Does the child penalty strike twice?

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ABSTRACT

This paper compares the labor market trajectories of grandparents before and after the arrival of their first grandchild. We find gender gaps in earnings of 4 and 10 percent five and ten years, respectively, after the first grandchild. These effects are driven by changes in women's labor supply at both the intensive and extensive margin. We provide evidence from multiple data sources that grandmothers' caregiving complements formal daycare, thereby offering essential flexibility for young parents. We document that grandchild penalties were larger in earlier periods characterized by low availability of daycare, shorter parental leave, and an earlier retirement age. Linking register data to geographical variations in daycare centers reveals that local daycare coverage is not associated with grandchild penalties. Detailed time use data show that grandmothers carry larger responsibilities for childcare than grandfathers. Recognizing the complementary nature of grandmaternal childcare is important for the design of policies attempting to reduce child penalties for both mothers and grandmothers.

1. Introduction

Despite narrowing gender gaps in education and labor force participation, convergence in the earnings gap between men and women remains stalled (Goldin, 2014). The arrival of children into a family emerges as a crucial factor in explaining the persistence of gender gaps (Adda et al., 2017; Angelov et al., 2016; Blau and Kahn, 2017; Browning, 1992; Goldin, 2014). Recent research consistently finds that women experience a significant and persistent drop in earnings after giving birth to their first child (Kleven et al., 2019a,b; Sieppi and Pehkonen, 2019). Although the motherhood penalty is reduced as the children grow up, the gender gap in earnings remains substantial as parents reach middle-age (Goldin et al., 2022). In this paper, we ask whether the arrival of the first grandchild can explain the persistence of gender gaps in labor market outcomes, and we explore the roots of these gaps over the life cycle.

To examine how gender inequality in labor market outcomes is affected by the arrival of a first grandchild, we adopt an event study approach to study the "grandchild penalty" on earnings, wage rates, labor force participation, full time employment, and hours of work.[1] To that end we use multi-generational high-quality Danish register data containing annual information for the period 1980–2017 on the full population of families in which an individual became a grandparent for the first time between 1985 and 2012. We find that, while labor market outcomes of grandfathers and grandmothers move in parallel before a first grandchild arrives, labor market outcomes start to diverge thereafter. Grandmothers' earnings drop, while grandfathers' earnings remain largely

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[1] Following Kleven et al. (2019b) we use the term "grandchild penalty" to refer to the difference in labor market outcomes between grandmothers and grandfathers upon the arrival of the first grandchild.

unaffected, leading to an earnings gender gap of 3.8 percent five years after the event and 10 percent after 10 years. Unlike what is found for mothers, we document that financial penalties are solely driven by labor supply declines at both the intensive and extensive margins and not lower wages. We find grandchild penalties in labor force participation of 1.8 percent and in hours of work of 2.7 percent. We also uncover a grandchild penalty in full time employment of 4.2 percent. The grandchild penalties documented here are economically significant, at about half the size of those incurred by mothers upon the arrival of a child (Kleven et al., 2019b).

We present evidence that a significant decline in grandmothers' labor market outcomes upon the arrival of a grandchild is driven by increased demand for a grandmother's childcare time. Exploiting the rich intergenerational and historical aspect of the Danish register data, we document that grandchild penalties were larger in the earlier period (1985–2001) – characterized by a combination of low availability of daycare, shorter parental leave, and an earlier retirement age – than in the later period (after 2002) with its more generous family policies and higher pension age. We also document that grandmothers residing closer to their grandchildren experience a larger grandchild penalty (4.5 percent vs. 3.2 percent), presumably because they face greater demand on their time. Linking the register data with geographical variation in formal daycare coverage, we document that differential access to daycare across municipalities in Denmark does not correlate with the grandchild penalty. This indicates that grandmothers' childcare complements rather than substitutes formal daycare. We also find that earnings decline more significantly for maternal grandmothers compared to paternal grandmothers. This finding is consistent with grandmothers' time being in higher demand when her first grandchild is born to her daughter rather than her son, likely because of intergenerational ties being stronger on the mother's side of the family than the father's (Brunello and Yamamura, 2023; Chan and Elder, 2000).

