Does the Child Penalty Strike Twice[*]

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Abstract

This paper studies the relative labor market outcomes of grandmothers in comparison to grandfathers before and after the arrival of the first grandchild using Danish administrative data and an event study approach. We find that women's labor market outcomes decline at a steeper rate than men's after the arrival of the first grandchild. We find gender gaps in earnings of three and nine percent five and ten years after the arrival of the first grandchild, which is almost exclusively driven by women's reductions in full-time employment. We document that these "grandchild penalties" are larger in periods with more generous retirement options.

JEL codes: J13, J14, J16, J22

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1 Introduction

The narrowing gaps in education and labor market outcomes between men and women has been one of the major economic achievements of the last century. Yet convergence in earnings remains stalled. Whereas women's relative earnings are in the 90 percent range of men's earnings at the beginning of employment, it soon declines below the 70 percent level (Goldin, 2014). The arrival of children plays an important role in explaining the persistence of the gender earnings gap. Recent evidence from several developed countries shows that a 20 percent drop in earnings for women after the birth of the first child can last well into the 50s (Kleven et al., 2019a,b; Sieppi and Pehkonen, 2019). This paper uses a quasi-experimental approach using rich administrative data for Denmark to document that the persistence in gender inequality in earnings can be reinforced by the arrival of grandchildren and persist into retirement age. While the recent literature has documented a "child penalty" that contributes to gender inequality, we document that this gap is further extended into old age in the form of a "grandchild penalty".

In many societies, care for children and the elderly is provided through intra-generational exchange of time and money.[1] In Denmark, about 14 percent of grandparents report spending time in child care activities during weekdays, and those who provide care spend on average 1.3 hours a day according to the 1987 and 2001 Danish time use surveys.

Research on the organization of care for children within the extended family has mostly focused on one direction of this exchange, namely how child care provided by grandparents affect parental (mainly maternal) labor supply (Posadas and Vidal-Fernandez, 2013; Bratti et al., 2018). The underlying assumption is that grandparents (mainly grandmothers) can be a source of support for female labor supply in motherhood, thus taking for granted that grandmothers' time is an unused and readily available resource.

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[1]The intergenerational transfer literature has identified several motives for transfers of time and money within the family. First, parents may be altruistic and care about their children's wellbeing (Becker, 1991). Second, parents may simply gain utility of giving, which is sometimes referred to as the warm glow motive (Andreoni, 1989). Third, parents may have an exchange motive and transfer money to their children in expectation of old age care from their children (Pezzin and Schone, 1999).

Grandparents usually enjoy spending time with their grandchildren (Triadó et al., 2014; Zanella, 2017). Yet, due to intra-household specialization of work in the household and the market (Becker, 1991), grandparenthood may impact labor market outcomes of women and men in different ways. As female labor supply has been increasing over the last 50 years across the Western world, working women are now increasingly approaching the age of grandparenthood. Moreover, pension reforms intended to postpone retirement age in order to secure financing of welfare and health services in old age imply that grandparents face a growing trade-off between working in the market versus taking care of grandchildren. Increasing the retirement age may increase grandmothers labor supply, but lower maternal labor supply. Understanding the trade-offs are crucial because of the cost of grandchildren to grandmothers.

We employ a quasi-experimental approach that closely follows the literature estimating causal effects of the birth of the first child (Kleven et al., 2019b). In particular, we adopt an event study approach to study the dynamic effects of having a grandchild on a wide range of outcomes such as earnings, wage rate, labor force participation, full time employment, hours of work, and disposable income. To that end, we use multi-generational high-quality Danish register data containing yearly information in the period 1980–2017 on families in which a person became a grandparent for the first time between 1985 and 2012.

As a preview of our results, we find that the arrival of the first grandchild reduces grandmothers' earnings by 3.4 percent relative to grandfathers' earnings which remains largely unaffected five years after the arrival of the first grandchild. Grandmothers and grandfathers labor market outcomes continue to diverge, such that ten years after the first grandchild is born the "grandchild penalty" in earnings is 8.6 percent. The reduction in earnings for grandmothers are primarily driven by grandmothers moving out of full time employment and not by shifts to lower payed jobs. Labor force participation start to decline after the arrival of the first grandchild for both men and women, however, the decline is steeper for women. Pre-trends are parallel before the arrival of the first grandchild. Ten years after the arrival of

the first grandchild grandmothers' labor force participation has fallen 8.3 percent compared to the year before the first grandchild was born. We furthermore find that the "grandchild penalty" for grandmothers, who had their first grandchild in periods, in which options for early retirement were more generous, is twice as large as the "grandchild penalty" for those who had their first grandchild in periods with less generous retirement options.

As an identification check, we study the effect of having grandchildren per se, by using a Difference-in-Differences (DiD) event study design including men and women who do not (yet) have grandchildren as controls in the analysis. Using men and women without grandchildren as controls confirms that grandmothers adjust their labor supply more than grandfathers upon the arrival of a grandchild.

To shed light on some potential mechanisms, we investigate heterogeneous effects across 1) two main cohorts (corresponding to two time periods with different pension regimes), 2) socioeconomic group of grandparents, 3) gender of the child (the parent of the grandchild), 4) socioeconomic group of child, 5) distance to child, 6) daycare availability in the municipality where the grandchild was born.

We contribute to the recent strand of research aimed at understanding how fertility can explain the persistent nature of gender inequality in the labor market (Adda et al., 2017; Angelov et al., 2016; Blau and Kahn, 2017; Goldin, 2014; Kleven et al., 2019b,a; Sieppi and Pehkonen, 2019). This literature has mostly focus on the case of motherhood. Recent evidence for a variety of countries suggests that women experience a large, immediate and persistent drop in earnings after the birth of their first child, while men are essentially unaffected. This change is quite persistent. Ten years after childbirth, women have not recovered and at this point the series have plateaued (Kleven et al., 2019a).[2]

In this paper, we focus on how the arrival of grandchildren may further aggravate gender inequality. Given that the women in our sample on average become a grandmother at age 53—on average 24 years after having the last child—our findings suggests that the grandchild

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[2]Kleven et al. (2019a) find child penalties in earnings in the United States (31%), United Kingdom (44%), Austria (51%), Germany (61%), Sweden (26%), and Denmark (21%).

penalty strikes well before women have had time to recuperate after the birth of their last child. We show that the effects of a grandchild can last up to—and well into—retirement.

Only a few other papers look at the effect of grandchildren using causality approaches. Rupert and Zanella (2018) use PSID data to examine how having a grandchild affects grandparents' labor supply. Estimating a structural labor supply model while instrumenting for grandparenthood with the gender of the firstborn child, they find that employed grandmothers reduce hours of work by 30 percent. Frimmel et al. (2020) also look at grandparents' labor supply. Modeling the duration until having a grandchild and the duration until labor market exit jointly using Austrian register data, they find that having a first grandchild increases the probability of early retirement for women by 8.5 percent. Asquith (2017) exploits state-year variation in access to various contraceptives to instrument fertility patterns in the US and finds that grandmothers are 8.5 percent more likely to be retired in response to a grandchild. Backhaus and Barslund (2019) use data from SHARE and an IV strategy based on gender of the first-born child to estimate the causal effect of grandparenthood on the labor supply of working-age grandparents in ten European countries. They find a large negative impact of grandparenthood on the labor supply of women aged 55 to 64. Using UK data, Zanasi et al. (2020) find that the birth of the first grandchild increases the probability of retirement for women aged 50-65 who have previously been active at the labor market by 8 percentage point.

While these papers investigate how becoming a grandparent affects different facets of labor supply, we broaden our understanding by considering six important labor market outcomes: earnings, participation, wage rates, full-time employment, hours worked, and disposable income. Furthermore, we extend previous analyses by using as identification strategy an event study methodology. The event study framework approach has several advantages compared to e.g. an instrumental variables strategy, which has been used in previous studies. First, we base our analysis on within-person variation as opposed to purely cross-sectional variation. This allows us to net out time invariant unobserved factors such as productivity or

preferences for work, leisure or family. Second, we avoid exclusion restrictions, which might not hold if grandparents' labor market outcomes were affected directly by the gender of their first-born child. Third, our estimates are not local average treatment effects, but all pertain to the arrival of the first grandchild, which implies that our estimates are comparable across our different estimation strategies. Fourth, the event study methodology allows us to follow the dynamics of the development in labor market outcomes after the arrival of the first grandchild. As in Kleven et al. (2019a), we estimate the gender gap in labor market outcomes by comparing the trajectories of men versus women after the birth of the first grandchild. We compare these estimates with a DiD estimate where we compare labor market outcomes of grandparents with a control group of comparable individuals who are parents but did not become grandparents in the observed time period.

The paper is organized as follows. Section 2 describes the Danish institutional background and the data used in our analysis. Section 3 outlines our empirical strategy, and Section 4 presents the results. Section 5 concludes.

2 Institutional Background and Data

2.1 Institutional Background

Scandinavian countries provide attractive opportunities for women to participate in the labor market while having a family. Institutions to promote female participation such as parental leave and public provision of highly subsidized universal daycare contribute to this picture.[3]

By international standards, female labor force participation is high in Denmark, and has been so over the three decades that we observe in our study. Two in three women participated in the labor force around the mid-80s; today this number is around 80 percent on average.

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[3]Universal daycare was rolled out from the 1960s. In the mid-1980s more than half of all children aged 0–6 were in daycare, increasing to almost 80 percent today, and more than 90 percent in the age group 3–6 attend preschool. As in the rest of Scandinavia, the tax pressure is relatively high (around 50 percent on average) in Denmark as the tax returns are used to finance public expenditure such as childcare, healthcare, education, and pensions.

With younger generations of women increasingly pursuing a full-time career in the labor market, the need for support from grandparents is evident. However, with high participation rates also among grandmothers, this option may be limited. Today, there is practically no informal childcare sector in Denmark (OECD, 2019), indicating that the role for grandparents to provide care may be limited. However, daycare institutions were not accessible for the youngest children in the entire period we observe.[4] Moreover, children may also need care when they are sick and outside the opening hours of the daycare institutions.

Despite seemingly high gender equality and the availability of institutions to support working families, the gender gap is still substantial (20 percent in 1980 and 15 percent in 2015) in Denmark, as documented in Kleven et al. (2019b), who ascribe the main part of this gap to the arrival of children, the "child penalty".

As the median age of a first-time grandmother is 53 years and 55 for a first-time grandfather, most grandparents will still have around 10 years in the labor market after the arrival of their first grandchildren. While research generally finds a positive association between grandparents spending time with their grandchildren and life satisfaction, some studies have also documented that grandmothers providing regular care reported high subjective time pressure compared to non-regular-caring grandmothers (Craig and Jenkins, 2016), that a positive association between providing childcare to grandchildren could primarily be explained when looking at cross-sectional variation (Danielsbacka et al., 2019; Di Gessa et al., 2016), and that grandparents providing higher hours of childcare were more likely to develop depression (Brunello and Rocco, 2019). This suggests that while grandparents often have a desire to support their offspring in caring for a new grandchild, they may sometimes also feel a pressure to offer their help.

As noted by Kanji (2018), the care grandparents provide is largely unrecognized and

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[4]Local municipalities have the responsibility of providing sufficient capacity and offer child care slots in center-based daycare institutions or slots in family-based care. Family-based care is the slightly cheaper alternative of care for children younger than three, but there is also evidence that the quality is lower (Datta Gupta and Simonsen, 2010). Both center-based care and family-based care are heavily subsidized; on average, parents pay around EUR 300 per month for a slot (Statistics Denmark, 2017).

gendered. Moreover, grandmothers and -fathers seem to be taking on different roles in caring for grandchildren (Sear and Coall, 2011), they provide different hours of child care, and a gender gap in norms about grandparenting is seen across European countries, including Denmark (Hank and Buber, 2009). As female labor supply is now high also among women aged 50+, grandmothers are trying to balance their careers with demand from children for grandparent care (Zamarro, 2020). Nevertheless, for grandparents nearing retirement age, retirement is an obvious exit strategy (Backhaus and Barslund, 2019). For the period we study, an early retirement scheme, Voluntary Early Retirement Pension (VERP) has been available from age 60.[5] In our empirical analysis, we take note of changes to the pension system by splitting up into two time periods, 1985–95 and 1996–2012.

