provide some type of childcare assistance (Hank and Buber, 2009; Thomese and Liefbroer, 2013). Hank and Buber (2009) study the prevalence and intensity of childcare provided by grandparents in ten continental European countries. For Germany, the authors report that around 56 (51) percent of grandmothers (grandfathers) provided some childcare in the past 12 months, and 30 percent of grandparents report providing childcare almost weekly or more often in the preceding year.[38] Hank and Buber (2009) also report that working grandparents are significantly less likely to provide regular grandchild care (almost weekly or more often). Descriptive findings from the SOEP also suggest that grandparental childcare plays an important role in Germany: 42 percent of mothers with children aged 0 to 13 years report that grandparents provide childcare in a typical week, with a conditional average of almost 12 hours per week.[39]

[38] These figures are for the years 2003 to 2004.

[41] The SOEP elicits time use nearly every year and we can therefore measure childcare provision for most elderly parents in our sample. Note, however, that the sample sizes in Table 1 and Table 4 are not identical because Table 1 reports findings for child-parent pairs, whereas Table 4 reports findings at the individual

Grandparent-provided childcare is most common and time intensive when children are aged four years or younger.[40] However, whether these associations are mirrored by a causal relationship of retirement on time transfers to younger generations is an open question that we aim to examine next.

In the SOEP questionnaire, respondents are asked how many hours they spend on a set of activities on a normal weekday, on a Saturday, and on a Sunday, such as childcare, housework, running errands, and repairs and gardening. Table 4 shows the results of RDD regressions of early retirement on father's and mother's average number of hours they spend on childcare on a typical weekday, on a Saturday, and on a Sunday.[41] Table 4 reports estimates of father's and mother's early retirement on their own provision of childcare (upper left and lower right panels) as well as mother's and father's early retirement on their spouse's childcare provision (lower left and upper right panels). Both fathers and mothers spend more time on childcare following early retirement on weekdays, although the effect is only statistically significant for mothers. Fathers spend on average 0.2 more hours on childcare upon retirement, and mothers report one more hour of childcare provision per weekday, on

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(parental) level. Moreover, sample sizes for childcare during weekdays and Sundays are larger than for Saturdays because until 1990, the SOPE elicited time use only for weekdays and Sundays.

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[41] The SOEP elicits time use nearly every year and we can therefore measure childcare provision for most elderly parents in our sample. Note, however, that the sample sizes in Table 1 and Table 4 are not identical because Table 1 reports findings for child-parent pairs, whereas Table 4 reports findings at the individual (parental) level. Moreover, sample sizes for childcare during weekdays and Sundays are larger than for Saturdays because until 1990, the SOPE elicited time use only for weekdays and Sundays.

average. This is a rather large effect since one more hour of childcare among retired mothers per weekday corresponds to an increase in childcare of more than 100 percent, and suggests seven hours of childcare provision during the week, on average.[42] Moreover, early retirement of the father increases mother's childcare provision on weekends, with an increase of 0.44 hours on Saturdays and 0.61 more hours on Sundays, on average. Note, however, that only the latter estimate is statistically significant at the ten percent level. Mother's early retirement not only increases her own time spent on childcare, but also those of her partner: if mothers retire early, elderly fathers provide 0.46 more hours of childcare on weekdays , which is statistically significant at the ten percent level. Overall, these findings support the hypothesis that early parental retirement leads to an increase in intergenerational time transfers from the parents to their adult children. We interpret these findings as important, since parents usually report that childcare assistance provided by the grandparents is more convenient, trustworthy, and beneficial for the child than support from other childminders (Fergusson et al., 2008; Geurts et al., 2012).[43]

The RDD results in Table 4 measure the effect of early retirement on childcare provision at a time when a grandchild is very young. This might explain why there is mainly an increase in childcare provision among elderly mothers, since (grand)fathers might simply be less comfortable with providing childcare when children are aged 0-1 years old. Figure 4 provides some suggestive evidence for this potential explanation. The order of the figure is as in Table 4. Panel A and panel D report father's and mother's childcare provision with respect to their

[42] Elderly mothers report spending 0.48 hours on weekdays on childcare. See Table A2 in the Appendix.

[43] Early retirement might not only affect grandparental childcare provision, but also other types of home production, such as supporting adult children with cooking, cleaning, or repairs and gardening. Unfortunately, with the SOEP data, it is not possible to distinguish between grandparents' time spent on home production in their own and in their children's household.

own retirement, respectively. Panel B displays the development of mother's childcare provision by time to paternal retirement, and Panel C shows the estimates on elderly father's childcare provision by time to maternal retirement. The point estimates together with the 95-percent-confidence interval in Panel A suggest an increase in paternal childcare provision mainly at weekends two to five years after child birth. Elderly mothers' childcare provision already increases in the year of her spouse's retirement, particularly on Sundays (Panel B). In contrast, elderly mother's own retirement results in an immediate increase in childcare provision on weekdays (rather than at the weekend) by around one hour per day, on average. This increase persists over time and is precisely estimated up to four years after maternal retirement (Panel D in Figure 4).

6 Robustness checks

Age polynomials and bandwidth. Several studies point out that it is important to study how sensitive RDD estimates are to alternative and more flexible assumptions (Van Der Klaauw, 2008; David S. Lee and Lemieux, 2010). We therefore present parametric estimates using higher order age polynomials such as a quartic and cubic age trends in the first two columns of Table 5. Using these alternative specifications results in somehow larger point estimates for the effect of parental retirement on adult children's fertility compared to the main estimates in Table 1. For elderly mothers, the point estimate with a quartic (cubic) age trend is slightly larger (smaller) in magnitude compared to the main result, and the estimates are not statistically significant.

Another important issue in RDD estimations is the selection of the bandwidth. On the basis of the cross-validation procedure, we decided to use a bandwidth of ten years in our main analysis. However, we also report results for a bandwidth of seven, five, and three years. The estimates with these smaller bandwidths are very similar to our main findings, with the exception of father's retirement and a bandwidth of three years.

Adult children aged 20 and younger. In the main analysis, we restricted the sample to adult children aged 25 to 40 years because outside this age range, the likelihood of a birth is low. To further assess the robustness of the results, we re-estimate our models using observations where the children are aged 20-40 and 17-40 years old. The results are shown in columns 6 and 7 of Table 5. A retired father increases the probability of childbirth by around 12 to 15 percentage points, and early maternal retirement increases fertility by around eight percentage points. Taken as a whole, we conclude that these robustness checks confirm our main findings.

Alternative definitions of early retirement. There are several potential definitions of retirement in the literature, based on individuals' self-assessed labour market status, the receipt of pension benefits, and reported hours of paid work (Kämpfen and Maurer, 2016). First, we alternatively define being retired if parents report fewer than four hours of paid work on a typical working day.[45] Second, we define retirement as being in receipt of pension benefits, defining parents as being retired the moment they report receiving an old-age or disability pension. The estimates in the last two columns of Table 5 show that the main findings are robust to these alternative definitions of early retirement.

Placebo outcomes. Assuming that the underlying assumptions hold, our fuzzy regression discontinuity design should ensure that the results are affected by neither selection bias nor by omitted variable bias. We provide further evidence for this by conducting a number of

[45] In unreported regressions, we also used fewer than three (two) hours of paid work on a typical working day as alternative definitions for early parental retirement. The findings were in line with our results in Table 1 and are available upon request.

placebo regressions. We estimate our main specification using variables as outcomes that should not be affected by parental retirement. In particular, we look at *(i)* whether adult children have a high school degree, *(ii)* whether they live in an urban or rural area, and *(iii)* whether they are very interested in politics. The results are shown in column 1 to 3 of Table 6. All coefficients are close to zero and not statistically significant at conventional levels.

Finally, we conduct a small simulation study to assess whether our findings could be driven by the correlation between parent's ages, adult children's ages and fertility rates. The simulation is described in detail in appendix E. In summary, the results suggest that it is highly unlikely that our findings are confounded by the correlation between parent's ages, adult children's ages and fertility rates.

7 Conclusions

Intergenerational time transfers caused by retirement might have important implications for policy design. Since the early 2000s, statutory retirement ages have been raised in many developed countries. If adult children benefit from their parents' retirement through support and childcare, later retirement entry due to these reforms might have implications for family planning and fertility decisions of the second generation. However, the public debate about intergenerational effects of retirement policies has mostly focused on two aspects. First, declining fertility rates and increasing life expectancy imply that both the number of retirees and the time spent in retirement will likely increase. Therefore, later generations face a rising financial burden to sustain pay-as-you-go pension systems. Second, retirement also increases the number of jobs released, which might help younger generations with their labour market entry and career progression (Vestad, 2013).

This paper provides new evidence regarding the effects of parental retirement on their adult children's fertility using a regression discontinuity design. We use a representative household panel study from Germany to link data on parents and their adult children. In the RDD, we exploit the eligibility age for early retirement in Germany for identification. The results indicate that early parental retirement increases the adult children's probability of childbirth. The estimates suggest that mother's and father's retirement increase the likelihood of a grandchild birth by around 10-16 percentage points. These effects are mainly driven by families living in close geographical proximity, and by a positive intergenerational effect at the second birth, rather than at the extensive margin. However, the findings suggest that early retirement does not increase the total number of grandchildren, since adult children seem to postpone births that would have happened at an earlier age to coincide with their parents' retirement.