In addition to the quantity of childcare time, we also find that the on-call nature of grandmothers' caregiving, as opposed to grandfathers' caregiving, is a significant driver of the decline in their labor market outcomes. Drawing on data from the Danish Time Use Surveys (DTUS) and the Survey of Health, Aging and Retirement in Europe (SHARE), with both surveys linked at the individual level to the registers, we document that grandmothers and grandfathers do different kinds of childcare, and that grandmothers typically take on more complex and less flexible childcare tasks, which likely explains the larger grandchild penalty they face compared to grandfathers. In particular, grandmothers are involved in childcare when their grandchild is a toddler whereas grandfathers become more involved as the grandchild reaches school age. Drawing on information in the detailed time use data about "with whom" time was spent during the day, we uncover that one-third of grandmothers' childcare time occurs with their husband being present, whereas two-thirds of grandfathers' childcare time happens with their wife being present. Exploiting the time diaries' account of the exact timing of activities, we document that grandparents' provision of childcare is indeed higher in the mornings and late afternoons, also suggesting that grandparents' childcare complements full-time daycare. In Denmark, while most children attend formal daycare starting at age one, the fixed schedules of daycare centers fall short of accommodating parents' work commitments and children's unpredictable needs, such as sudden illness (Datta Gupta and Simonsen, 2010; Gørtz et al., 2024). Taken together, this evidence suggests that grandmothers' on-demand childcare complements, rather than substitutes, formal daycare, filling the gaps where structured care falls short.

Social norms and expectations on women to stop working and to provide childcare among older cohorts may explain why women to a greater extent than men drop out of the labor force and increase childcare as they become grandmothers. Recent literature has shown that social norms and gender identity play an important role in explaining women's labor market decisions (Bertrand, 2011; Bertrand et al., 2021), and Kleven et al. (2019a) have demonstrated that cross-country variation in social norms regarding labor force participation of mothers to under school age children is strongly correlated with long-run child penalties across countries. Using data from the 2008 European Value Survey and from the 2006 European Social Survey for Denmark, we demonstrate (in Appendix F) clear age gradients in gendered views related to young mothers working, in fathers caring for children, and in the perception of an appropriate retirement age for men and women. The decline over time and across cohorts in gender-stereotypical views is in line with previous literature (Bertrand, 2011). The substantial gender gap in views of young mothers' work and men's ability to perform childcare provides suggestive evidence that may explain part of the gap in labor market outcomes opening up at birth of the first grandchild.

Our paper contributes to the growing body of literature on persistent gender gaps in economic outcomes over the life cycle, particularly those driven by caregiving responsibilities (Adda et al., 2017; Goldin, 2014, 2021; Angelov et al., 2016). While the detrimental effects of motherhood on women's career trajectories are well-established (Kleven et al., 2019b,a, 2023), there is limited understanding of how the gendered division of labor interacts with the provision of childcare during grandparenthood and the broader implications for economic outcomes across generations. Existing research on grandparenthood, such as studies by Backhaus and Barslund (2021), Rupert and Zanella (2018), and Frimmel et al. (2020), largely finds that grandparenthood has a negative effect on female labor supply, particularly when formal daycare is limited. Karademir et al. (forthcoming) find that both men and women adjust their labor supply. These studies are often limited in their ability to disentangle how grandmothers' roles in childcare may complement or substitute formal daycare due to constraints in data on detailed breakdowns of the different types of childcare activities, on the gendered division of grandparental roles, or variability in childcare provision. Our study addresses this gap by leveraging register data, detailed time use surveys, and geographic variations in daycare coverage to uncover grandparental labor supply responses upon grandparenthood. We find that the "grandchild penalty" in earnings is largely driven by a decline in work hours for women as they move out of full-time employment, whereas the effects on men are minimal. The gender gap upon grandparenthood can be explained by grandmothers not only providing more childcare than grandfathers but also engaging in different types of care that require grandmothers to be on-call. As a result, grandmothers often serve as complements to formal daycare by providing on-call childcare, suggesting they make labor market sacrifices to fulfill this role. This aligns with findings from Goldin (2014), Goldin and Katz (2016) and Goldin (2021), who argue that the demand for on-call work is a key driver of persistent gender gaps in the labor market.