2.2   Data

The analysis is based on administrative register data on the full population in Denmark covering the years 1980–2017. The unique Danish register data combines several administrative registers, which are linked via personal identification numbers.[6] The data contains information on socioeconomic characteristics such as family, labor market attachment, earnings and income, and education. Important for our study, individuals can be linked to family members even if they are not a part of the same household. This allows us to study inter-generational links. We use data on three generations—children, parents, and grandparents—and we are able to distinguish between grandparents on the mother's and the father's side of the family.

We draw our sample of grandparents from this data set. We base our analysis on a

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[5]The Danish pension system consists of a mix of public, occupational and private pensions. A universal public old age pension (OAP, *"Folkepension"*) scheme has been available for people over age 67 for the entire observed period. In 1999, the OAP pension age was reduced to 65 for all individuals born after 1939. Moreover, an early retirement scheme (VERP, *"Efterløn"*) enabled workers to retire at age 60. Participating in VERP requires making modest contributions to qualified unemployment insurance funds during working life. Benefits are flat-rate, and result in a fixed amount paid to all workers equal to roughly $27,000 annually (in 2010 USD). And until 1996, it was even possible to retire already from age 50 following a short period of unemployment (*"Overgangsydelse"*). For a review of changes to the Danish pension system, see García-Miralles and Leganza (2020) or Bingley and Lanot (2007).

[6]Danish register data is accessible in anonymized form for researchers based in Danish universities and research institutions through a secured access to Statistics Denmark.

balanced panel and restrict the sample to include only those who are alive and resident five years before through five years after the first grandchild is born. From the register data on demographic characteristics, we use information on the birth year of the first grandchild for each grandparent. The event studied is the birth of an individual's first grandchild. For each event, we observe calendar year and age of the grandparent, the grandparents spouse, and their child (the parent of the grandchild). We restrict the sample to people who become grandparents between age 35 and 80 (cf. Appendix Figure A1). Our final sample consists of 1,196,598 individuals who become grandparents to 560,235 grandchildren during 1985–2012.

Table 1: Summary Statistics of Background Characteristics for Grandmothers and Grandfathers

	(1) Grandfathers	(2) Grandmothers	(3) Diff.
Grandparent			
Age at first child's birth	26.96	24.40	2.565***
	(3.883)	(3.799)	(297.45)
Age at last child's birth	31.92	29.12	2.795***
	(5.732)	(4.745)	(288.46)
Age at first grandchild's birth	55.78	53.41	2.370***
	(6.821)	(6.821)	(189.53)
Year of birth	1942.5	1944.8	-2.283***
	(10.00)	(9.906)	(-125.19)
Same municipality as grandchild	0.363	0.385	-0.0220***
	(0.481)	(0.486)	(-24.82)
Single-headed household	0.146	0.214	-0.0680***
	(0.353)	(0.410)	(-96.45)
Child (parent of grandchild)			
Age at first child's birth	27.76	27.94	-0.181***
	(4.182)	(4.296)	(-23.27)
Year of birth	1970.5	1970.3	0.267***
	(8.249)	(8.337)	(17.57)
Grandchild			
Year of birth	1998.3	1998.2	-0.0862***
	(8.021)	(8.027)	(5.86)
Observations	556,095	640,503	1,196,598

 Note— The table shows mean and standard deviation in parenthesis of the background characteristics separately for grandmothers and grandfathers. The headline *Child (parent of grandchild)* refers to the parent of the first born grandchild and the headline *Grandchild* refers to the first born grandchild.

Table 1 show, separately for grandfathers and grandmothers, the mean and standard deviation of a number of characteristics for the three generations. The grandmothers in our sample were on average two years younger when they had their first child than the grandfathers in our sample. Women are also on average younger than men when becoming a grandparent.

For each individual we use register information on annual earnings and labor market status between 1980 and 2017 for a ten year window before and after the arrival of their first grandchild. Annual labor earnings are measured before tax and excludes unemployment insurance benefits and other public transfers. Earnings are reported directly from employers to the tax authorities, so bias/measurement error stemming from self-reporting is not an issue. We construct a dummy variable for labor force participation taking the value one for individuals with positive earnings and zero for those with no earnings. We use register information on work hours in bins. This measure is based on information from employer contributions to a mandatory pension scheme, ATP.[7] This allows us to construct a measure of hours of work capturing weekly hours of work averaged across the year. Thus we are not able to distinguish between people who work part time throughout the year and people who for example work full time half the year and quit working the rest of the year. Nevertheless, our measure of hours of work allows us to capture labor adjustments on the intensive margin. We calculate wage rates simply by scaling the annual earnings with 52 weeks and diving with our measure of weekly hours of work. As the hours based on ATP information is capped at the top, work hours may be underestimated, and thus the imputed hourly wage rate may be overestimated for full-time employed working more than the top cap.

We construct a full time dummy taking the value one if the grandparent work full time full year and zero otherwise (including if grandparent retires, works part time, or has never worked). This variable captures people who switch from working more than 27 hours per

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[7]The ATP scheme (*"Arbejdsmarkedets Tillægspension"*) requires all employers to make contributions for each employee based on their individual work hours, aggregated in bins (0–8, 9–17, 18–26, 27+, if paid per week, or 0–38, 39–77, 78–116, 117+, if paid monthly).

week (or more than 177 per month) through out the year to working less. Additionally, we collect information on disposable income net of tax and dividends. We reflate all monetary outcome variables to reflect 2018-prices and top code at 1 million DKK.
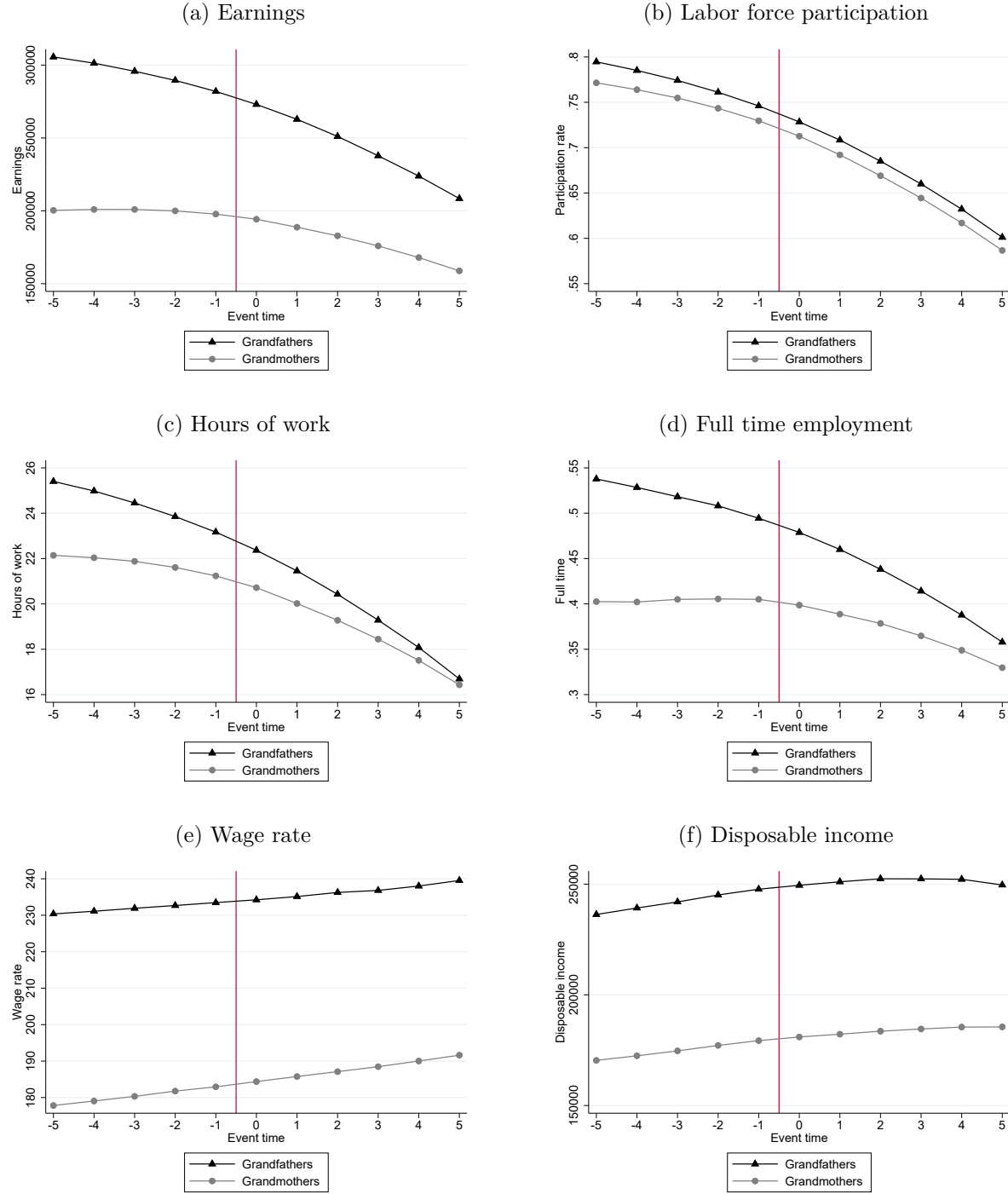
Figure 1 plots the average of all the outcomes variables five years before through five years after the arrival of the first grandchild separately for grandmothers and grandfathers. On average grandfathers have higher earnings than grandmothers, but grandfather's earnings decrease more than grandmother's earnings across the ten year window around the arrival of the first grandchild. The faster decrease of grandfathers is expected, as grandfathers are older than grandmothers when they have their first grandchild and thus closer to retirement age. We control non-parametrically for this in our event study design by including age fixed effects.

In order to investigate heterogeneity across our sample of individuals who become grandparents between 1985–2012, we exploit register information on civil status and households to investigate if the grandchild penalties vary between single-headed households and coupled grandparents. We use information in the registers on the municipality of residence for both grandchild and grandparent in the year the first grandchild was born to investigate if proximity between grandparents and grandchildren plays a role. In addition, we collect information on the average enrollment rate in formal child care for children aged 0–6 for all municipalities in the period 1985–2012. We use this date to construct an indicator variable taking the value one for municipalities with an enrollment above the mean enrollment rate for each year, we link the information on formal child care enrollment to the individuals in our sample based on the municipality of residence and birth year of the first grandchild.

3 Empirical Strategies

The goal in this paper is to estimate the dynamic causal effects of grandparenthood on grandparents labor supply and earnings. The empirical challenge is that individuals who have a

11

Figure 1: Mean of Outcome Variables

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows means of the outcome variables across the event time window separately for grandmothers and grandfathers.

grandchild may be different from those that do not have children in relation to work. For example, if individuals who have grandchildren are more family oriented and less ambitious at

work, they would have had lower earnings regardless of whether they ever actually have grand-children or not. The ideal experiment would be to randomly assign grandchildren to people and examine their labor responses over time. Given the infeasibility of randomly assigning grandchildren, we employ as our preferred empirical strategy an event study methodology. We compare the results from this approach with a difference-in-differences (DiD) strategy.