Looking at time use data, we document that 42 percent of mothers with children aged 0 to 13 years report that grandparents provide childcare in a typical week, with a conditional average of almost 12 hours per week. Moreover, we find that retired parents (in particular mothers) spend more time on childcare. Taken in conjunction, these findings suggest that retirement induces intergenerational time transfers from retired parents to their adult children. These findings only hold for early retirement. We argue that this is likely caused by the difference in their children's age, i.e. the majority of the children's generation will have completed their family planning by the time their parents are close to the official retirement age.

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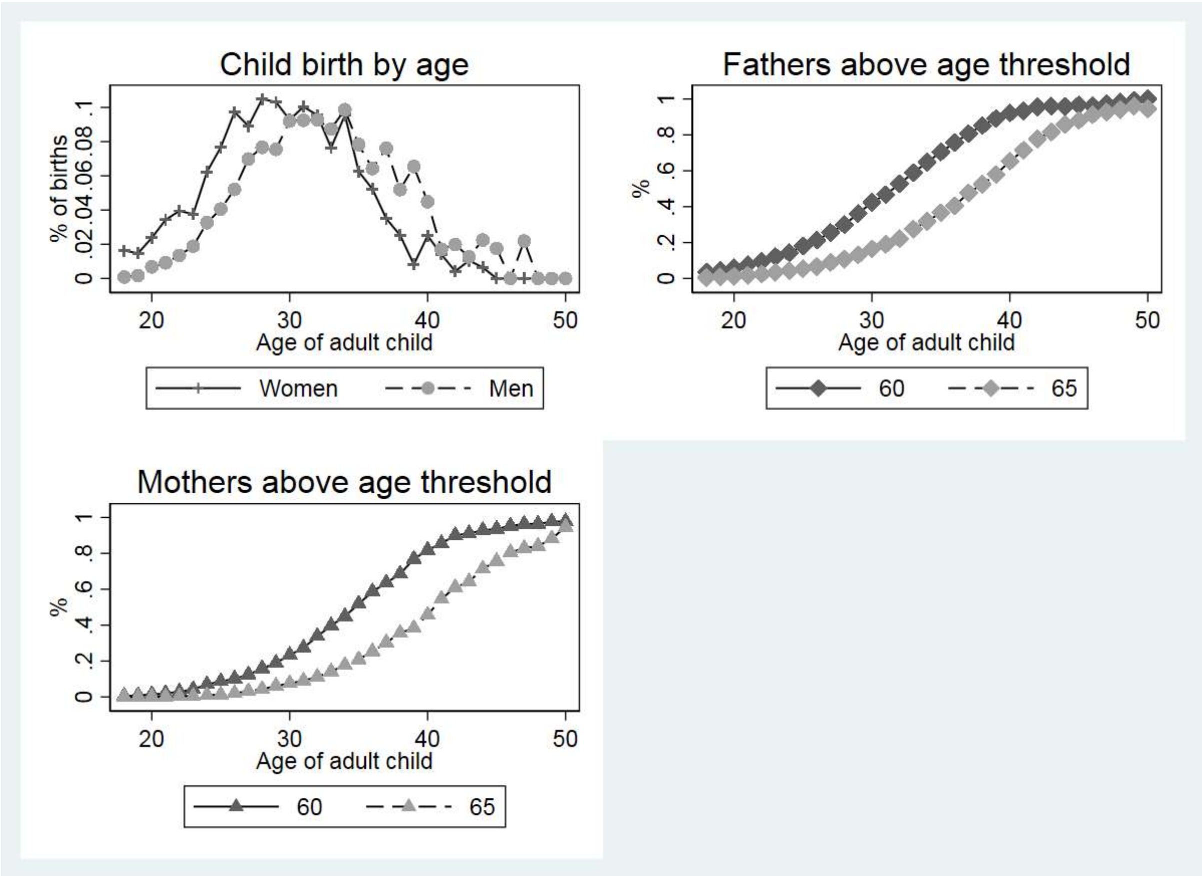
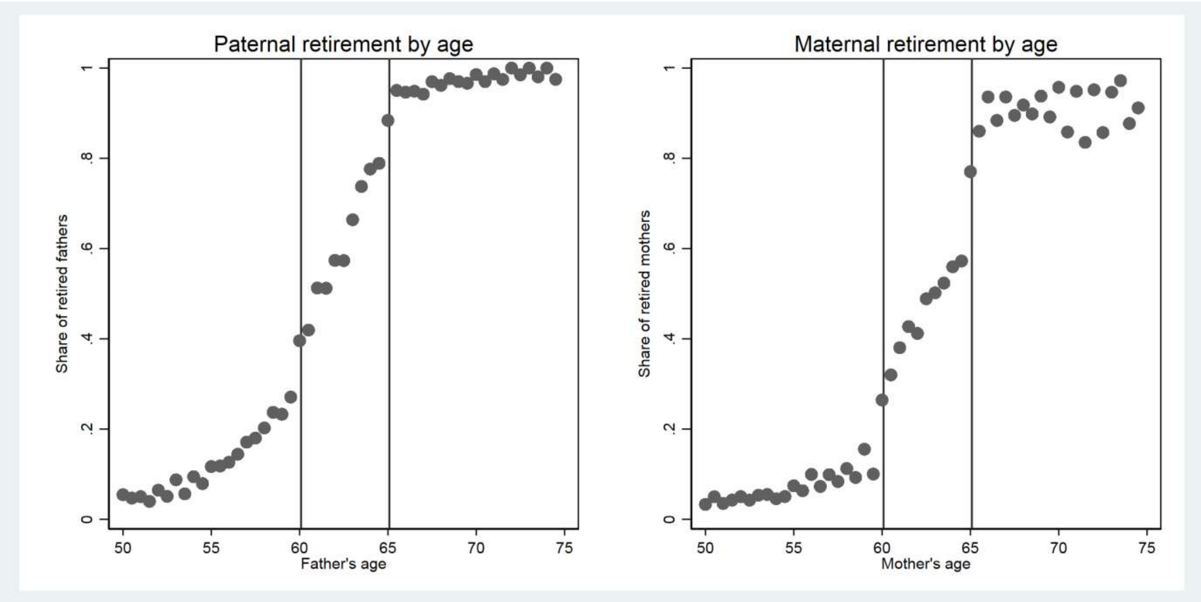
Figures and Tables

Figure 1: Grand(child) birth and parental eligibility by adult children's age



Source: SOEPv32.1. The upper left panel shows the share of adult children with a childbirth in a given year by age. The upper right and lower left panel show the share of fathers/mothers above the age threshold at age 60 and 65 by adult children's age.

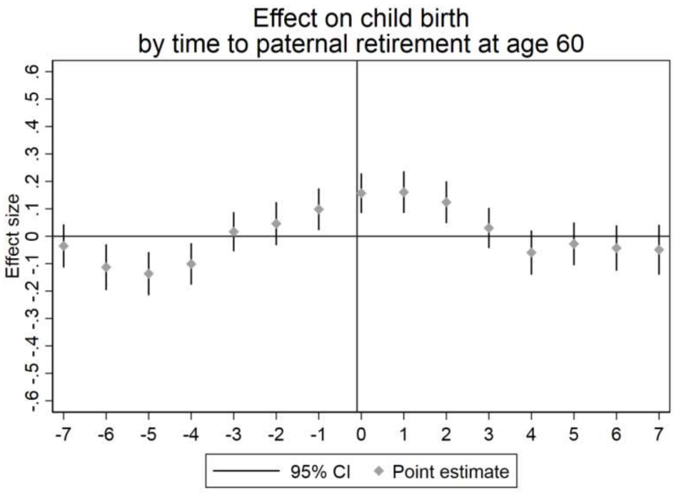
Figure 2: Parents' propensity to retire by age



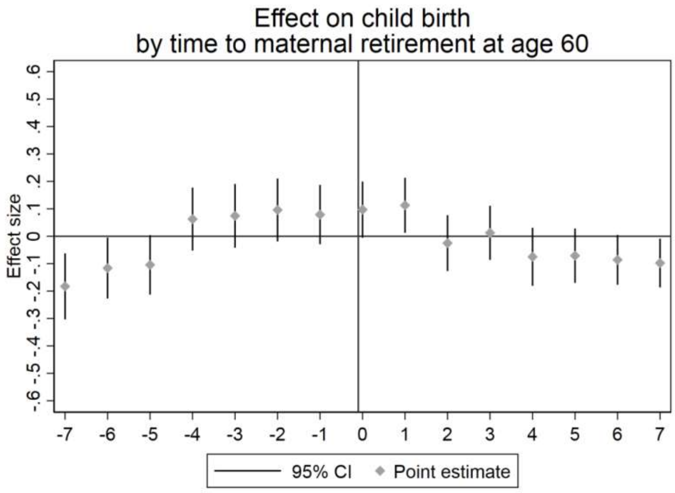
Source: SOEPv32.1, own calculations. The dots show the share of retired parents in the working sample over bins of six months. The vertical lines mark the thresholds for early and official retirement in Germany.