We also contribute to the literature looking at understanding the labor market implications of grandparenthood. The literature relying on local treatment effects has yielded important insights, such as showing that grandparenthood negatively impacts women's labor force participation. Commonly used methods include instrumental variable techniques, such as leveraging the gender of the first-born child (Backhaus and Barslund, 2021; Rupert and Zanella, 2018), twin-births (Frimmel et al., 2020), or regional variation in various family policies (Asquith, 2017; Wang and Marcotte, 2007), as well as panel data approaches (Zanasi et al., 2020).[2] The paper most similar to ours is the concurrent study by Karademir et al. (forthcoming), which employs a global treatment effect event study approach in Canada and finds that the arrival of a grandchild reduces grandmothers' employment by 8 percent and earnings by 16 percent. Because of data limitations in their administrative sample of taxpayers, Karademir et al. (forthcoming) is limited to two outcomes, earnings and an indicator for employment based on having positive earnings in a year. Our paper is able to address the global treatment effect by leveraging the comprehensive Danish register data, which provides two key advantages. First, because the data covers the entire population, we identify all grandparents and pinpoint the exact year they become grandparents, without being restricted to certain subgroups like taxpayers or specific age ranges. Second, the granularity of the data allows us to analyze not just employment as a zero–one decision but also responsive labor market margins such as participation, fulltime versus parttime, hours worked and wage rates. By addressing both the extensive and intensive margins of labor supply, we offer a deeper understanding of how grandparenthood influences economic outcomes across genders, contributing to the broader goal of understanding and addressing gender disparities in economic outcomes over the life cycle.

Our findings suggest that to effectively address gender disparities in labor outcomes across generations, it is crucial to recognize that grandmaternal childcare complements formal daycare and imposes unique labor supply constraints on women. While policies have traditionally targeted mothers, our findings reveal that social norms and expectations drive a significant portion of the gendered division of childcare across the lifespan. This aligns with existing literature on the motherhood penalty (Kleven et al., 2019a; Bertrand et al., 2021), which highlights how societal norms shape women's labor force participation. Consequently, the pressure on women to take on caregiving as they transition to grandparenthood exacerbates the gender gap in labor supply, underscoring the need for policies that support grandmothers in balancing work and family responsibilities and address deeply rooted expectations that drive unequal labor outcomes.

The paper is organized as follows. Section 2 presents the data we use in our analysis. Section 3 outlines our empirical event study approach, and Section 4 presents the results. Section 5 concludes.

2. Data

We construct a multi-generational data set by linking individuals across three generations of children, parents, and grandparents. Danish register data combine several administrative registers, which are linked via personal identification numbers. The breadth of the register data allow us to combine data on a range of socioeconomic characteristics such as employment histories, labor market earnings, education and, e.g., to distinguish between grandparents on the mother's and father's side of the family.[3]

Our main sample includes 1,193,748 grandparents who become grandparents for the first time over the 1985–2012 period to a total of 556,503 grandchildren. The event studied is the birth of an individual's first grandchild. For each event, we observe calendar year and grandparent's age, and socio-economic characteristics of the grandparent, an eventual partner, and the parents of the grandchild. We restrict the sample to individuals who become grandparents to their first grandchild between the ages of 35 and 80 and for whom we observe a balanced panel of individuals that are alive five years before and five years after the first grandchild is born.[4] Table 1 shows summary statistics for our sample of grandparents. The grandmothers were about 2.5 years younger than the grandfathers in our sample when they had their first child. Similarly, the grandmothers are younger than the grandfathers when they have their first grandchild.

We utilize the longitudinal nature of the registers to examine the long-run impact of grandchildren, measured ten years after the arrival of the first grandchild. In the long-run analysis, we allow for gradual attrition of individuals in our sample between six and ten years following the birth of the first grandchild, which may be attributed to mortality or emigration. Ten years after the birth of the first grandchild, 78 percent of the individuals in our main sample remains included in the analysis.

We analyze the effects of grandparenthood using five labor market outcomes: (a) Annual labor earnings[5]; (b) Labor force participation (a dummy taking the value one for individuals with positive earnings and zero otherwise); (c) Work hours, allowing us to capture labor adjustments on the intensive margin[6]; (d) Dummy for full time work[7]; (e) Hourly wage rates[8]; All monetary variables are inflated to reflect 2018-prices and annual incomes top coded at one million DKK.