3.1 Event Study Methodology

The event study approach relies on the sharp changes around the birth of the first grandchild for grandmothers relative to grandfathers. The event study methodology has been used previously in the context of parental child penalties (Kleven et al., 2019b). As in similar event studies, the idea is that although becoming a grandparent is not exogenous, the event of having a grandchild may generate sharp changes in labor market outcomes that are orthogonal to unobserved factors that affect the smooth development of those outcomes. We estimate the following regression separately for grandmothers and grandfathers:

$$Y_{ist}^{gp} = \theta_{pre}^{gp} \cdot t + \sum_{j \neq -1} \alpha_j^{gp} \cdot \mathbb{1}[j = t] + \sum_{k} \beta_k^{gp} \cdot \mathbb{1}[k = age_{is}] + \sum_{\lambda} \gamma_\lambda^{gp} \cdot \mathbb{1}[\lambda = s] + \mu_{ist}^{gp} \qquad (1)$$

where Y_{ist}^{gp} is the labor market outcome of interest for individual i in year s at event time t. The superscript gp refers flexibly to the type of grandparent (e.g. grandmothers and grandfathers or, more specifically, maternal and paternal grandmothers and grandfathers, respectively). We omit the event time $t = -1$ so that the estimated event time coefficients α_j^{gp} refer to the year just before the first grandchild is born. We also include a full set of age dummies and year dummies. Age dummies control nonparametrically for underlying life-cycle trends, which is important in this context because women become grandmothers about two years earlier than men. Moreover, age dummies take account of age-related rules for e.g. retirement eligibility. Year dummies take into account in a nonparametrical way any time trends during this period, which may result for example from business cycle effects or

changes in pension legislation.

The underlying assumption in Equation (1) is that while changes in individual family and work preferences evolve gradually over an individual's life time, the birth of a grandchild is a more sudden event. As a result, any sharp change in labor market outcomes right around the birth of a first grandchild is likely to be the result of the arrival of the grandchild at that particular point in time, rather than being due to a change in family and labor market preferences. This so-called smoothness assumption is common to all event studies and is likely to hold in our analysis because it focuses on short run effects five years after the birth of a grandchild. An additional advantage of the event study is that it describes the dynamic adjustment to a new situation of being a grandparent.

Because the age of grandparenthood is also an age when the earnings profile starts descending, we use the pre-event years to correct for any pre-trend. More specifically, the term $\theta_{pre}^{gp} \cdot t$ represents a linear pre-trend, which is estimated separately for grandmothers and grandfathers using the five pre-event years. Extrapolating the pre-event trends is valid under the assumption that the post-event behavior of the confound can be inferred from the pre-event trend (Jakobsen et al., 2020). Following Kleven et al. (2019b), we specify the equation in levels rather than logs to keep all those with zero earnings in the data. We convert the estimated effects in levels to percentages by scaling the estimates with the counterfactual outcome absent grandchildren: $P_t^{gp} \equiv \hat{\alpha}_t^{gp} / \mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$, where $\tilde{Y}_{ist}^{gp}$ is the predicted outcome when the event time dummies are omitted from equation (1). We construct the "grandchild penalty" as the percentage by which grandmothers fall behind relative to grandfathers due to the arrival of a grandchild at event time t as:

$$P_t \equiv \frac{\hat{\alpha}_t^{gf} - \hat{\alpha}_t^{gm}}{\mathbb{E}[\tilde{Y}_{ist}^{gm}|t]} \tag{2}$$

The grandchild penalty is thus thought of as the gender gap in labor market outcomes associated with having a grandchild. In order to understand the potential long run labor market implications of having grandchildren, rather than just having the first grandchild, we

also estimate long-run grandchild penalties by extending the period to 10 years after the birth of the first grandchild. The long-run effects are estimated on an unbalanced panel, however, we still observe 78 percent of our sample 10 years after the birth of the first grandchild. As the smoothness assumption may not hold in the long run, we additionally use a DiD event study design to validate results from the event study.

3.2 Difference-in-Differences

In order to study the effect of having grandchildren per se, we use a DiD event study design using men and women who do not (yet) have grandchildren as controls. To include non-grandparents in an event study design where the event analyzed is having one's first grandchild, we assign "placebo" grandchildren to individuals born 1920–1969 who have at least one child above age 15 but no grandchildren. To achieve a suitable control group, we mimick the distribution of age at first grandchild observed among the sample of grandparents within each birth cohort. As before, we base our analysis on a balanced panel of 1,547,929 individuals, adding 351,331 people without grandchildren to our sample of grandparents. Thus we use a DiD design to compare individuals observed in a ten year window around the birth of their first grandchild to individuals observed in a ten year window around the placebo assignment of a grandchild, as outlined in Equation (3):

$$E[Y_{i,t>0} - Y_{i,t<0}|gc_i > 0] - E[Y_{i,t>0} - Y_{i,t<0}|gc_i = 0] \tag{3}$$

where t denotes the year the grandchild (or placebo grandchild) arrives. $gc_i > 0$ for individuals i who have at least one grandchild, and $gc_i = 0$ for people who have been assigned a placebo grandchild. Identification of Equation (3) relies on the usual parallel trends assumption, which we validate in our event study design by estimating the pre-trend.

Including a control group allows us to construct a "grandchild penalty" as the percentage by which grandmothers (grandfathers) fall behind relative to non-grandmothers (non-

grandfathers) due to the arrival of a grandchild at event time t as:

$$P_t \equiv \frac{\hat{\alpha}_t^{ngp} - \hat{\alpha}_t^{gp}}{\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]} \tag{4}$$

where ngp refers to non-grandparents and gp refers to grandparents.

4   Results

Figure 2 shows the percentage change in labor market outcomes in a given event time t relative to the year before the first grandchild is born five years before and after the birth of the first grandchild using pre-trend corrected event time estimates of Equation (1). For all estimated event coefficients we also include 95 percent confidence intervals. Results are presented separately for grandmothers and grandfathers.

Panel (a) in Figure 2 shows the event time estimates of earnings separately for grandmothers and grandfathers. Whereas earnings evolve in parallel before the arrival of the first grandchild, they start to diverge right after the first grandchild is born and continue to diverge thereafter. In particular, grandmothers experience a drop in earnings of 1.6 percent the year immediately after the birth of the first grandchild, whereas the earnings of grandfathers do not decrease. Grandmothers' earnings continue to decline thereafter at a much steeper rate than the decline in earnings for grandfathers. As a result, the grandchild penalty as defined in Equation (2) amounts to 3.4 percent five years after the arrival of the first grandchild.

Panels (b)-(d) in Figure 2 show that the relative decline in earnings experienced by grandmothers after the birth of the first grandchild is primarily driven by declines in hours of work and full time employment, and to a much lesser extent to declines in labor force participation and wage rates. The pre-trend trajectories for each of these outcomes are parallel prior to the arrival of the first grandchild.

A qualitatively similar pattern is observed in Panels (b) and (c) showing declines in labor market attachments in terms of participation and hours after the birth of the first grand-

child for grandmothers, indicating that both the extensive and intensive margins are partly responsible for the widening of the earnings gaps after the first grandchild. In particular, Panel (c) shows that grandmothers' hours of work start a steep decline immediately after the birth of the first grandchild. There is no sign of recovery in hours of work five years after the arrival of the first grandchild. Whereas grandfathers' hours of work also decline during the five years after the birth of the first grandchild, they do so at a less steeper way so that by the end of the five years after the arrival of the first grandchild the grandchild penalty in hours worked amounts to 2.3 percent. Specifically, Panel (d) shows a sharp and continuing fall in full time employment for grandmothers and not for grandfathers after the birth of the first grandchild so that five years after the birth of the first grandchild grandmothers are 3.7 percent less likely to work full time than grandfathers, which further indicates that grandmothers react on the intensive margin. Panel (e) shows a constant wage rate pre and post the event for grandmothers and grandfathers. Finally, Panel (f) shows virtually no effect on disposable income.

Most other studies on the effect of grandchildren on grandparents' labor market outcomes analyze the effect of the arrival of the first grandchild on the probability of retirement or labor market exit. Most estimates using different estimation strategies and representative samples from several countries lie around an 8 percent increase in the retirement probability. Notable exceptions are results from the PSID, suggesting reductions in hours of work as high as 30 percent (Rupert and Zanella, 2018), and zero effects found in Kridahl (2017), who find no strong evidence that grandmothers are more likely to retire than grandfathers, and argues that it is because grandmothers in Sweden are not the primary caregiver of their grandchildren.

By international comparison, the childcare provided by grandparents is fairly low in Denmark, compared to countries with much higher reliance on inter-generational provision of care. As such, our estimates are probably a lower estimate of what would be in other countries with non-public provision of child care such as the US. We find drops in labor force

participation of 3.1 and 8.3 percent for grandmothers in our sample, and 2.1 and 5.3 percent for grandfathers respectively five and 10 years after the birth of the first grandchild.

Comparing our results to the long-run child penalties in Kleven et al. (2019b), the grandchild penalties found in our paper are of a considerable size. Kleven et al. (2019b) find a child penalty for parents of around 20 percent on average - we find a grandchild penalty of 3.4 percent five years after the first grandchild, corresponding to about 1/6 of the child penalty incurred a generation earlier. While grandchild penalties on hours worked and participation rates are equally large compared to the child penalty, there is no grandchild penalty on wage rates, indicating that grandparents do not adjust by selecting into other occupations, sectors or firms at this point in their career.
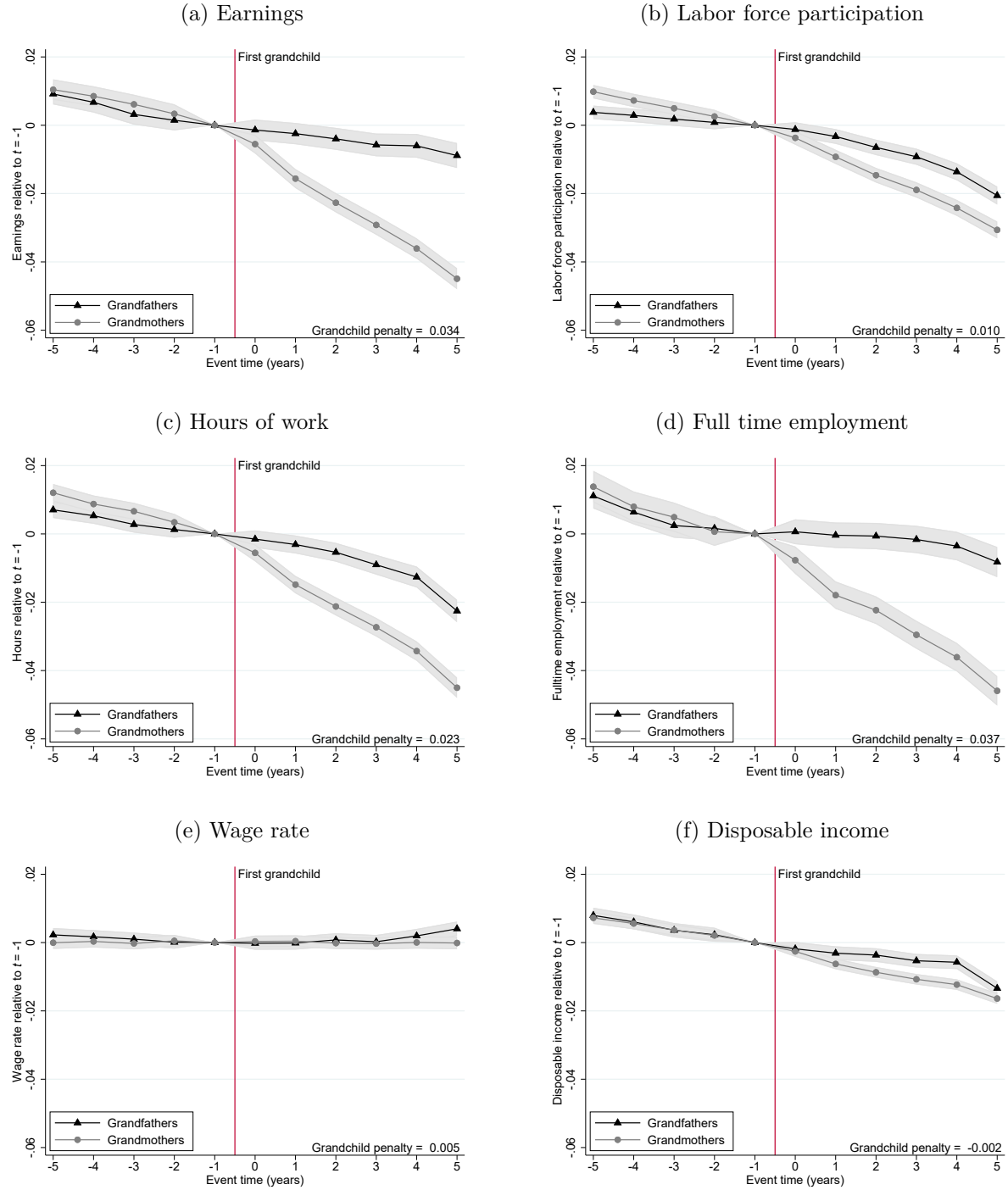
While Kleven et al. (2019b) base their main estimates on a balanced panel of parents who have their first child between 1985–2003, they also expand their sample to an unbalanced panel of parents who have their first child between 1970–2013, allowing them to estimate child penalties 20 years after the arrival of the first child. They find that hours worked start to converge between 10 and 20 years after the first child. However, the child penalty in hours worked is still present 20 years after the first child arrives in the sense that women work 6.5 percent less hours per week 20 years after the first child.