Figure 3: Parents' retirement at age 60 and the timing of grandchild birth

A. Father's retirement



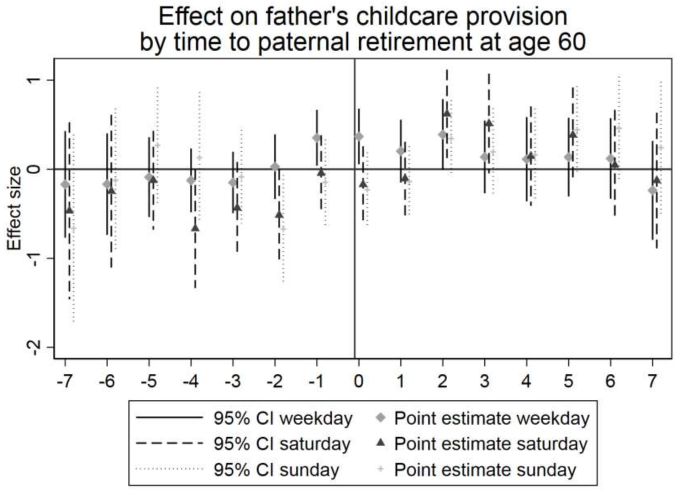
B. Mother's retirement



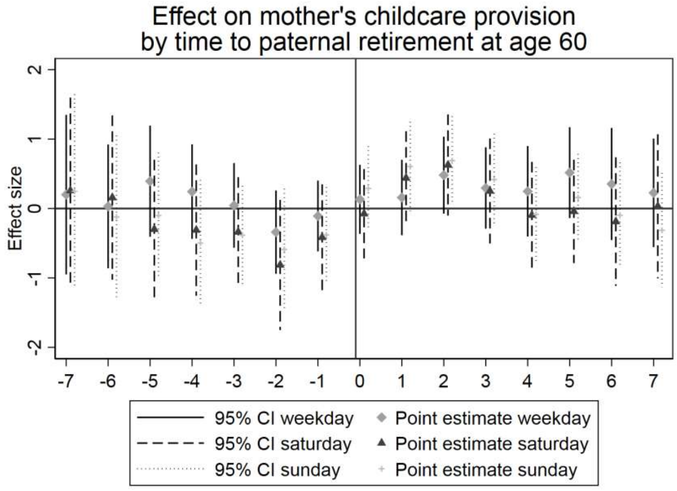
Source: SOEPv32.1, own calculations. The figure shows the effect of parental retirement in year *t* on the probability of child birth in each year between *t-7* to *t+7*. The models include a quadratic trend for parental age. Models for paternal retirement include a linear trend in children's age and models for maternal retirement include a quadratic trend in children's age. Children are aged 25 to 40, parents are aged 50 to 70. Dots show the point estimates and the lines provide 95-percent confidence intervals.

Figure 4: Parents' retirement at age 60 and the timing of childcare provision

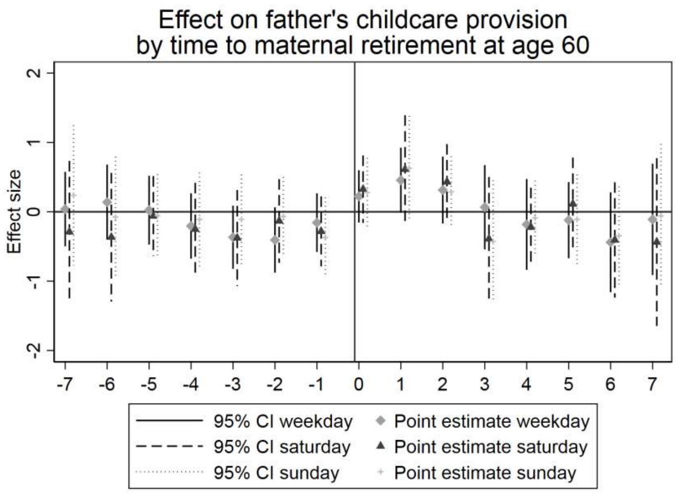
Panel A



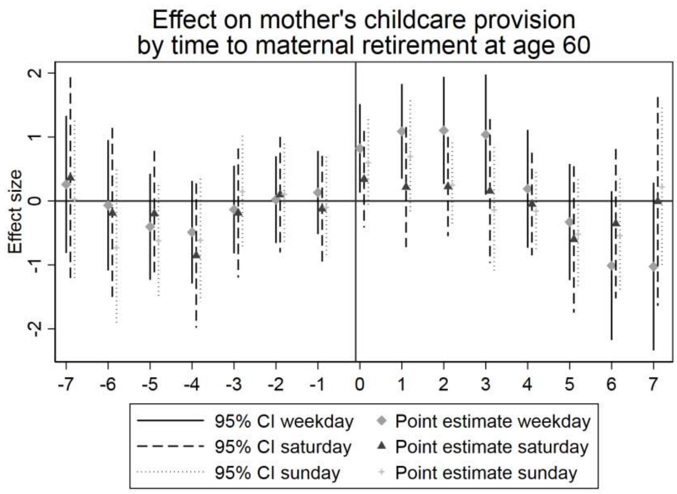
Panel B



Panel C



Panel D



Source: SOEPv32.1, own calculations. The figure shows the effect of parental retirement in year *t* on childcare provision by the father/mother in each year between *t-7* to *t+7*. The models include a quadratic trend for parental age. Children are aged 25 to 40, parents are aged 50 to 70. Dots show the point estimates and the lines provide 95-percent confidence intervals. Panels A and D show the effect of paternal/maternal retirement on their own childcare provision, while panels B and C shows the effect of retirement of the father on childcare provision by the mother and vice versa.

Table 1: Parents' early retirement and adult children's fertility

Dependent variable: Grandchild birth in year t+1			
	All	Daughters	Sons
A. Fathers			
Retired	0.161***	0.176***	0.149***
	(0.039)	(0.058)	(0.052)
Above discontinuity (first-stage)	0.195***	0.195***	0.194***
	(0.013)	(0.019)	(0.018)
Wald F	211.046	100.725	109.507
N	20,519	9,552	10,967
B. Mothers			
Retired	0.113**	0.139*	0.091
	(0.051)	(0.075)	(0.070)
Above discontinuity (first-stage)	0.146***	0.144***	0.148***
	(0.016)	(0.023)	(0.023)
Wald F	84.266	40.392	43.448
N	19,486	9,224	10,262

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. All models include child-fixed effects. Children are aged 25 to 40. The models include a quadratic trend for child's age, father's age as well as mother's age. Parents are aged 50 to 70. Significance: * p<0.1, ** p<0.05, *** p<0.01.

Table 2: Parents' early retirement and adult children's fertility–Heterogeneous effects by individual characteristics

Dependent variable: Child birth of second generation in the next year							
	Child-parent geographic distance		Adult children's household income before parent's early retirement		Adult children's family size before parent's early retirement		
	≤ 1 hour	> 1 hour	≤ 25th pct	> 75th pct	0	1	2+
Panel A							
Father-child	0.219***	0.084	0.125*	0.274***	0.067	0.341**	0.205
	(0.060)	(0.149)	(0.067)	(0.079)	(0.048)	(0.137)	(0.143)
Wald F	102.25	17.495	51.430	57.679	86.520	27.390	17.545
N	11,363	2,398	2,904	2,964	6,282	2,901	3,220
Panel B							
Mother-child	0.139*	0.179	0.028	0.252***	0.110**	0.460**	-0.153
	(0.071)	(0.151)	(0.090)	(0.097)	(0.050)	(0.198)	(0.123)
Wald F	52.551	14.883	19.754	22.055	45.306	11.866	20.570
N	11,477	2,399	2,241	2,321	4,485	2,371	2,757

Sources: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include child-fixed effects. Children are aged 25 to 40. Parents are aged 50 to 70. The models for fathers include a linear trend for child's age, models for mothers include a quadratic trend. Significance: * p<0.1, ** p<0.05, *** p<0.01.

Table 3: Parents' early retirement and adult children's fertility—Heterogeneous effects by contextual factors

Dependent variable: child birth of the second generation				
	Place of residence of the parent in 1989		Time period	
Robustness check	East Germany	West Germany	1984-1999	2000-2015
Panel A				
Father-child	0.190**	0.161***	0.221	0.127***
	(0.078)	(0.047)	(0.161)	(0.047)
Wald F	53.688	144.278	20.805	142.02
N	5,331	14,794	5,370	14,975
Panel B				
Mother-child	0.005	0.296**	0.296**	0.098
	(0.037)	(0.140)	(0.149)	(0.064)
Wald F	140.743	16.212	19.342	55.673
N	5,008	14,105	4,740	14,582

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include child-fixed effects. * p<0.1, ** p<0.05, *** p<0.01.

Table 4: Early retirement and elderly parents' time use

	Dependent variable: Average hours of childcare in year t+1 provided by…					
	Father			**Mother**		
	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
Retired father	0.203	-0.105	-0.138	0.158	0.44	0.605*
	(0.180)	(0.211)	(0.201)	(0.277)	(0.344)	(0.328)
Wald F	105.862	84.736	88.543	102.239	79.352	79.916
N	10,443	4,993	5,069	10,506	5,026	5,089
Retired mother	0.456*	0.614	0.627	1.089***	0.217	0.695
	(0.239)	(0.397)	(0.383)	(0.378)	(0.479)	(0.445)
Wald F	54.035	38.848	37.749	53.724	37.834	39.186
N	9,772	4,689	4,753	9,850	4,719	4,780

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include quadratic age trend for parental age. Parents are aged 50 to 70 and have children aged 25 to 40. Significance: * p<0.1, ** p<0.05, *** p<0.01.