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[2] Our results are comparable to those in the literature investigating how older workers adjust their labor market outcomes in response to a grandchild. We find a 17.5 percent drop in grandmothers' earnings and 13.5 percent in labor force participation at event time 10, consistent with Frimmel et al. (2020) who estimate increased probability hazards of leaving the labor market of 8–11 percent. Papers using the gender of the firstborn child to instrument for the timing of grandparenthood generally find large effects on labor force participation in the range 33–36 percent (Rupert and Zanella, 2018; Backhaus and Barslund, 2021), although these are local average treatment effects and not directly comparable to our results.

[3] Data are accessible in anonymized form for researchers based in Danish research institutions through secured access to Statistics Denmark.

[4] Fig. A.1 panel (a) shows a histogram of age a first grandchild's birth.

[5] Measured before tax and excluding any unemployment insurance benefits or 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. See Fig. A.1 panel (b) for an age profile of earnings.

[6] This measure, which is recorded in bins, is based on information from employer contributions to a mandatory pension scheme, ATP. The ATP scheme (*"Arbejdsmarkedets Tillægspension"*) requires all employers to make contributions for each employee based on their individual work hours, aggregated in bins

Table 1
Background characteristics for grandfathers and grandmothers.

	(1) All	(2) Grand- father	(3) Grand- mother	(4) Difference
Age at first child's birth	25.58 (4.840)	26.96 (4.834)	24.39 (4.518)	2.566*** (299.55)
Age at first grandchild	54.53 (6.918)	55.80 (6.817)	53.43 (6.816)	2.370*** (189.45)
Year of birth	1943.7 (10.01)	1942.5 (9.997)	1944.8 (9.901)	−2.282*** (−125.03)
Single-headed household	0.182 (0.386)	0.146 (0.353)	0.214 (0.410)	−0.0678*** (−96.13)
Maternal grandparent	0.538 (0.499)	0.540 (0.498)	0.537 (0.499)	0.00310*** (3.39)
High daycare enrollment	0.425 (0.494)	0.423 (0.494)	0.426 (0.495)	−0.00259*** (−2.85)
Commute time >20 min	0.609 (0.488)	0.622 (0.485)	0.597 (0.490)	0.0249*** (27.83)
Observations	1,193,748	554,870	638,878	1,193,748

Note—The table shows means and standard deviations of the background characteristics of the sample in column (1) and separately for grandfathers and grandmothers in columns (2)–(3). Column (4) plots *t*-statistics of the difference between grandfathers and grandmothers.

Fig. 1 plots the averages of all outcomes five years before through five years after the arrival of the first grandchild. On average, grandfathers have higher earnings than grandmothers, but grandfathers' earnings drop more than those of grandmothers, reflecting that grandfathers are older than grandmothers when having their first grandchild and thus closer to retirement (panel a). Our event study controls non-parametrically for these life-cycle patterns by including individual and age fixed effects. Hours of work and full time employment evolve similarly (panels c and d); the levels are initially higher for grandfathers than for grandmothers, but drop at a faster rate across the event time window. In contrast, we see similar levels of labor force participation of grandmothers and grandfathers across the event time window (panel b). The wage rates increase slightly across the event time window at a similar rate for grandmothers and grandfathers (panel e).

To inform on the mechanism at play, we first investigate heterogeneity across our sample of individuals who become grandparents between 1985 and 2012, we exploit register information on cohabitation/marital status, and municipality of residence for both the grandchild and the grandparents, which we combine with data on travel time and distance between municipalities to investigate if proximity between grandparents and grandchildren plays a role. In addition, we utilize information on the average enrollment rate in formal daycare for all municipalities in the period 1985–2012. We use this data to construct an annual indicator variable taking the value one for municipalities with above-mean enrollment rates, and we link these to the individuals in our sample by municipality of residence of the first grandchild in its birth year.

Second, we link our sample of grandparents to additional information from Danish time use surveys to understand whether there are indeed gender differences in the time spent with grandchildren and when during the day grandparents provide child care time. Because the survey samples are drawn from the administrative data, and maintained by Statistics Denmark, we can link the time use surveys back to the registers. This feature allow us to observe 5111 time spells for 2446 of the grandparents from the main sample pooling the data from the three time use surveys conducted in 1987, 2001 and 2008.