Figure 3 shows the long-run effects measured up to 10 years after the arrival of the first grandchild.[8] In general, the gender gap measured 10 years after the arrival of the first grandchild expands and often more than doubles compared to the 5-year gap. The earnings gap e.g. increases from 3.4 percent after 5 years to 8.6 after 10 years. Specifically, 10 years after the birth of the first grandchild, grandmothers earn 10.1 percent less than the year before the first grandchild was born. Whereas grandfathers earnings only decrease by 1.2 percent. The labor force participation for both grandmothers and grandfathers decrease

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[8]Given that our sample of grandparents are older and nearing retirement, we think of long-term effects as effects measured 10 years after the first grandchild is born. The 10-year follow-up is based on a balanced panel of individuals observed 5 years before and 5 years after the birth of their first grandchild. Following up on labor supply effects 20 years after grandparenthood would be difficult due to retirement and attrition due to mortality.
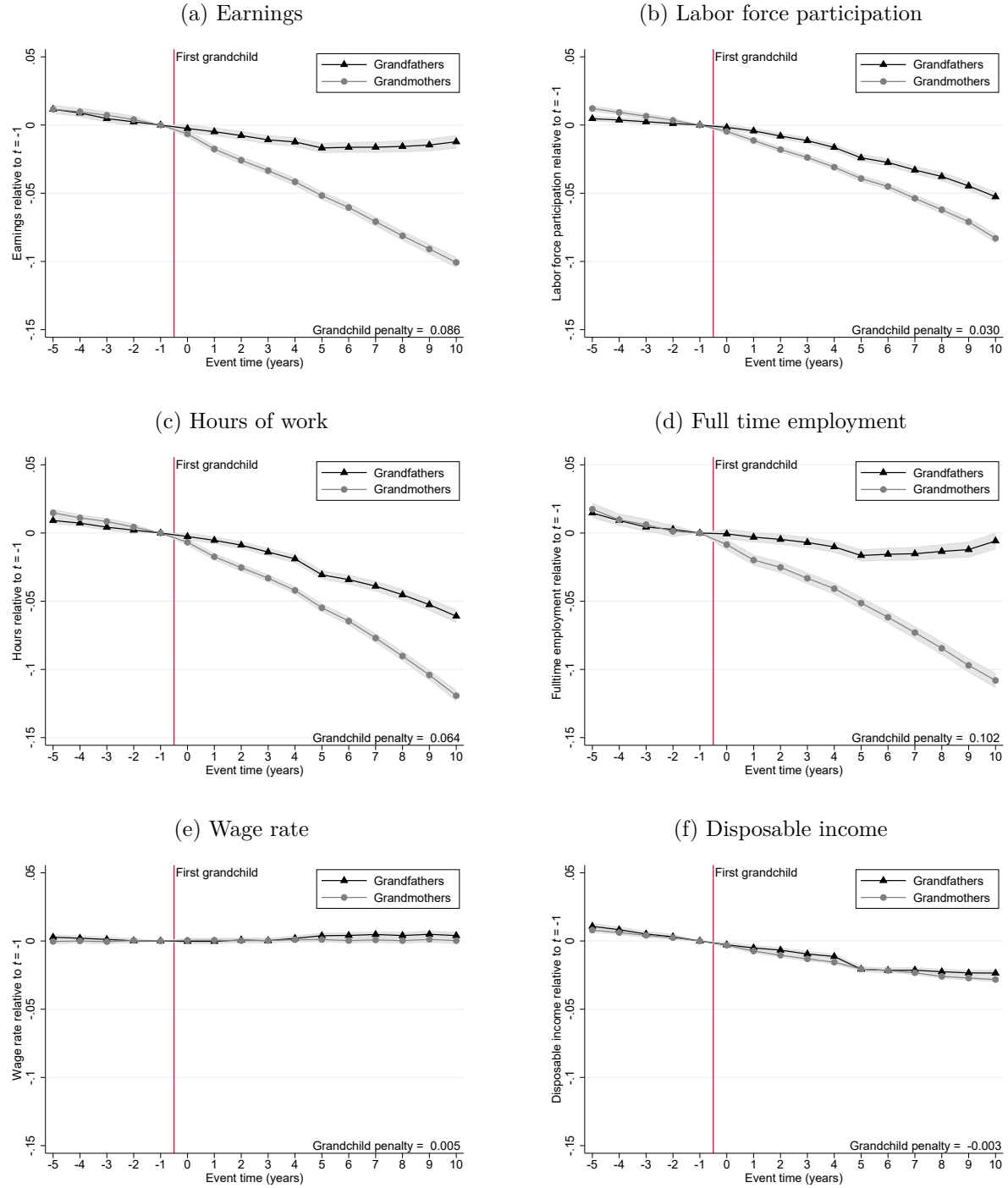
gradually after the birth of the first grandchild, such that grandmothers' participation is reduced by 8.3 percent and grandfathers' by 5.3 percent 10 years after the birth of the first grandchild.

Figure 2: The Impact of Grandchildren

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.

Figure 3: The Long-run Impact of Grandchildren

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the coun-terfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t])$ for grandfathers and grandmothers sep-arately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grand-child penalty is measured at event time 10. The effects on wage rates are estimated conditional on partici-pation. The shaded 95 percent confidence intervals are based on robust standard errors.
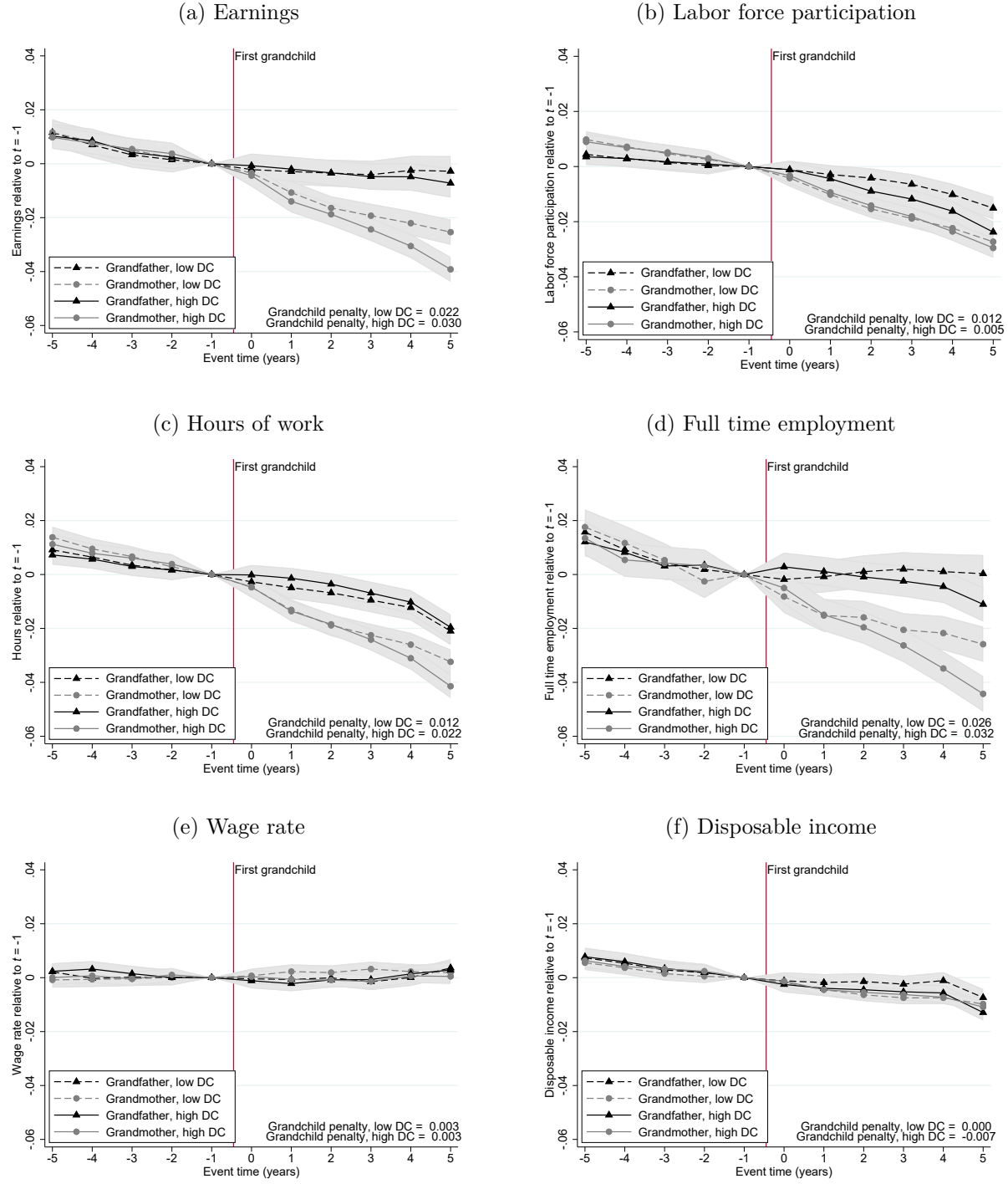
4.1 Heterogeneous Results and Mechanisms

This section investigates heterogeneous responses across our sample. We explore whether the grandchild penalty varies across six dimensions: Whether the grandchild lived in a municipality with high or low availability of daycare at birth, whether grandparents live in same or different municipality from grandchild, grandparents are single or married/cohabiting, whether the child (parent of grandchildren) is a daughter or a son of the grandparent, and whether the grandchild is born in an early or later part of the time period.

Differences between low and high daycare enrollment areas

Starting in the 1960'es, Danish municipalities initiated a roll-out of daycare institutions for preschool children, and this effort was intensified from the 1990'es with municipal policies to ensure that all children were guaranteed a childcare slot and after-school care. Today, the majority of Danish children enroll in center-based daycare before they start school, nevertheless, regional differences in the availability of daycare may affect the choices new grandparents make regarding their labor supply following the birth of their first grandchild. To investigate this channel, we stratify the sample based on the daycare coverage in the municipality where the firstborn grandchild lives at birth, distinguishing between municipalities with high and low daycare coverage.

Panels (a)–(f) in Figure 4 show the event study coefficients for the two groups with low and high daycare coverage, respectively. The coefficients are not statistically different between the two groups.

Figure 4: The Impact of Grandchildren by Daycare Enrollment

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985—2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first grandchild. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.