Table 5: Parents' early retirement and adult children's fertility—Robustness checks

	Dependent variable: child birth of the second generation								
	Higher order age polynomials		Smaller bandwidth			Alternative sample selection		Alternative definitions of early parental retirement	
Robustness check	Quartic age trend	Cubic age trend	Bandwidth of seven years	Bandwidth of five years	Bandwidth of three years	Adult children aged 20-40	Adult children aged 17-40	Retired if working less than four hours[a]	Retirement pension receipt
Panel A									
Father-child	0.192**	0.171*	0.182***	0.165**	0.076	0.141***	0.129***	0.314***	0.137***
	(0.094)	(0.088)	(0.066)	(0.079)	(0.094)	(0.035)	(0.034)	(0.088)	(0.032)
Wald F	50.423	57.328	84.823	85.933	118.671	222.005	220.73	57.817	280.751
N	20,519	20,519	16,475	12,485	7,759	29,765	32,603	19,135	18,822

Continued on next page…

Panel B

Mother-child	0.121	0.067	0.126*	0.104*	0.142*	0.078*	0.073*	0.167***	0.091*
	(0.084)	(0.064)	(0.072)	(0.055)	(0.082)	(0.041)	(0.041)	(0.062)	(0.055)
Wald F	52.744	92.066	54.173	151.849	135.955	106.902	106.719	102.587	75.133
N	19,486	19,486	14,930	11,028	6,765	27,708	29,266	17,920	18,019

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include child-fixed effects. * p<0.1, ** p<0.05, *** p<0.01. [a] Early retirement is being defined as working less than 4 hours on a typical working day.

Table 6: Parents' early retirement and child outcomes—Placebo regressions

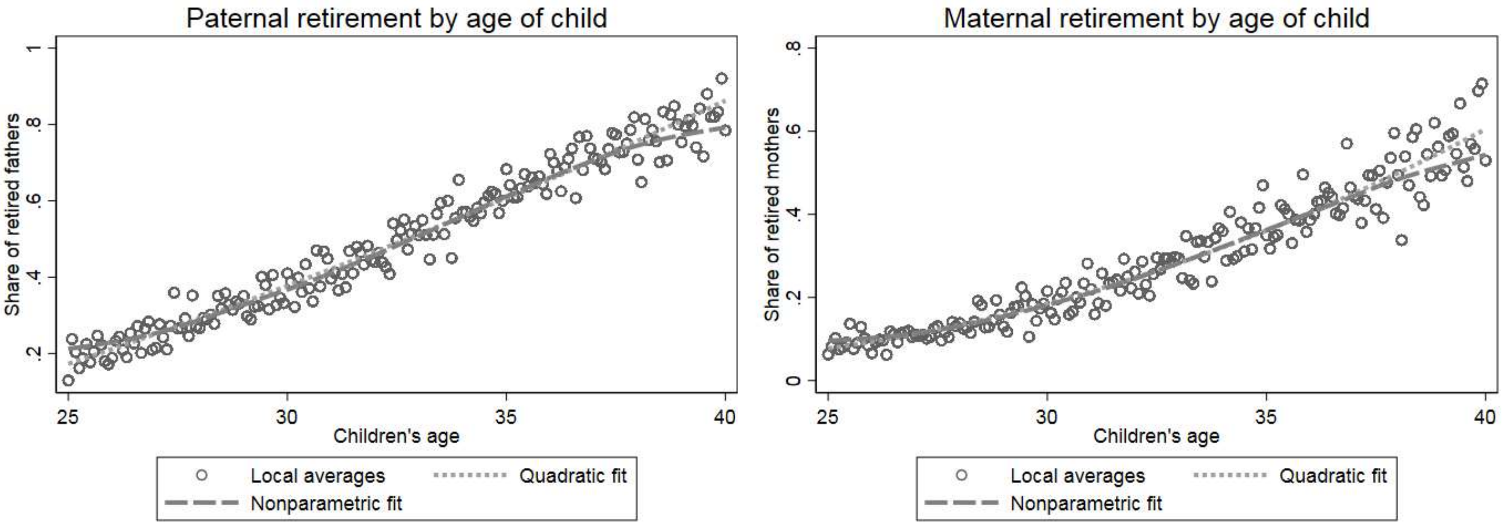
Placebo outcome	High school degree	Urban area	Strong political interest
Panel A			
Father-child	0.021	0.014	0.002
	(0.019)	(0.026)	(0.045)
Wald F	221.101	226.64	226.606
N	22,916	23,719	23,633
Panel B			
Mother-child	0.03	-0.025	-0.056
	(0.030)	(0.039)	(0.062)
Wald F	86.506	89.319	90.171
N	21,948	22,646	22,567

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include child-fixed effects. * p<0.1, ** p<0.05, *** p<0.01.

Appendix

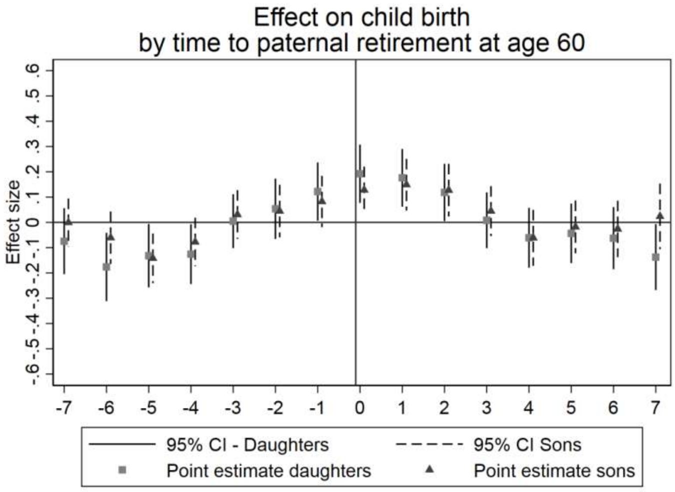
A. Additional Figures and Tables

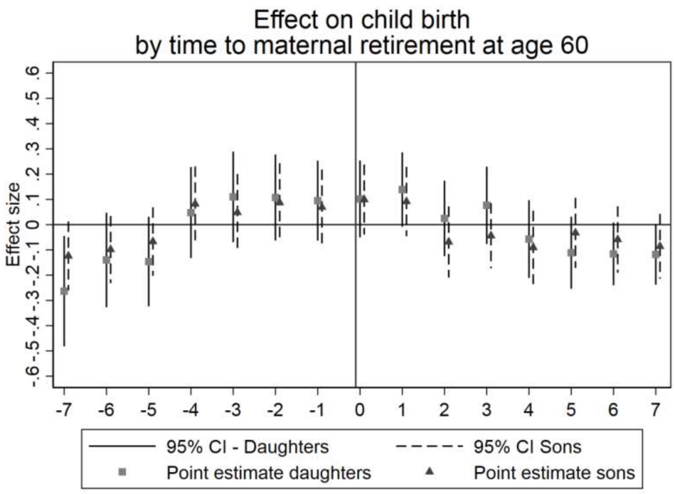
Figure A1: Parental retirement by age of child



Source: SOEPv32.1. The dots mark local averages by months of age.

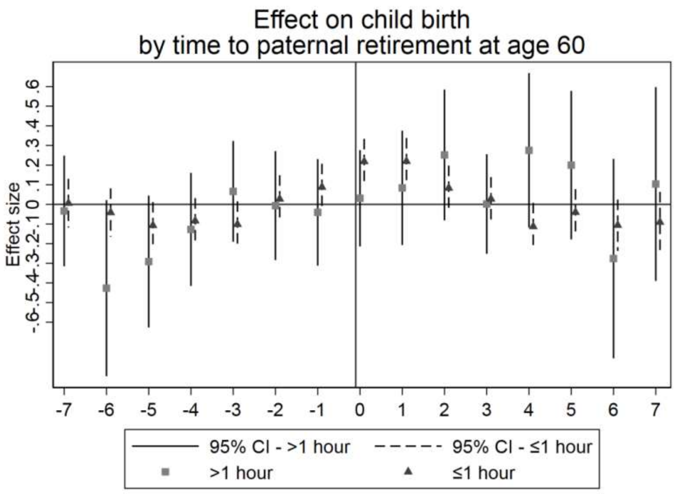
Figure A2: Parents' retirement at age 60 and the timing of grandchild birth by gender of the child

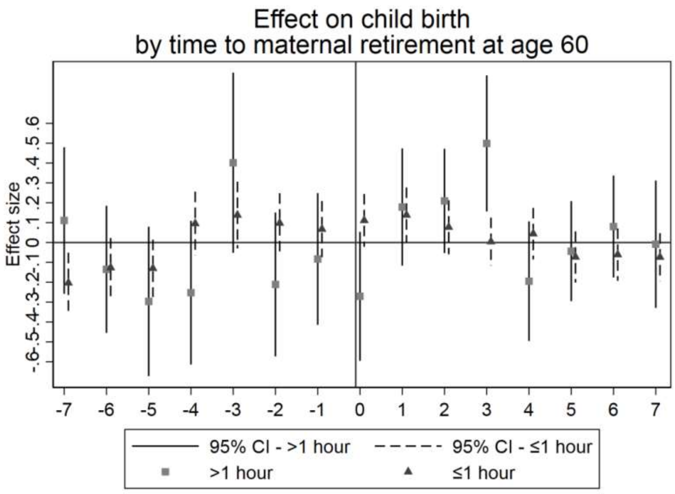




Source: SOEPv32.1, own calculations. The figure shows the effect of parental retirement in year *t* on the probability of child birth in each year between *t-7* to *t+7*. The models include a quadratic trend for parental age as well as children's age. Children are aged 25 to 40, parents are aged 50 to 70. Dots show the point estimates and the lines provide 95-percent confidence intervals.