Third, we exploit auxiliary data in terms of the Danish parts of two international surveys, the European Value Survey (EVS) wave 4 from 2008 to analyze age and gender differences in attitudes to young women working, and the European Social Survey (ESS) wave 3 from 2006 to investigate age and gender differences in attitudes to elderly women and men working.

3. Empirical strategy

To gauge the impact of having a grandchild on grandparents' labor dynamics and identify grandchild penalties, we implement an event study approach that relies on sharp changes around the birth of the first grandchild for grandmothers relative to grandfathers

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(0–8, 9–17, 18–26, 27+, if paid per week, or 0–38, 39–77, 78–116, 117+, if paid monthly). Unfortunately, we are not able to distinguish between people who work part time throughout the year and people who, e.g., work full time half the year and quit working the rest of the year. Based on this information, we construct a measure of weekly hours of work averaged across the year.

[7] We construct a full time dummy taking the value one if the grandparent works full time the entire year and zero otherwise (including if the grandparent retires, works part time, or has never worked). This variable captures people who switch from working more than 27 h per week (or more than 177 per month) through out the year to working less.

[8] Hourly wage rates are calculated from annual earnings divided by 52 weeks times our measure of weekly hours of work. As work hours are capped at the top, these may be underestimated, and the imputed hourly wage rate may thus be overestimated for full-time employed working more hours than the top cap.
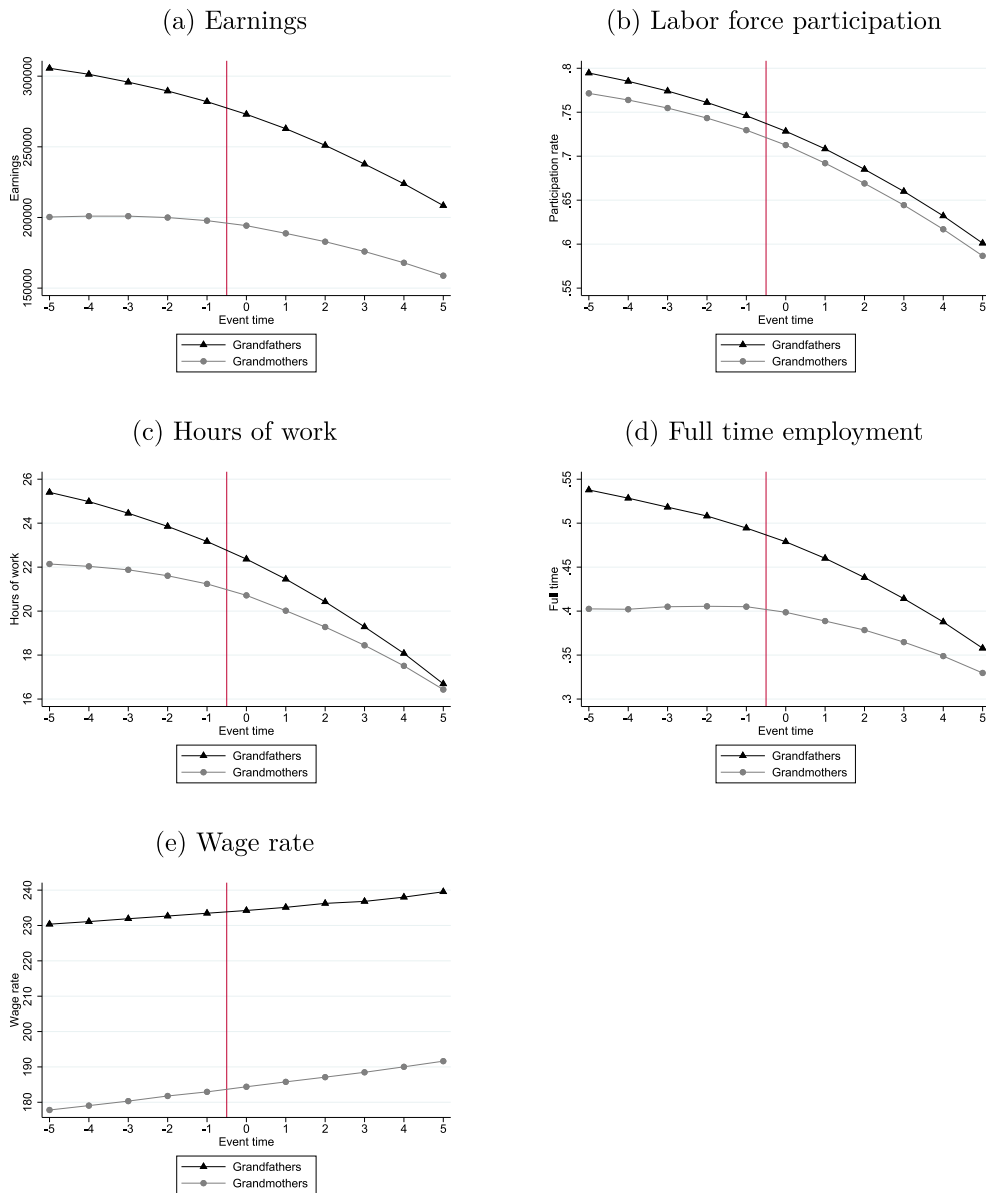
Fig. 1. Mean of outcome variables. NOTE—The figure shows means of the outcome variables across event time separately for grandmothers and grandfathers.