23

Grandparents' proximity

While there are many reasons why grandparents spend time with their grandchildren, including caring for them when they are sick and cannot attend daycare, grandparents who live closer to their grandchildren experience lower costs in terms of time and transport when going to see their grandchildren and as a result are more likely to provide childcare. Indeed, Compton and Pollak (2014) combine US Census data and the National Survey of Families and Households to show that residential proximity to grandmothers (a distance less than 25 miles) increases labor force participation of women with children younger than 12 by about 10 percentage point. Here we examine if grandparents proximity affects the grandchild penalty by stratifying the sample according to whether grandparents live in the same municipality/region as their firstborn grandchild.[9]
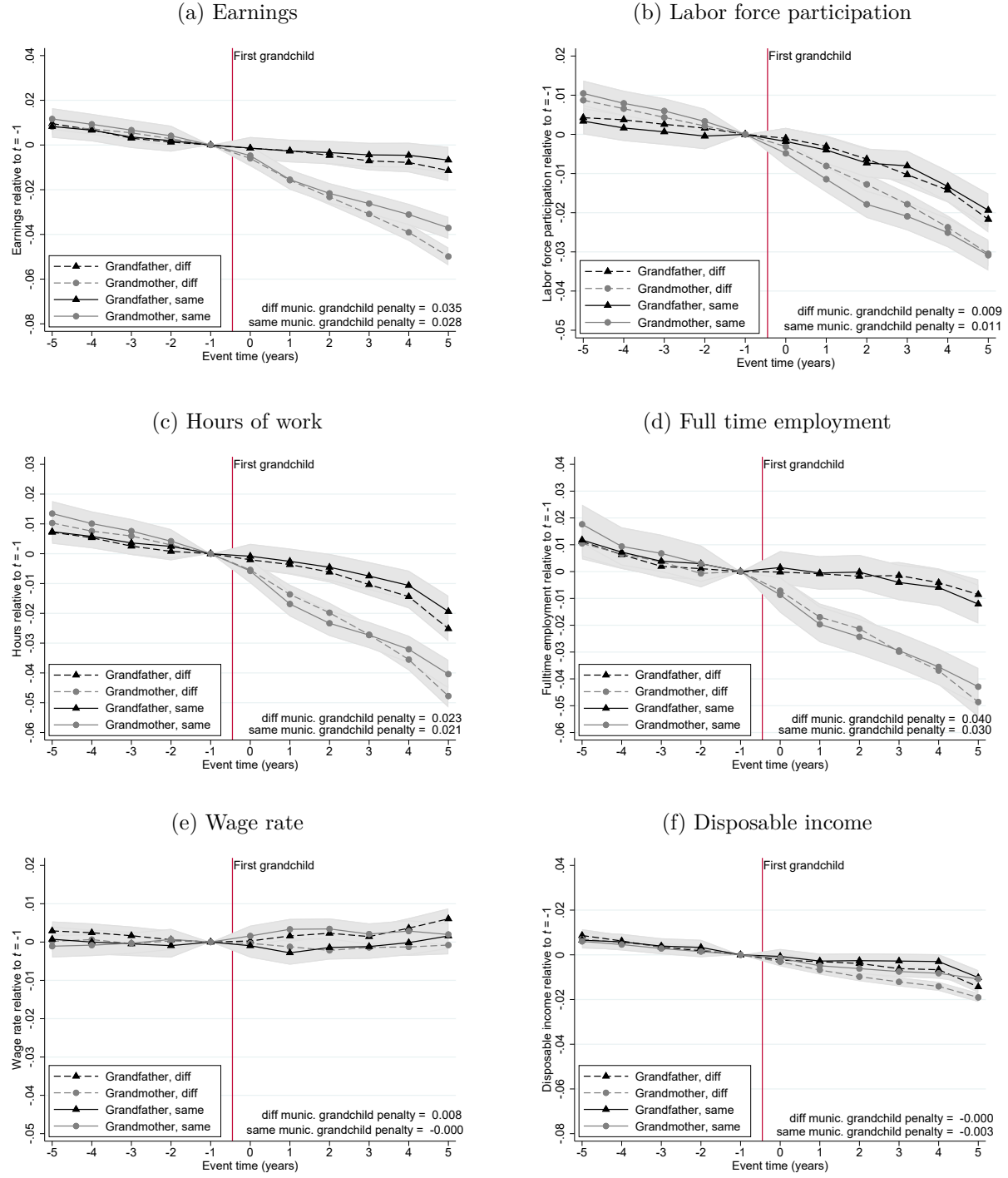
Figure 4 shows the event time estimates of our outcome variables separately for grandmothers and grandfathers who live far away from and close by their firstborn grandchild.

We find that the grandchild penalty changes very little depending on the proximity to grandchildren for grandmothers and grandfathers, and, if anything, the penalty is larger if living further away for grandmothers.[10]

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[9]There are currently 98 municipalities in Denmark. The median municipality has around 43,000 inhabitants. Municipalities range in size from a few very small islands with around 2,000 inhabitants to Copenhagen with more than 600,000 inhabitants in recent years.

[10]There may be several explanations for this zero effect. While grandparents who live further away from their grandchildren may have a higher cost of seeing their grandchildren due to higher transportation costs, their preferences for grandchildren might be lower and their labor market outcomes thus less affected by the arrival of a grandchild. Moreover, the fact that grandparents and their children live further apart may also reflect that the children have moved away from their hometown to educate and work, which is perhaps more prevalent among the high-educated.

Figure 5: The Impact of Grandchildren by Proximity

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985—2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first grandchild. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.
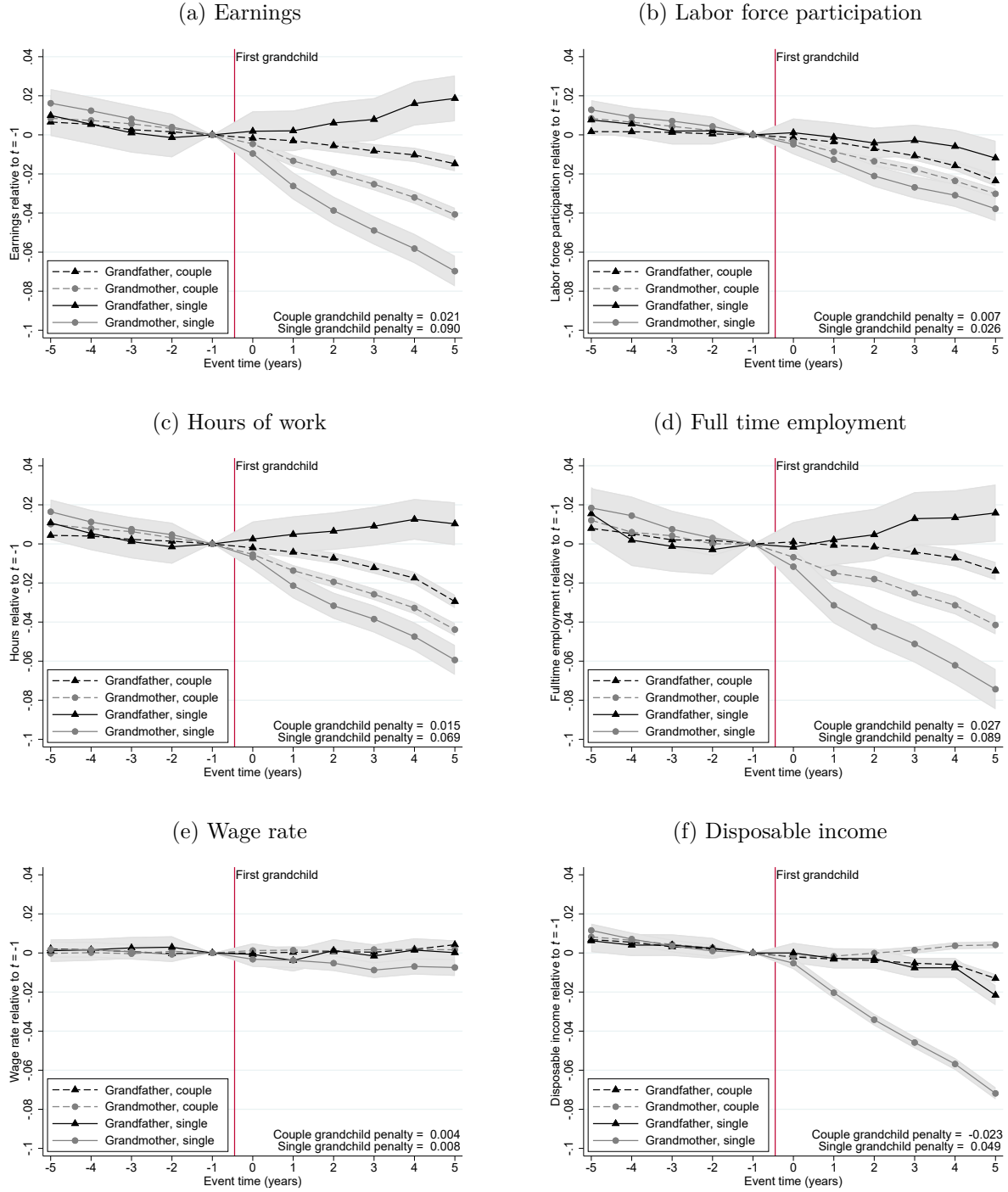
25

Single and coupled grandparents

Figure 6 shows the event time estimates of our outcome variables separately for grandmothers and grandfathers, depending on whether a grandparent lives in a single-headed household or in a couple. Panel (a) shows that single grandmothers experience the largest grandchild penalty, followed by grandmothers in a couple and grandfathers in a couple. Interestingly, single grandfathers experience an increase in earnings after the birth of the first grandchild. Five years after the birth of the first grandchild the earnings of single mothers drop 9 percent below single grandfathers. The grandchild penalty in earnings for coupled grandparents is much lower than the penalty for single grandparents, at 2.1 percent.

Panels (c) and (d) show that the earnings patterns in Panel (a) are driven by reductions in hours of work and in full time employment for all groups with the exception of single grandfathers, for whom the probability of full-time employment and hours of work increase.

Overall our findings suggest that single grandfathers contribute towards the younger generation by transferring money, while single grandmothers and grandparents in a couple contribute time. The coordinated reaction of married/cohabiting grandmothers and grandfathers is in accordance with a vast literature showing that spouses generally value joint leisure (Browning et al., ming) and coordinate their retirement patterns in old age (Bingley and Lanot, 2007; García-Miralles and Leganza, 2020).