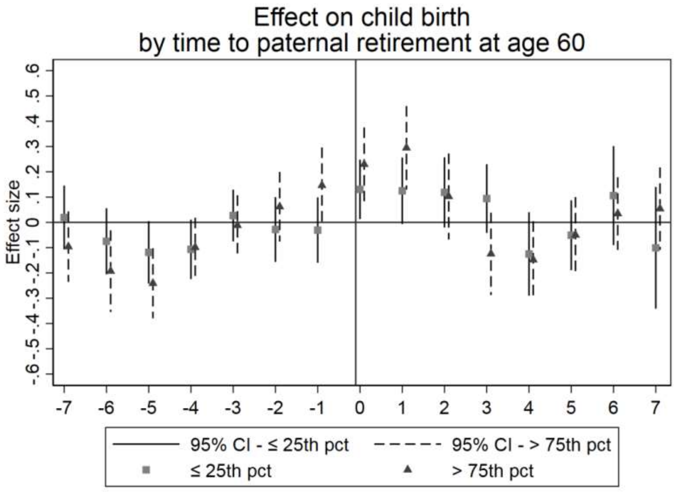
Figure A3: Parents' retirement at age 60 and the timing of grandchild birth by child-parent geographic distance

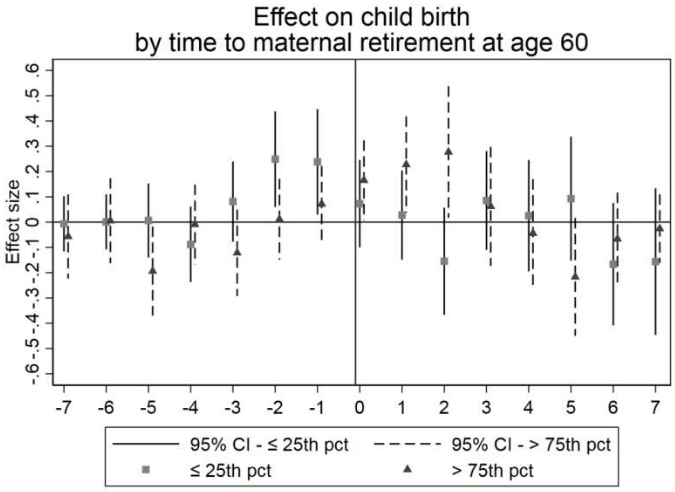




Source: SOEPv32.1, own calculations. The figure shows the effect of parental retirement in year *t* on the probability of child birth in each year between *t-7* to *t+7*. The models include a quadratic trend for parental age as well as children's age. Children are aged 25 to 40, parents are aged 50 to 70. Dots show the point estimates and the lines provide 95-percent confidence intervals.

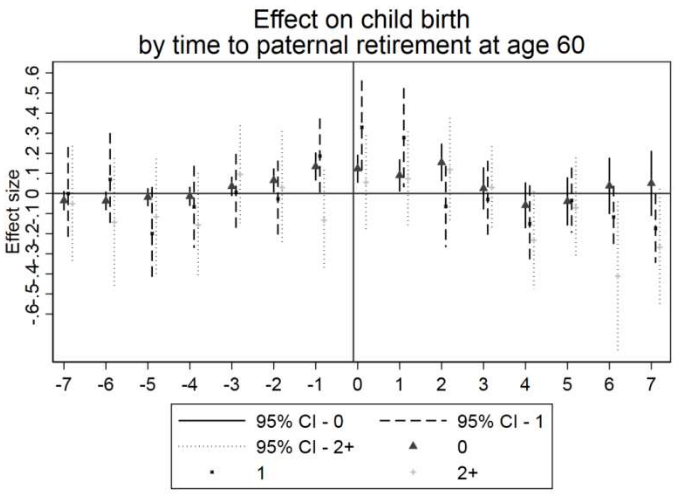
Figure A4: Parents' retirement at age 60 and the timing of grandchild birth by adult children's household income before parent's early retirement

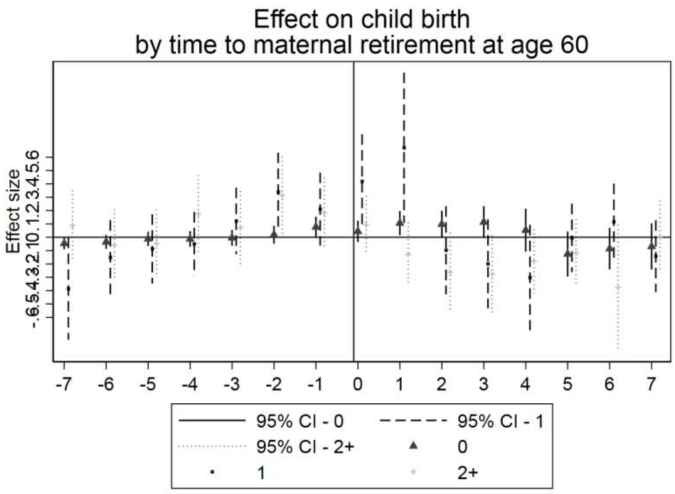




Source: SOEPv32.1, own calculations. The figure shows the effect of parental retirement in year *t* on the probability of child birth in each year between *t-7* to *t+7*. The models include a quadratic trend for parental age as well as children's age. Children are aged 25 to 40, parents are aged 50 to 70. Dots show the point estimates and the lines provide 95-percent confidence intervals.

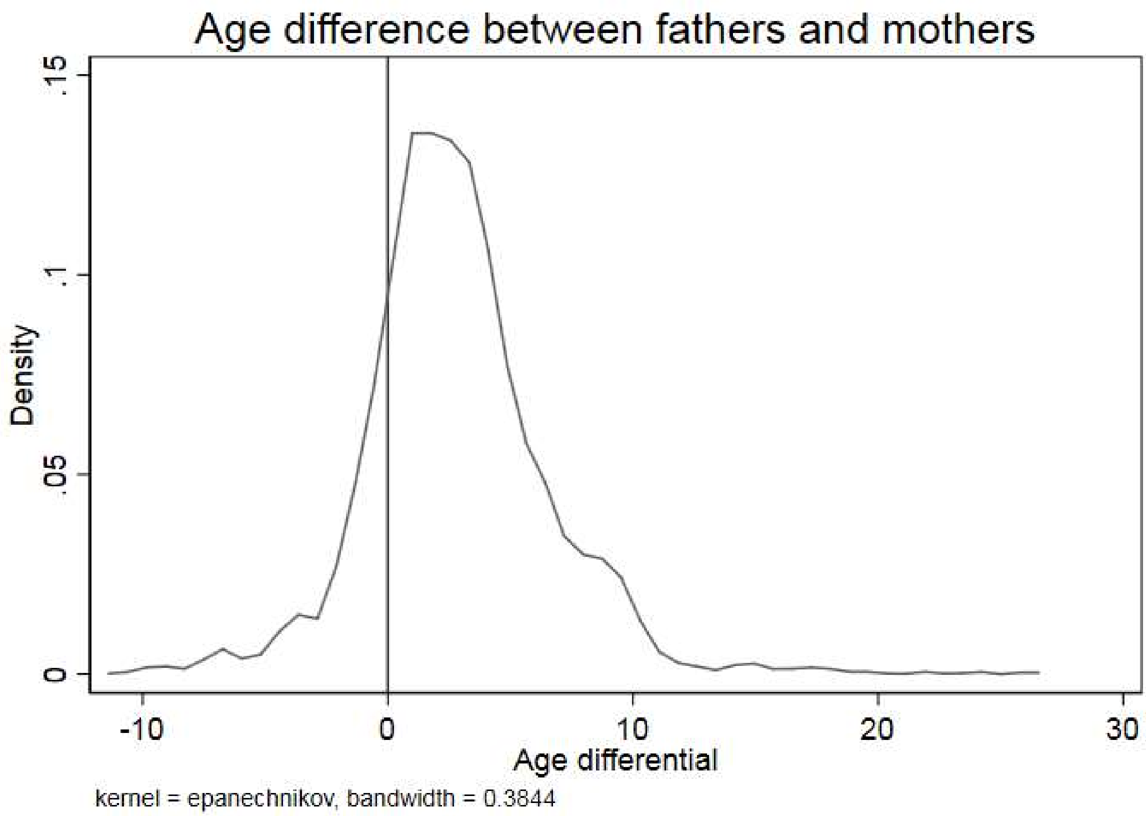
Figure A5: Parents' retirement at age 60 and the timing of grandchild birth by adult children's family size before parent's early retirement