following similar event studies of the birth of a first child (Angelov et al., 2016; Kleven et al., 2019b; Andresen and Nix, 2022). While becoming a grandparent *per se* is not exogenous (although more so than becoming a parent), the event study relies on variation in the timing of age at first grandchild rather than comparing grandparents to non-grandparents. We estimate the following regression separately for grandmothers and grandfathers:

$$Y_{ist}^{gp} = \sum_{j \neq -1, -5} \alpha_j^{gp} \cdot \mathbb{1}[j = t] + \sum_k \beta_k^{gp} \cdot \mathbb{1}[k = age_{is}] + \sum_\lambda \gamma_\lambda^{gp} \cdot \mathbb{1}[\lambda = s] + \upsilon_i^{gp} + \mu_{ist}^{gp} \tag{1}$$

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 include a full set of age and year dummies, denoted by k and λ, respectively. Age dummies control non-parametrically for underlying life-cycle trends, which is important as women on average become grandmothers two years earlier than men become grandfathers. Moreover, age dummies take account of age-related rules for, e.g., retirement eligibility. Year dummies take into account in a non-parametrical way any time trends resulting, e.g., from business cycle effects or changes in pension legislation or parental leave schemes.

The underlying assumption behind identification of causal effects in an event study model as Eq. (1) is that, conditional on becoming a grandparent and age, year and individual fixed effects, the age at the birth of the first grandchild is exogenous to the labor market dynamics. As parenthood is a precondition for grandparenthood, and parenthood have large and persistent effects on the relative earnings dynamics between men and women, controlling for age and year dummies alone is not necessarily enough to ensure a flat pre-trend. We therefore also include an individual fixed effect, υ_i^{gp}, capturing the grandparent's underlying health level and own fertility choices. Our model is estimated on a balanced sample, conditioning on all individuals being in the data from $t = -5$ to $t = 5$. Following Borusyak et al. (2024), we omit the event times $t = -5$ and $t = -1$ so that the estimated event time coefficients α_j^{gp} refer to the trend between the years before the first grandchild is born. The event study describes the dynamic adjustment to a new situation of being a grandparent, i.e., the gradual increase in child care demand incurred by having grandchildren in the toddler and preschool age rather than babies (who are cared for by their parents due to the generous parental leave policies) and potentially having several grandchildren in the five year period.

The identifying assumption behind the event study model is less demanding in our setting than in similar event studies estimating labor market dynamics around the birth of one's first child rather than one's first grandchild (Angelov et al., 2016; Kleven et al., 2019b; Andresen and Nix, 2022). One concern could be that coming parents time their fertility with the coming grandparents' retirement. However, Fig. A.1 shows no discontinuities in the age at the birth of the first grandchild around the eligibility age for pensions minimizing such concerns.[9] In contrast, the identifying assumption behind causal interpretation of Eq. (2) relies on the usual parallel trends assumption. In particular, while changes in individual, family, and work preferences evolve gradually over an individual's life course, 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.