Figure 6: The Impact of Grandchildren by Household Type

(a) Earnings

Couple grandchild penalty = 0.021
Single grandchild penalty = 0.090

(b) Labor force participation

Couple grandchild penalty = 0.007
Single grandchild penalty = 0.026

(c) Hours of work

Couple grandchild penalty = 0.015
Single grandchild penalty = 0.069

(d) Full time employment

Couple grandchild penalty = 0.027
Single grandchild penalty = 0.089

(e) Wage rate

Couple grandchild penalty = 0.004
Single grandchild penalty = 0.008

(f) Disposable income

Couple grandchild penalty = -0.023
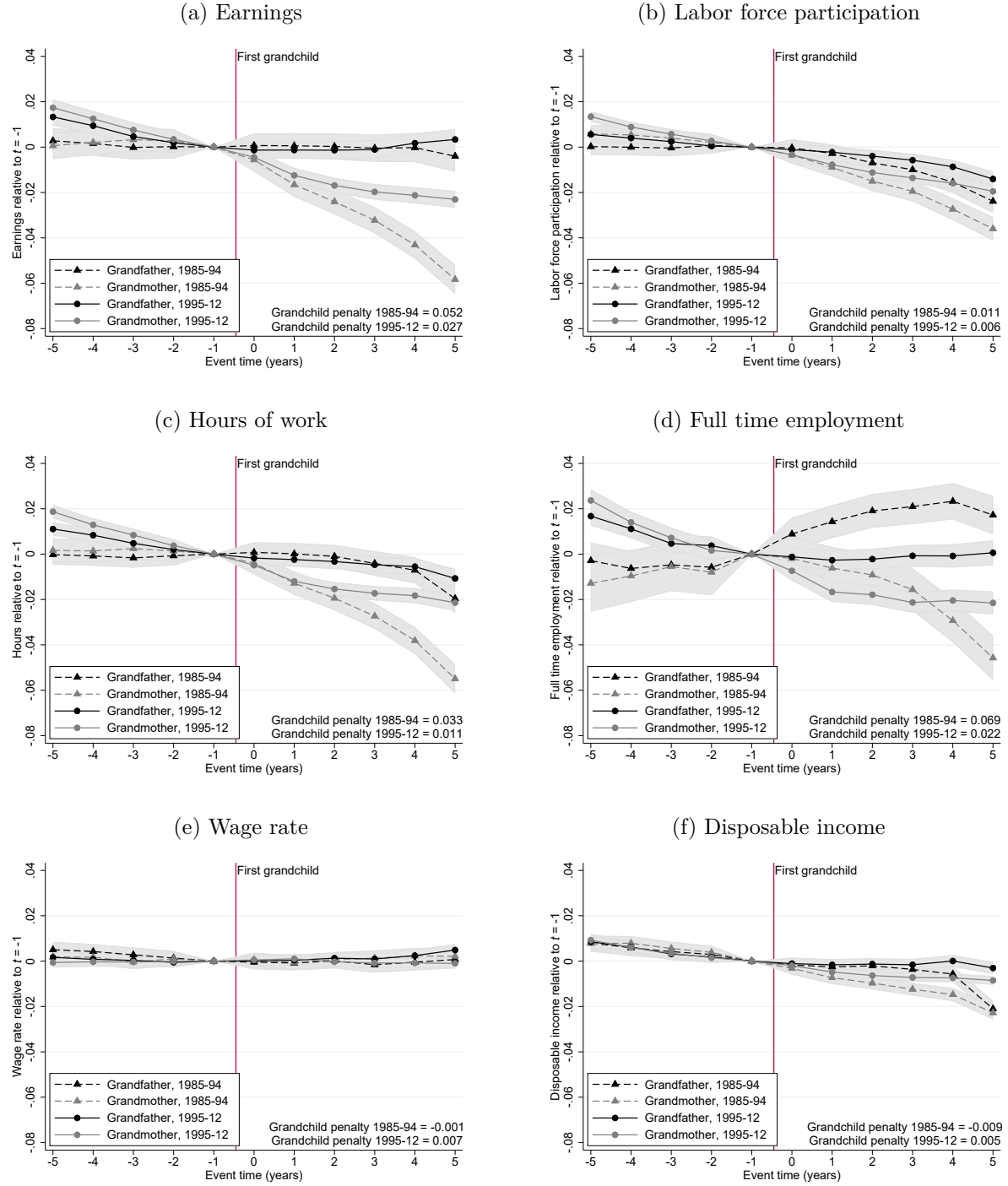Single grandchild penalty = 0.049

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t])$ for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985—2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first grandchild. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.

27

Differences across time periods

Figure 7 shows the event study estimates separately for grandmothers and grandfathers who become grandparents between 1985–94 and 1995–2012. Panel (a) shows that the grandchild penalty is largest for women who become grandmothers between 1985 and 1994, as they experience a drop in earnings of 5.2 percent compared to men who become grandfathers in the same period.

Figure 7: The Impact of Grandchildren by Different Time Periods

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate
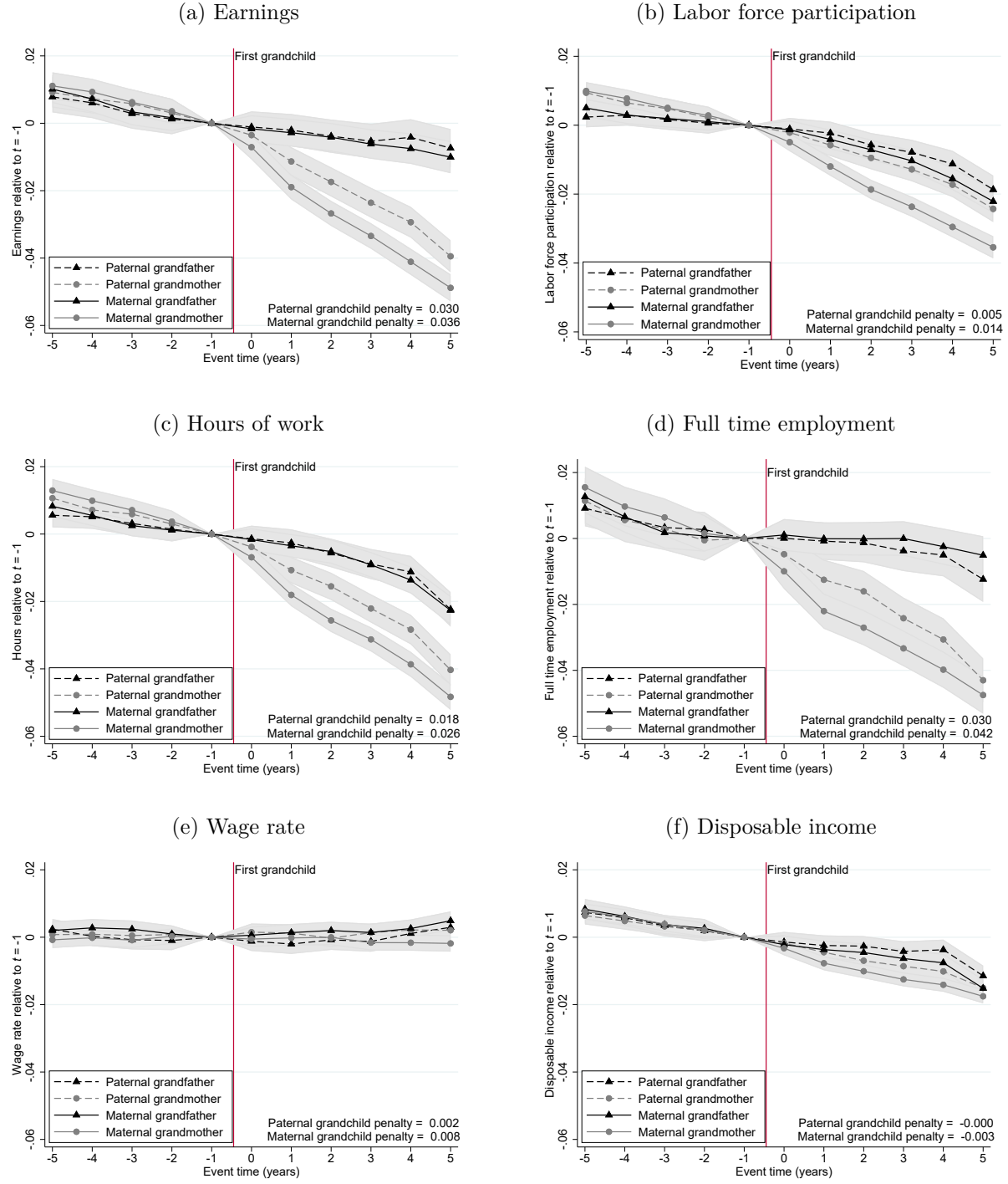

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp} / \mathbb{E}[\tilde{Y}_{ist}^{gp}|t])$ for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985—2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first grandchild. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.

29

Differences between daughters and sons

We next investigate whether grandparents' labor market adjustments depend on whether their first grandchild is by a daughter or a son. Figure 8 shows the event time estimates separately for grandmothers and grandfathers depending on whether a son or a daughter provided the first grandchild. Defining the maternal (paternal) grandchild penalty as the percentage grandmothers on the mother's (father's) side of the family fall behind grandfather's on the mother's (father's) side of the family due to grandchildren. Panels (a)–(f) show that maternal grandchild penalties are larger than the paternal grandchild penalties across all outcomes. This confirms Frimmel et al. (2020), who find that labor market exits are three percent higher in the case of a daughter's child compared to a son's child.

Figure 8: The Impact of Grandchildren by Gender of Child

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985—2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first grandchild. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.

31

Time use data

In many time use surveys, grandparents report spending time in child care activities. Because the Danish time use surveys can be linked to our register data, we are able to investigate if there are any differences in the amount of time grandparents spend doing childcare depending on their own gender and the gender of the parent to their firstborn grandchild. Utilizing the time use surveys in 1987 and 2001, we have diary data for 403 of the grandparents in our main sample. Among these grandparents, 14 percent report spending time in child care activities. Those who report spending time doing child care, spend on average 84 minutes per day including both dairies from week days and weekend day. Focusing on diaries from week days only, the grandparent spend on average 80 minutes per day.

Figure 9: Time in Childcare Activities by Age of Grandchild

(a) Childcare time
(b) Childcare time
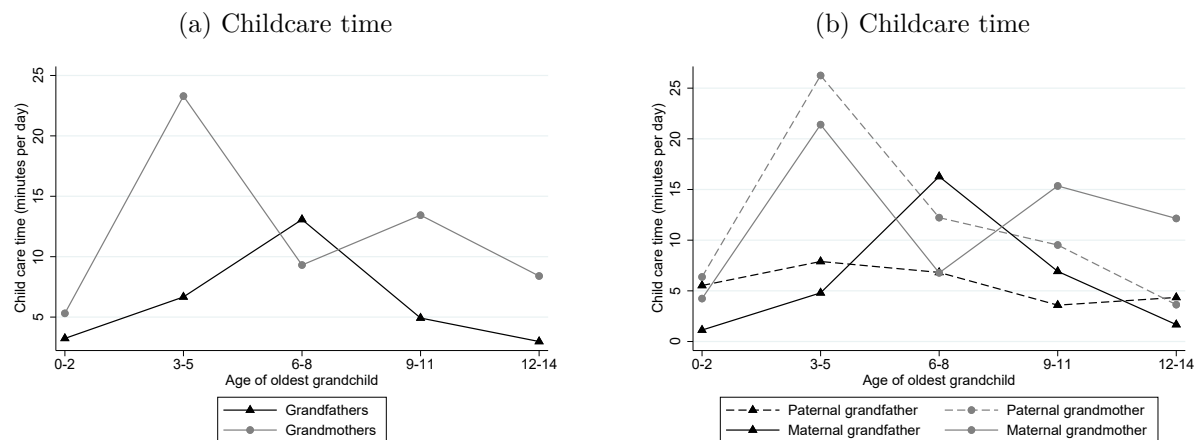
NOTE— The figure shows the average minutes per day grandparents report spending in childcare activities in the Danish Time Use Surveys from 1987 and 2001