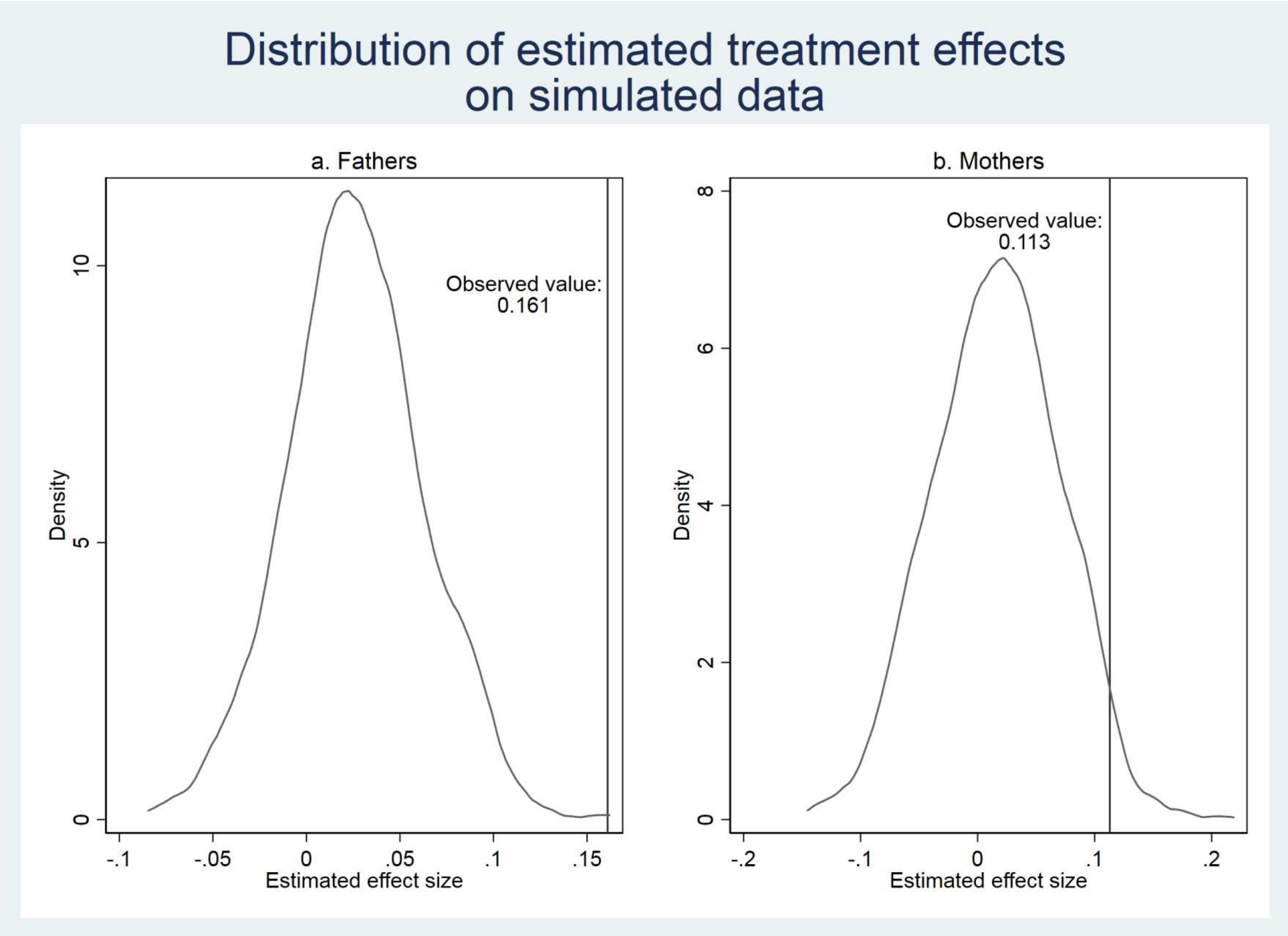
Source: SOEPv32.1, own calculations. The figure shows the effect of parental retirement in year *t* on the probability of child birth in each year between *t-7* to *t+7*. The models include a quadratic trend for parental age as well as children's age. Children are aged 25 to 40, parents are aged 50 to 70. Dots show the point estimates and the lines provide 95-percent confidence intervals.

Figure A6: Age difference between fathers and mothers



Source: SOEPv32.1, own calculations. Kernel density estimation of the distribution of age differences between linked fathers and mothers in the sample.

Figure A.7: Distribution of estimated treatment effects on simulated data under the null hypothesis



Notes: The figures show kernel density estimates using an Epanechnikov kernel. The vertical lines mark the estimated effects from Table 2.

Table A1: Summary statistics

Variable	Mean	SD	Min	Max	N
		A. Adult children			
Child birth	0.078	0.269	0	1	25,993
Time spent on childcare					
Weekday	2.6	4.8	0	24	24,494
Saturday	3.7	5.8	0	24	12,151
Sunday	4.0	5.9	0	24	12,286
Demographics					
Age	31.0	4.0	25	40	25,993
Male gender	0.533	0.499	0	1	25,993
Household income	3,144.6	1,789.9	0	48,262	24,977
		B. Elderly fathers			
Demographics					
Age	60.1	5.8	41	84	25,903
Retired	0.433	0.496	0	1	25,990
Time spent on childcare					
Weekday	0.2	0.9	0	20	23,751
Saturday	0.3	1.0	0	24	11,792
Sunday	0.2	1.0	0	24	11,928

continued on next page…

Variable	Mean	SD	Min	Max	N
		C. Elderly mothers			
Demographics					
Age	57.2	5.7	40	77	25,889
Retired	0.227	0.419	0	1	25,990
Time spent on childcare					
Weekday	0.5	1.5	0	40	23,908
Saturday	0.5	1.6	0	24	11,894
Sunday	0.4	1.6	0	24	12,002

SOEPv32.1

Table A2: Bandwidth selection using 50-fold cross-validation

Bandwidth	10	7	5	3
Age range	50-70	53-67	55-65	57-63
A. Fathers				
% correctly predicted treatment	0.616	0.622	0.640	0.639
% correctly predicted outcome	0.925	0.925	0.925	0.921
B. Mothers				
% correctly predicted treatment	0.786	0.777	0.774	0.775
% correctly predicted outcome	0.930	0.930	0.930	0.929

Sources: SOEPv32.1. Results are based on the data for father's retirement. Estimates are derived from a linear regression model including a linear trend for children's age, a quadratic trend for father's age, child-, year- and month-fixed effects. Predicted outcome and treatment were assumed to take the value "1" if the linear predictor was above 0.5, and "0" otherwise.

Table A3: Parents' early retirement and adult children's fertility–Heterogeneous effects by individual characteristics

Dependent variable: Child birth of second generation in the next year							
	Child-parent geographic distance (travel time)		Adult children's household income before parent's early retirement		Adult children's family size before parent's early retirement		
	≤ 1 hour	> 1 hour	≤ 25th pct	> 75th pct	0	1	2+
Panel A							
Father-child	0.219***	0.084	0.125*	0.274***	0.067	0.341**	0.205
	(0.060)	(0.149)	(0.067)	(0.079)	(0.048)	(0.137)	(0.143)
Wald F	102.25	17.495	51.430	57.679	86.520	27.390	17.545
N	11,363	2,398	2,904	2,964	6,282	2,901	3,220
Father-daughter	0.214***	-0.083	0.193**	0.294**	0.099	0.373**	0.117
	(0.079)	(0.294)	(0.098)	(0.136)	(0.080)	(0.171)	(0.162)
Wald F	56.769	4.603	27.356	22.051	35.509	16.841	11.137
N	5,464	1,228	1,447	1,276	2,651	1,541	1,620
Father-son	0.238**	0.112	0.067	0.249***	0.045	0.310	0.337
	(0.094)	(0.176)	(0.100)	(0.093)	(0.059)	(0.222)	(0.294)
Wald F	46.093	12.08	21.095	35.834	51.181	9.867	5.705
N	5,899	1,170	1,457	1,688	3,631	1,360	1,600
Panel B							
Mother-child	0.139*	0.179	0.028	0.252***	0.110**	0.460**	-0.153
	(0.071)	(0.151)	(0.090)	(0.097)	(0.050)	(0.198)	(0.123)
Wald F	52.551	14.883	19.754	22.055	45.306	11.866	20.570
N	11,477	2,399	2,241	2,321	4,485	2,371	2,757
Mother-daughter	0.194**	0.025	0.065	0.236	0.114	0.521	-0.117

	(0.099)	(0.178)	(0.122)	(0.145)	(0.078)	(0.323)	(0.146)
Wald F	27.71	8.559	10.360	11.153	23.375	4.418	12.983
N	5,669	1,248	1,163	1,031	1,864	1,274	1,460
Mother-son	0.073	0.372	-0.026	0.270**	0.105	0.443*	-0.174
	(0.102)	(0.295)	(0.127)	(0.122)	(0.065)	(0.263)	(0.214)
Wald F	24.557	5.791	10.485	11.842	23.105	7.687	7.310
N	5,808	1,151	1,078	1,290	2,621	1,097	1,297

Sources: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include child-fixed effects. Children are aged 25 to 40. Parents are aged 50 to 70. The models for fathers include a linear trend for child's age, models for mothers include a quadratic trend. Significance: * p<0.1, ** p<0.05, *** p<0.01.