A recent and active literature discusses the econometric problems related to heterogeneous treatment effects in event studies, as treatment effects may depend systematically on the unit type, time, or context (Dobkin et al., 2018; Sun and Abraham, 2021; Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021; De Chaisemartin and d'Haultfoeuille, 2020; Roth, 2022; Miller, 2023). In the light of this rapidly evolving literature, we perform (a) robustness checks estimating our model both with and without unit fixed effects and (b) a number of heterogeneity analyses, which add to our understanding of the grandchild penalty across time periods, cohorts, institutional settings and individual characteristics.

Following Kleven et al. (2019b), we specify the equation in levels rather than logs to keep those with zero earnings in the data, and we convert the estimated effects in levels to percentages by scaling the estimates with the counterfactual outcome absent grandchildren. Thus, the percentage change in outcomes of each grandparent is given by $P_t^{gp} \equiv \hat{\alpha}_t^{gp} / \mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$, where $\tilde{Y}_{ist}^{gp}$ is the predicted outcome when the event time dummies are omitted from Eq. (1). Following Kleven et al. (2019b), 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:

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

The grandchild penalty is thus defined as the gender gap in labor market outcomes associated with having a grandchild.

We also estimate long-run grandchild penalties by extending the period to ten years after the birth of the first grandchild. The ten-year follow-up is based on our main sample of individuals observed five years before and five years after the birth of their first grandchild.

Furthermore, as an additional identification check, we study the effects of having grandchildren *per se* in a Difference-in-Differences (DiD) event study where men and women who do not (yet) have grandchildren function as control groups.

4. Results

This section reports the results from our event study. We estimate Eq. (1) separately for grandmothers and grandfathers. Fig. 2 shows the percentage changes of the labor market outcomes at a given event time t relative to the years before the first grandchild is born. Panel (a) in Fig. 2 shows a large drop in earnings after the first grandchild is born, particularly for grandmothers. While earnings of grandmothers and grandfathers evolve in parallel before the arrival of the first grandchild, they start diverging shortly after the first grandchild is born. In particular, whereas earnings of grandfathers do not change much in the first years after the birth of their first grandchild, grandmothers experience an earnings drop of 1.6 percent the first year, and their earnings continue to decline at a much steeper rate than the earnings of grandfathers. Five years after the arrival of the first grandchild, the earnings of grandmothers have dropped 6.0 percent, while the earnings of grandfathers have only dropped by 2.2 percent. As a result, the grandchild penalty as defined in Eq. (2) amounts to 3.8 percent five years after the arrival of the first grandchild.

To understand the source of the widening earnings gap and the implications hereof, panels (b)–(e) of Fig. 2 document the changes in other labor market outcomes. Each of the labor market outcomes in panels (a)–(e) show parallel pre-trend trajectories prior to the arrival of the first grandchild, but only earnings and labor supply outcomes (at the extensive and intensive margin) exhibit changes shortly after the first grandchild is born. In particular, the relative decline in grandmothers earnings is primarily driven