Figure 9, Panel (a) shows minutes per day spent in childcare activities for grandmothers and grandfathers across the age of the firstborn grandchild. While grandmothers spend more time doing child care when their firstborn grandchild is 3–5 years, both grandmothers and grandfathers spend about 10 minutes per day when their first born grandchild is 6–8 years. That grandmothers spend more time with their grandchildren when the oldest grandchild is 3–5 could signal that grandmothers assist parents with picking up children in daycare. Panel
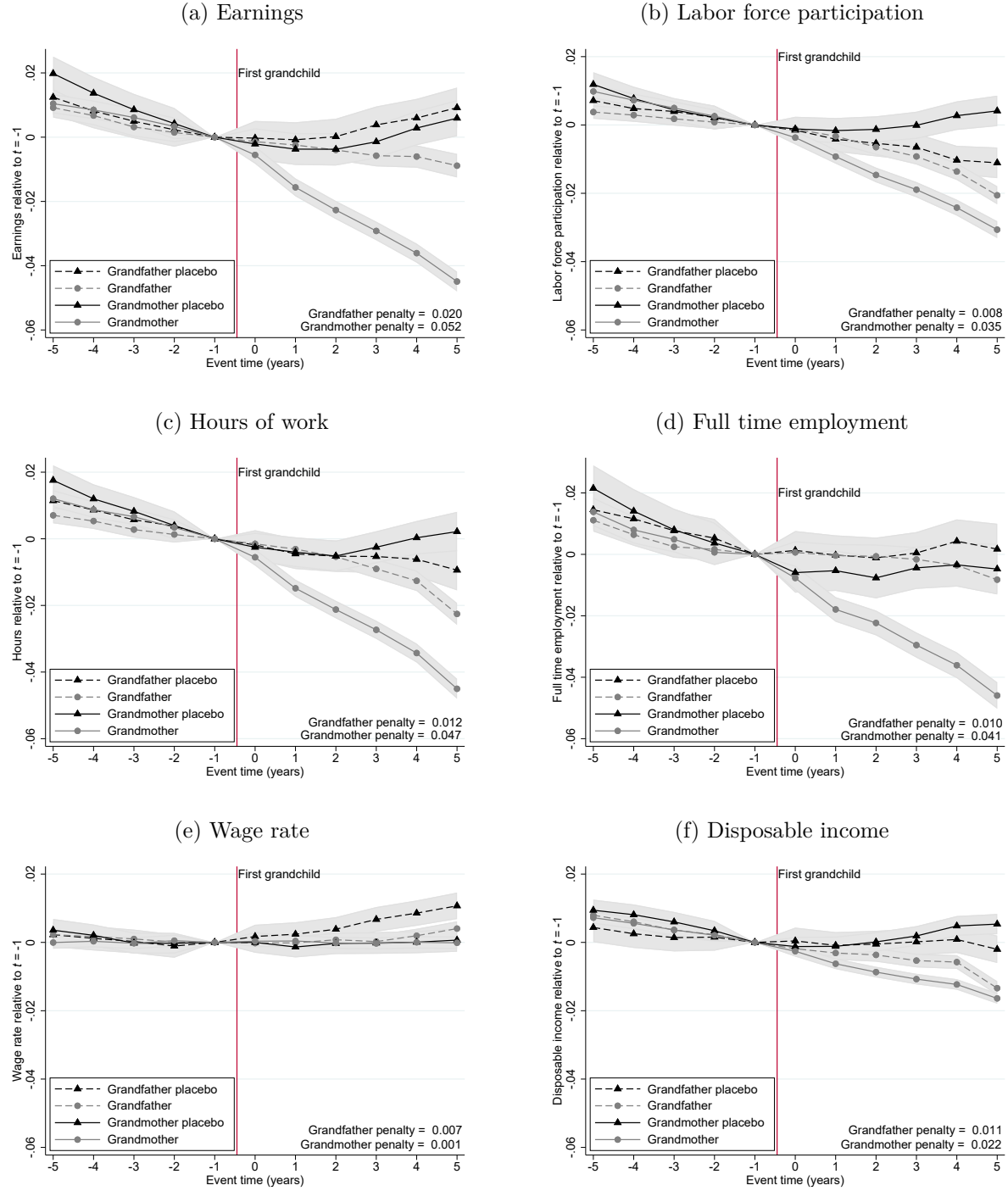
32

(b) show time spent in child care activities separately for maternal and paternal grandmothers and grandfathers. Again, bot maternal and paternal grandmothers spend more time with their grandchildren, when the oldest grandchild is 3–5 years, than grandfathers.

4.2 Robustness and Sensitivity Analysis

DiD event study

Figure 10 shows event study estimates for individuals who become grandparents between 1985–2012 and for individuals whom have been assigned a placebo grandchildren between 1985–2012. Each panel in Figure 10 reports an overall "grandparent penalty", the percentage by which grandmothers (grandfathers) are falling behind women (men) without grandchildren due to grandchildren, as defined in Equation (4). Thus in the DiD event study, we compare women to women, and we compare men to men, as opposed to our gender gap estimates comparing women to men. The results presented so far have shown that there is also an effect for men once they become grandfathers, the DiD event study allow us to estimate the effect of grandparenthood per se for grandmothers and grandfathers, respectively. Panel (a) shows that the grandmother penalty in earnings is 5.2 percent, while the grandfather penalty in earnings is 2 percent. Although, the placebo estimates are less precisely estimated. Panel (b) suggests that a smaller part of this negative effect on earnings for women works through participation, while the main part of the earnings reduction is due to reductions in hours (Panel (c)) and a transition from full-time to part-time work (Panel (d)).

Figure 10: DiD Event Study of the Impact of Grandchildren

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp} / \mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for men and women with and without grandchildren separately and for different outcomes. Each panel also reports a "grandchild penalty", as defined in Equation (4) measured at event time 5. All of these statistics are estimated on a balanced sample of people who have (been assigned) their first grandchild between 1985—2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first (placebo) grandchild. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.

34

5 Conclusion

Recent research documents a sizable and persistent child penalty as measured by a drop in earnings for women after the birth of the first child across several developed countries (Kleven et al., 2019a,b; Sieppi and Pehkonen, 2019). The child penalty contributes to gender inequality over working age. Our paper extends this literature by documenting that this gap is further extended into old age in the form of a grandchild penalty. Using a quasi-experimental approach and exploiting unique and rich administrative data for Denmark, we show that the persistent gender gap is reinforced by the arrival of grandchildren and thus continues into retirement age. Following Kleven et al. (2019b), we employ a quasi-experimental approach to estimate the causal effects of the birth of the first grandchild. Our event study approach allows us to show the dynamic effects of having a grandchild on earnings, wage rate, labor force participation, full time employment, hours of work, and disposable income. We find that the arrival of the first grandchild reduces grandmothers' labor force participation by 1 percent in comparison to grandfathers' labor force participation. Thus, we show that the child penalty due to fertility strikes again when women enter grandparenthood, although to a much smaller extent. After the arrival of the first grandchild, female earnings start decreasing in comparison to male earnings, which are unaffected when we control for year and age effects. Five years after the arrival of the first grandchild, the gender gap in earnings has been extended by 3.4 percent due to the arrival of a grandchild. This effect is almost entirely driven by reductions in full time employment. We compare our event study estimates of the gender gap in labor market outcomes to a DiD event study design. This alternative approach generally confirms our results based on the event study strategy comparing grandmothers and grandfathers. To shed light on some potential mechanisms, we furthermore explore the effects across different groups and time periods, leading to several interesting additional insights. First, we investigate the results by two subperiods, 1985-94 and 1995-2012. We show that the gender earnings gap is stronger for the earlier period, in which options for early retirement were much more generous, parental leave shorter, and daycare availability

lower than in later periods. At the same time, female labor supply was generally lower and parttime work more prevalent for women becoming grandmothers in this period. Second, we find that the effects of becoming a grandparent vary by the gender of the child (the parent of the grandchild). Thus grandmothers are significantly more likely to reduce their work hours if it is their daughter who gives birth to a grandchild relative to their son. This suggests that the inclination to transfer time across generations is stronger in the mother-daughter relationship than in the mother-son relationship. Third, we find that labor market effects for grandparents are stronger if grandparents and children live further apart. This is a relatively surprising result which requires more investigation. Fourth, we find very different effects for grandparents who are single compared to grandparents who live in couples. We find the strongest negative effects on labor market outcomes for single grandmothers, while we find a positive effect on earnings and hours for single grandfathers. For couples, the labor market outcomes move more closely together, but the grandchild penalty is still larger for women than for men. Fifth, we find that the labor supply effects are not significantly different depending on whether the child (parent of the grandchild) lives in a municipality with relatively high coverage of childcare.

Our results point to several policy relevant insights. We show that it is crucial to take a broader family perspective that recognizes the provision of grandparental childcare in order to reduce gender inequalities in the labor market that open up at first child birth, expand at the arrival of the first grandchild, and persist into retirement. Recent evidence suggests that decades of childcare subsidies and maternity leave policies have achieved little in terms of closing the gender earnings gap (Kleven et al., 2020; Olivetti and Petrongolo, 2017; Rossin-Slater, 2017). Previous research has pointed to the availability of grandparental care as an important factor as especially grandmothers transfer a substantial amount of time resources to their children, and this provision of time positively affects maternal labor supply (Del Boca, 2002; Bratti et al., 2018; Zamarro, 2020).

After decades of reductions in the gender gap in education and increasing female labor

supply in Denmark, grandmothers' time is no longer an unused resource to the same extent as it was perhaps 30 years ago. Furthermore, pension reforms intended to postpone retirement contribute to this picture. As such, family policies targeted young families such as childcare subsidies may not lead to increases in maternal supply if mothers use the subsidy to free up grandmother's childcare provision (Havnes and Mogstad, 2011). Parental leave policies may increase grandmothers labor supply, while doing little to maternal labor supply.

Our research documents that trade-offs between mothers' and grandmothers' labor supply abound. However, previous research also shows that gender norms are correlated across generations (Kleven et al., 2019a). Policies that help grandmothers stay in the labor force while supporting mothers' labor market attachment are desirable.

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A   Appendix

Figure A1: Age at Grandparenthood and Earnings across Age

(a) Age at grandparenthood

(b) Earningsprofile
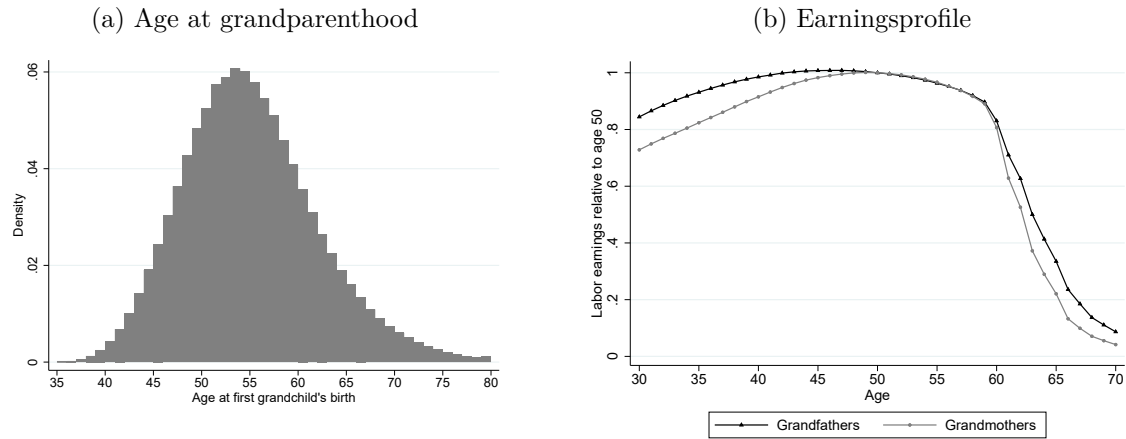
NOTE— The figure in panel (a) shows the distribution of age at the birth of the first grandchild for all grandparents in Denmark. The figure in panel (b) shows earnings between age 30 and 70 (indexed at age 50) for individuals who at some point in their live become grandparents.