Table A4: Parents' early retirement and adult children's fertility—Heterogeneous effects by contextual factors

Dependent variable: child birth of the second generation				
	Place of residence of the parent in 1989		Time period	
Robustness check	East Germany	West Germany	1984-1999	2000-2015
Panel A				
Father-child	*0.190***	0.161***	0.221	0.127***
	(0.078)	(0.047)	(0.161)	(0.047)
Wald F	*53.688*	144.278	20.805	142.02
N	*5331*	14794	5370	14975
Father-daughter	*0.219**	0.172**	0.101	0.159**
	(0.116)	(0.070)	(0.267)	(0.067)
Wald F	*27.112*	69.309	8.322	72.553
N	*2480*	6920	2273	7200
Father-son	0.178*	0.151**	0.305	0.096
	(0.104)	(0.064)	(0.210)	(0.064)
Wald F	26.989	74.416	11.958	69.5
N	2,851	7,874	3,097	7,775
Panel B				
Mother-child	0.005	0.296**	0.296**	0.098
	(0.037)	(0.140)	(0.149)	(0.064)
Wald F	140.743	16.212	19.342	55.673
N	5008	14105	4740	14582

Mother-daughter	-0.019	0.492*	0.420*	0.114
	(0.052)	(0.287)	(0.250)	(0.090)
Wald F	77.998	5.67	8.177	29.008
N	2377	6688	2021	7129
Mother-son	0.027	0.177	0.208	0.08
	(0.052)	(0.156)	(0.181)	(0.092)
Wald F	62.113	10.618	11.199	26.414
N	2,631	7,417	2,719	7,453

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include child-fixed effects. * p<0.1, ** p<0.05, *** p<0.01.

Table A5: Elderly parents' joint retirement

	Dependent variable: both parents retired
Retired father	-0.087
	(0.071)
Wald F	113.734
N	13,359
Retired mother	0.626***
	(0.071)
Wald F	65.086
N	12,599

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. Wald F provides the Kleibergen-Paap Wald F statistic for the first-stage regression. All models include father- or mother-fixed effects as well as a quadratic age trend for the father's or mother's age, respectively. Parents are aged 50 to 70.

Table A.6: Maternal, paternal and joint retirement and adult children's fertility

Dependent variable: grandchild birth in year t+1			
	All children	Daughters	Sons
Retired father	0.147***	0.175***	0.126**
	(0.043)	(0.066)	(0.056)
Retired mother	0.160**	0.203**	0.122
	(0.074)	(0.101)	(0.110)
Both retired	-0.146	-0.172	-0.113
	(0.120)	(0.184)	(0.161)
N	18,124	8,556	9,568

Source: SOEPv32.1, own calculations. Clustered standard errors in parentheses. All models include child-fixed effects. Children are aged 25 to 40. The models include a quadratic trend for the child's age, the father's age, and the mother's age. Parents are aged 50 to 70.

B. State pension schemes in Germany

The German state pension fund offers six different pension types. While contributing to the pension fund, individuals do not have to choose between these different types. Instead, these pension types represent different routes into retirement, essentially allowing certain subgroups of the population to claim a pension earlier than others. In the following, we describe these different schemes and provide details on recent reforms to these pension types. The description is primarily based on information from the German pension fund (DRV, 2015b) as well as the relevant legal norms (§235ff. SGB VI).

The standard old age pension is intended to be the normal route into retirement, i.e., this pension type has the highest age threshold, but features only minimal additional eligibility criteria. Specifically, individuals need to have been insured for at least five years before claiming the standard old age pension. In the past, the age threshold for this pension was 65 years. For cohorts born between 1947 and 1958 the eligibility age increases by one month per cohort, while for cohorts born between 1959 and 1963 the eligibility age increases by two months per birth cohort. For individuals born from 1964 onwards the age threshold will be 67 years.

The pension for women was intended to offer an earlier retirement to women. Women born in 1939 or earlier were able to claim a full pension, if they have been insured for at least 15 years and paid contributions for 10 years after their 40th birthday. The age threshold of 60 was increased by one month per birth month for cohorts born between 1940 and 1944. For women born from 1945 to 1951, the age threshold for a full pension was 65 years. However, women born between 1940 and 1951 were still able to retire at 60, however, they had to accept deductions from their pension of 0.3% for each month of early retirement. For example, a women born in 1946 could retire at age 60 if she would be prepared to accept a deduction of 18% from her monthly pension (0.3% for each of the 60 months between age 60 and the age threshold at age 65), while the deduction for a women born in January 1941 would be 3.6%, since the official age threshold for her cohort was 61 years. Women born from 1952 onwards are not able to claim this type of pension anymore.

The pension for long-term insured individuals offers individual with at least 35 years of insurance the option to retire early. For individuals born before 1949, the eligibility age for a full pension was 65 years. For individuals born between 1949 and 1964, the age threshold increases stepwise from 65 years to 67 years. For individuals born from 1965 onwards the age threshold is 67 years. This means that the age threshold for a full pension is almost exactly the same as the age threshold for the standard old age pension. However, in contrast to the standard old age pension the pension for long-term insured offers eligible individuals the option to retire early at age 63 regardless of their birth cohort. However, individuals have to accept deductions of 0.3% for each month of early retirement. Certain individuals are also eligible to retire early before age 63 due to grandfathering rules. Further details are provided in DRV (2015b).

The pension for especially long-term insured individuals allows individuals with at least 45 contribution years to retire early with a full pension (i.e., without the deductions described above). While periods of non-employment due to childcare provision, long-term care provision, long-term sickness or injury as well as military or civil service are counted against the requirement of 45 contribution years, periods of unemployment, pension splitting among spouses as well as pension rights adjustments due to divorce are not counted against this requirement (in contrast to the pension for long-term insured, which does take these periods into account). Individuals born before 1953 can claim this pension from age 63 onwards. For individuals born between 1954 and 1963 the age threshold is increased stepwise. For individuals born from 1964 onwards, the age threshold is 65 years.

The pension for severely disabled individuals allows individuals with a severe disability to retire early. Severely disabled individuals are defined as individuals whose degree of disability is 50 or above.[48] However, individuals born before 1951 were also able to claim this pension type if they had an occupational disability.[49] To be eligible, individuals also need at least 35 years of insurance. For individuals born before 1952, the age threshold for a full pension was 63 years. Early retirement was possible from age 60 onwards, however, this involved a deduction of 0.3% for each month of early retirement. For individuals born between 1952 and 1963, the age threshold is increased stepwise from 63 to 65, while the age threshold for early retirement increases from 60 to 62. For individuals born from 1964 onwards, the age threshold for a full pension is 65, while early retirement with a reduced pension is possible from age 62 onwards. It should be noted that there are also grandfathering rules for certain subgroups.

Finally, the pension for unemployed or partially retired individuals allowed unemployed or partially retired individuals to claim their pension early. This pension type required eligible individuals to have been insured for at least 15 years as well as having paid contributions for at least eight out of the last ten years. To claim a pension due to unemployment, eligible individuals had to be unemployed when claiming their pension. Moreover, they were only eligible if they had been unemployed for at least 52 weeks since turning 58 years and 6 months old. Partially retired individuals were eligible to claim their pension if they had been in partial retirement for at least 24 months. In this context, partial retirement meant that individuals had agreed on a partial retirement scheme with their employer. In general, these partial retirement schemes allowed older employees to reduce their working time in old age

[48] The degree of disability is based on the limitations in their usual activities caused by an individual's health problems. It ranges from 20 to 100 in increments of 10.

[49] In contrast to the degree of disability, occupational disability only considers an individual's capacity to work.

by half, while employers were obligated to pay a salary of at least 60% of their original salary (50% of the original salary plus a top-up of at least 20%) in addition to higher pension insurance contributions. In turn, employers were able to reclaim these additional expenses from the state if they hired a trainee or unemployed person to replace the partially retired employee. The scheme granted employers and employees considerable leeway regarding the distribution of the reduced working time. In practice, the most common agreement involved two separate phases: In the first phase, employees would continue to work fulltime while already having their salary reduced. Then, in the second phase employees would stop working, while their employer continued to pay their reduced salary until they were able to claim a state pension.

The eligibility age for the pension for unemployed or partially retired individuals was increased several times since the year 2000. Individuals born before 1937 were able to claim a full pension from age 60 onwards. The age threshold increased by one month per birth month cohort for individuals born between January 1937 and December 1941. Individuals born between 1942 and 1951 were able to claim a full pension from age 65 onwards. Individuals born before 1945 were able to retire early at age 60, however, they had to accept deductions of 0.3% for every month of early retirement. The age threshold for early retirement was increased stepwise from 60 to 63 for individuals born between January 1946 and December 1948. Individuals born from 1949 to 1951 were able to claim their pension early from age 63 onwards. Individuals born from 1952 onwards are not eligible for this type of pension.