Table A1: Summary Statistics of Background Characteristics for Grandmothers and Grandfathers with Firstborn Sons and Firstborn Daughters

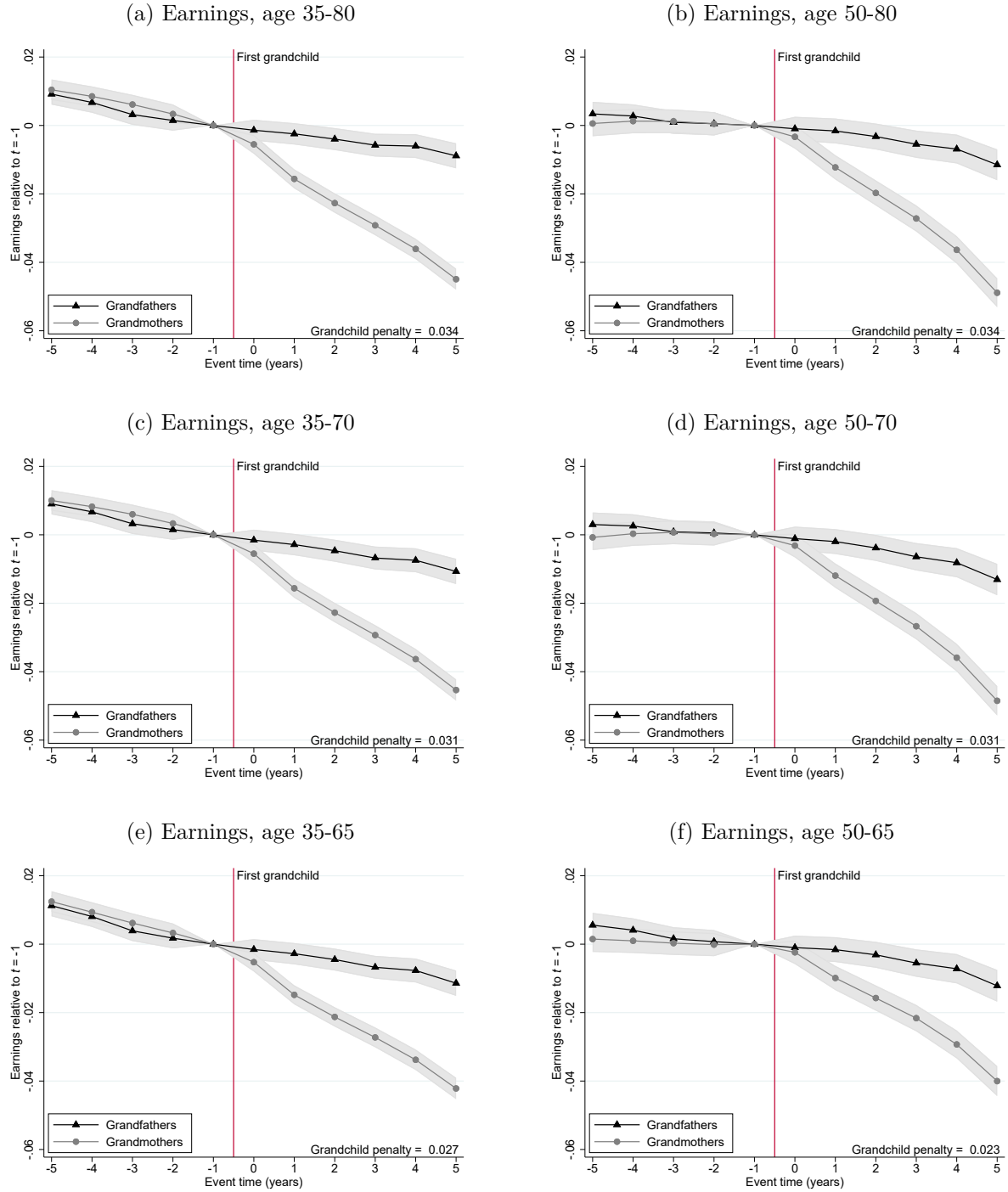| | (1) | (2) | (3) | (4) |
| | Grandfathers w. firstborn | | Grandmothers w. firstborn | |
	sons	daughters	sons	daughters
Grandparent				
Age at first child's birth	26.93	27.00	24.37	24.42
	(4.833)	(4.842)	(4.558)	(4.479)
Age at last child's birth	31.67	31.38	28.97	28.71
	(5.343)	(5.274)	(4.841)	(4.778)
Age at first grandchild's birth	56.42	55.10	54.09	52.69
	(6.804)	(6.773)	(6.832)	(6.733)
Year of birth	1941.8	1943.3	1944.0	1945.6
	(10.12)	(9.820)	(10.04)	(9.689)
Child (parent of grandchild)				
Age at first child's birth	28.19	27.30	28.39	27.46
	(4.260)	(4.048)	(4.402)	(4.125)
Year of birth, parent	1970.0	1971.1	1969.7	1970.9
	(8.332)	(8.124)	(8.436)	(8.188)
Grandchild				
Year of birth, grandchild	1998.2	1998.4	1998.1	1998.3
	(8.047)	(7.992)	(8.046)	(8.005)
Observations	286,723	269,372	332,073	308,430

 Note— The table shows mean and standard deviation in parenthesis of the background characteristics separately for grandmothers with firstborn sons and daughters and separately for grandfathers with firstborn sons and daughters. The headline *Child (parent of grandchild)* refers to the parent of the first born grandchild and the headline *Grandchild* refers to the first born grandchild.

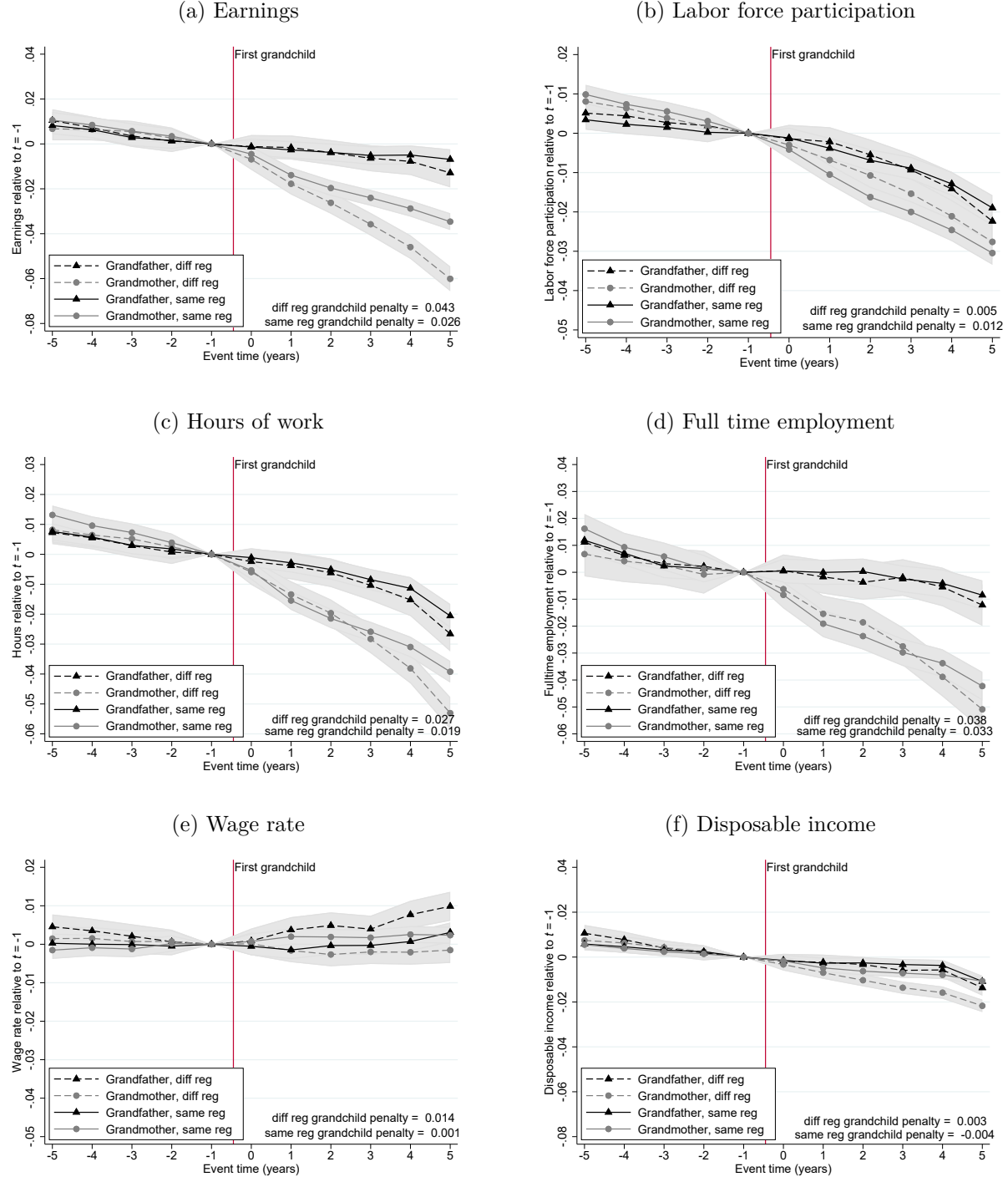Figure A2: Event Study with and without Pre-trend Adjustment
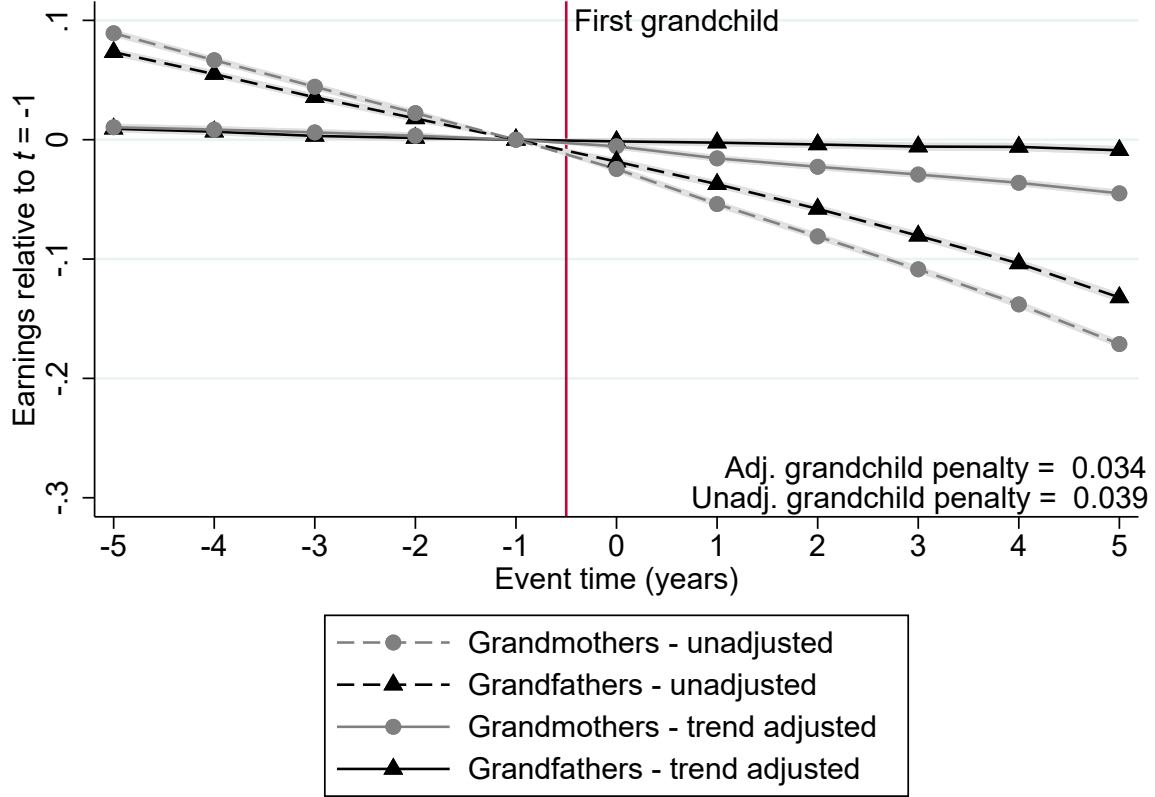
NOTE— The figure shows event time coefficients estimated from equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$ as defined in Section 3) for grandfathers and grandmothers separately. The "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, defined as $P_t \equiv (\hat{\alpha}_t^{gf} - \hat{\alpha}_t^{gm})/\mathbb{E}[\tilde{Y}_{ist}^{gm}|t]$, are reported separately for the pre-trend adjusted and unadjusted analysis. The grandchild penalty is measured at event time 5. All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985-–2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first grandchild. The effects on earnings are estimated unconditional on employment status. The shaded 95 percent confidence intervals are based on robust standard errors.

Figure A3: The Impact of Grandchildren for Different Age Groups

(a) Earnings, age 35-80

(b) Earnings, age 50-80

(c) Earnings, age 35-70

(d) Earnings, age 50-70

(e) Earnings, age 35-65

(f) Earnings, age 50-65

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers separately of different age groups and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.

Figure A4: The Impact of Grandchildren by Proximity (Regions)

(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

(f) Disposable income

NOTE— The figure shows event time coefficients estimated from Equation (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp} / \mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Equation (2). The grandchild penalty is measured at event time 5. All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985—2012 and who are observed in the data during the entire period between five years before and five years after the birth of their first grandchild. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on robust standard errors.