C. Bandwidth choice

The choice of the age polynomial for parents as well as the bandwidth is crucial to obtain valid estimates of the discontinuity in the first- and second-stage equation. The bandwidth limits the age range used for the estimation and requires a trade-off between bias and variance. A narrow bandwidth would restrict our sample to observations where the parents are very close to the age threshold. This would minimize bias but result in a large variance of the estimates, since the estimation sample would consist of very few observations. In contrast, a wide bandwidth would result in a low variance due to the higher number of observations but would increase the risk of bias in our estimates. The choice of the age polynomial is related to this trade-off, since a large bandwidth would require a more complex age polynomial to accurately model the relationship between parent's age and fertility or retirement, respectively.

This implies that we have to simultaneously choose an optimal bandwidth and age polynomials. We approach this problem by selecting the optimal bandwidth for a pre-specified age trend. We chose a quadratic trend for parental age, since quadratic age trends are commonly used in the literature on retirement and health (see, e.g., Coe and Zamarro, 2011; Insler, 2014). For the choice of the optimal bandwidth, we adopt a cross-validation procedure suggested by Lee and Lemieux (2010). Specifically, we divide our sample into 10 subsamples. Then, for both the first- and the second-stage equation, we estimate a linear regression of the outcome (i.e., childbirth or parental retirement) on adult children's age, a quadratic trend for parental age, and fixed effects for child as well as year and month of the interview using 9 of the 10 subsamples. The estimates of the regression are used to predict the outcome for the subsample left out of the estimation. This is done in turn so that each subsample is used once. Following the literature, we only use observations within a narrow range of the threshold (one year) for prediction.

Since both our treatment and outcome variables are binary indicators, we use the percentage of correctly predicted events (i.e., retirement or childbirth) as a measure of goodness of fit. If the linear predictor is at or above 0.5, the event is predicted as being one, and zero otherwise. This procedure is then repeated using different bandwidths for the estimation. We initially chose a bandwidth of ten years, since this bandwidth has been used in earlier studies on retirement (Moreau and Stancanelli, 2013; Stancanelli and Van Soest, 2012). We then explore smaller bandwidths of seven, five, and three years. We apply this cross-validation procedure to both the first- and the second-stage equation and analyse the mother's and father's retirement separately.

Table A2 shows that larger bandwidths result in better prediction accuracy for the outcome for both fathers and mothers. For the treatment variable, a bandwidth of 5 years provides the highest prediction accuracy for fathers, while for mothers the accuracy is highest for a bandwidth of 10 years. Therefore, we chose a bandwidth of ten years and a quadratic trend for parental age as our main specification.

D. Joint parental retirement

So far, we have studied parents' retirement decisions independently of each other. In this sub-section, we distinguish between mother's, father's, and joint retirement decisions. Figure A6 displays the distribution of the age difference between fathers and mothers in our sample. The figure shows that in the majority of elderly couples, men are older than women, with the mass of the density of around one to five years age difference. Table A.5 presents estimates of parents' joint retirement decisions. Using our preferred specification, we estimate the effect of the mother's and father's retirement on the probability that both partners are retired,[50] respectively. The results from the two linear probability models clearly show that father's retirement is not positively related to joint retirement, with a point estimate of -0.087. In contrast, mothers' retirement significantly increases the likelihood that both parents are retired, with an increase of around 63 percentage points. This association is precisely estimated and significantly different from zero at the one percent level. Hence, these findings suggest that *(1)* fathers tend to retire first, and *(2)* that maternal (but not paternal) retirement increases the likelihood of joint retirement.

Table A.6 presents estimates of paternal, maternal, and joint retirement on adult children's fertility behavior. In contrast to Tables 1 to 3, the models in Table A.6 include three endogenous regressors—a dummy variable for father's retirement, a dummy variable for mother's retirement and an interaction effect of both. Similarly, we use three instruments—*(i)* whether the father is above the age threshold for early retirement, *(ii)* whether the mother is older than 60, and *(iii)* whether both father and mother are above age 60. Consequently, the results should be interpreted as follows. The first row, "retired father," shows the effect of father's retirement if the mother is not (yet) retired. The second row, "retired mother," shows the effect of the mother's retirement if the father is not yet retired. The third row, "both

[50] The outcome is equal to one if both parents are retired, and zero otherwise.

retired," shows the interaction effect between the father's retirement and the mother's retirement. If the effects of retirement on fertility and time use are driven by joint retirement decisions, we would expect the estimates in this third row to be significant, which would indicate that joint retirement has an effect over and above the effects of the father's and mother's retirement when analysed separately. Conversely, if the effect of joint retirement can be entirely explained by analysing the father's and mother's retirement separately, we would expect the interaction effect to be close to zero and not statistically significant. Finally, if joint retirement occurs very rarely, the effect will be imprecisely estimated. In all three of these cases, the full effect of joint retirement (i.e., both the father and mother are retired) can be derived by adding up the point estimates in all three rows. The estimates in Table A.6 show that the effects of parents' retirement on their children's fertility are unlikely to be the result of joint retirement: the estimated coefficients on the variable "both retired" are negative and not significantly different from zero at conventional levels.

E. Simulation Study One potential limitation of our research design is that for most observations in our sample both retirement and child birth occur within relatively narrow age ranges–i.e., most parents retire between ages 60 and 65 (Figure 2), while for their adult children child birth is most common between ages 25 and 35 (Figure 1). Even though we control for both parents' and children's age, the correlation between parents' and children's age is still of concern. If there is a strong link between children's and parents' age, then it would be possible that the age range in which most parents' retire coincides with the age range where child birth is more common for their adult children. We conduct a simulation study to assess whether this phenomenon could confound our estimates. We simulate 1,000 datasets under the null hypothesis, i.e., no effect of retirement on child birth. Then, we estimate our preferred specification (Table 1) on each of these simulated datasets to obtain a point estimate under the null hypothesis. Finally, we can compare our actual estimates in

Table 1 against the distribution of point estimates from the simulated data. The position of our observed estimate in the distribution of simulated estimates shows how "extreme" our observed estimate is, i.e., how often we would observe a point estimate of comparable magnitude if the null hypothesis were true. If our identification strategy works as intended, we would expect that the distribution of point estimates from the simulated data is centered around zero, while our observed estimates represent extreme values in the tails of the distribution. In contrast, if our results are indeed confounded by the correlation between children's fertile ages and parents' retirement ages, then the distribution of point estimates under the null hypothesis could be centered around positive values.

We generate datasets under the null hypothesis by constructing "placebo outcomes", i.e., outcomes which are independent of parents' retirement, but which still depend on parents' and children's age.[51] For this purpose, we calculate average birth rates, taking into account gender of the child, age of the child, age of the parent, and year of observation.[52] We calculate the average birth rate for all combinations of these characteristics by averaging over our outcome variable (child birth in year t+1). This birth rate is by construction independent of parent's retirement, since we do not use information on parent's retirement when calculating the birth rates. Moreover, the cells for parent's age are deliberately chosen to include observations on both sides of our threshold in the regression discontinuity design. Therefore, treated and untreated observations within the same cell are assigned the same birth rate. We generate placebo outcomes using a random draw from a Bernoulli distribution,

[51] We use placebo outcomes rather than placebo treatments, since a placebo treatment variable would be affected by weak instrument problems. The relationship between treatment and instrument is not of concern in this analysis, and therefore we need to preserve the relationship between both variables.

[52] To be precise, we distinguish between the following groups. Age of the child: 25-29, 30-34, and 35-40 years. Age of the parent: 47.5-52.5, 52.5-57.5, 57.5-62.5, 62.5-67.5, and 67.5-72.5 years. Year of observation: 1984-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014.

where the birth rates serve as success probabilities. This process should provide us with a simulated dataset in which the null hypothesis holds (i.e., retirement does not affect child birth probabilities, since treated and untreated individuals within the same cell have equal child birth probabilities), while at the same time the correlations between parents' age, children's age, time period, and child birth are preserved.

The results of this simulation study are shown in Figure A.7. The left panel shows the distribution of estimated effects for father's retirement, while the right panel shows the distribution of estimates for mother's retirement. The vertical lines mark the position of the observed estimates in Table 1 within the distribution. We note that while the distribution of treatment effects for mother's retirement is indeed centered around zero, the distribution of treatment effects for fathers is shifted slightly to the right, with a mean value of 0.026. This indicates that the correlation between father's age, child's age, and child birth might indeed result in a positive estimated treatment effect even if the null hypothesis holds. However, we also see that our observed estimated treatment effect for father's retirement is located at the far end of the right tail of the distribution. Only one of the estimates on simulated data is larger in magnitude than our observed estimate, which would correspond to a two-sided p-value of 0.001.

For mothers, the distribution is centered closer to zero (mean value of 0.016), however, the variance of the simulated estimates is also larger. Nevertheless, the observed estimate of 0.113 is located in the right tail of the distribution. 36 simulated estimates are larger in magnitude (i.e., larger than 0.113 or smaller than -0.113) than our observed estimate, which would correspond to a two-sided p-value of 0.036. In summary, the simulation suggests that our reported estimates are unlikely to be confounded by the correlation between children's age, parents' age and birth rates.