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[9] The large public provision of parental leave and subsidized daycare in Denmark entails that parents are less dependent on informal care on a regular basis provided by grandparents compared to many other countries (OECD, 2019).
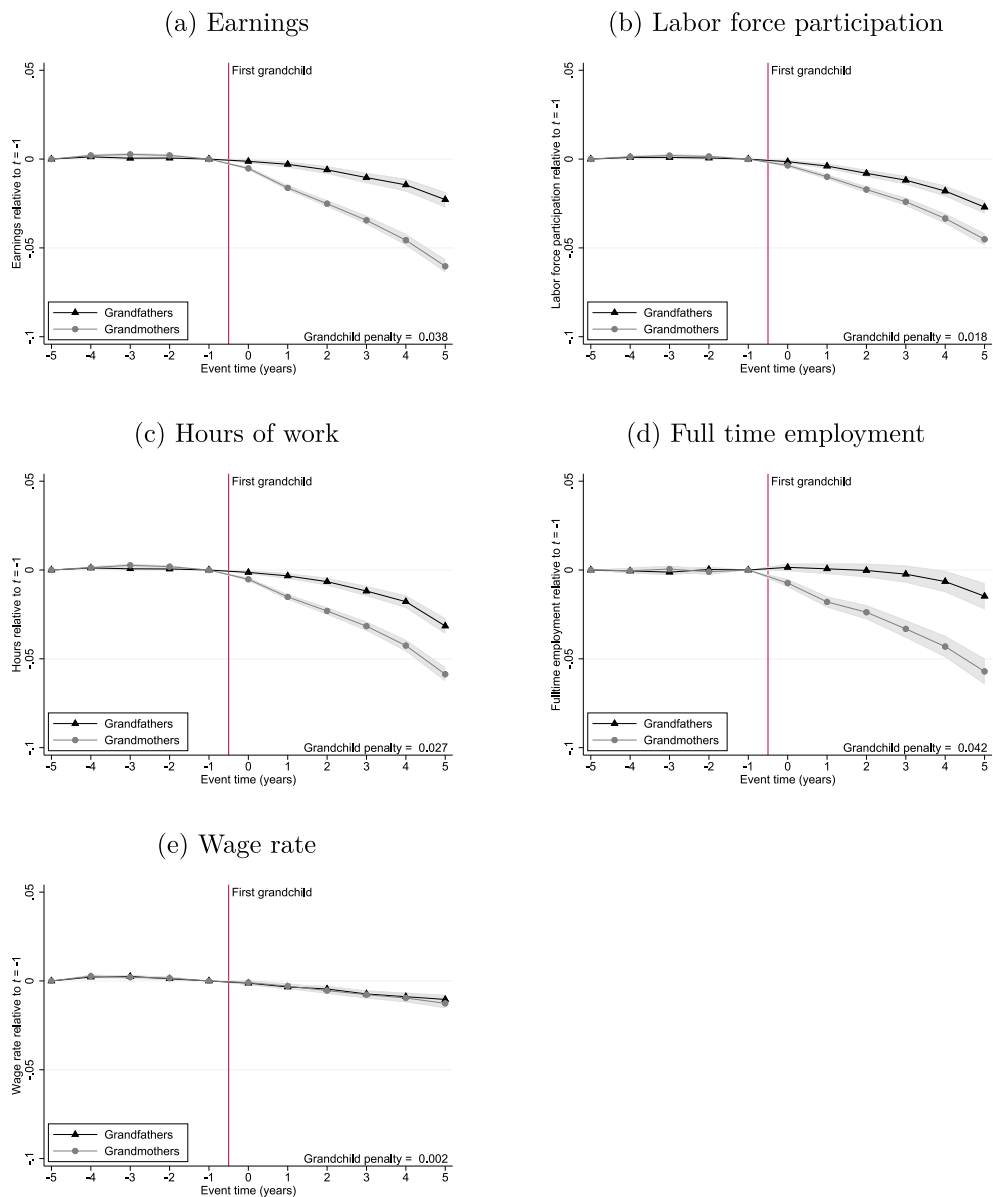
(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

Fig. 2. The impact of grandchildren. NOTE—The figure shows event time coefficients estimated from Eq. (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 fall behind grandfathers due to grandchildren, as defined in Eq. (2). The grandchild penalty is measured at event time 5. The wage effects are estimated conditional on participation. The shaded 95 percent confidence intervals are based on bootstrapped standard errors.

by declining hours of work, full time employment, and labor force participation. Panel (c) shows that while both grandparents experience declining work hours after the birth of the first grandchild, the drop in grandmothers' work hours is steeper and more persistent than grandfathers' hours. Five years after the arrival of the first grandchild, the grandchild penalty in hours worked amounts to 2.7 percent. Similarly, the results in panel (d) show that whereas grandfathers experience almost no change in full time employment over the five year period after the arrival of the first grandchild, there is a sharp and continuing fall in full time employment for grandmothers, implying that grandmothers are 4.2 percent less likely to work full time than grandfathers. This suggests that grandfathers do not experience the same challenge of balancing child care and market work as grandmothers. Furthermore, as expected the gradual decline in labor market outcomes may reflect the gradual increase in child care demand incurred by having grandchildren who are enrolled in non-parental childcare rather than cared for by their parents on parental leave in addition to having more grandchildren in the five year period. Finally, we find no adjustments in the wage rate; panel (e) shows a constant wage rate both pre- and post-event for both grandmothers and grandfathers. Indicating that grandparents do not change their type of job, but rather adjust their labor supply in the response to a grandchild. In the longer-run, i.e., ten years after

the arrival of the first grandchild, the gender gaps expand and often more than double compared to the five-year gap, as evidenced in Fig. B.1.[10] The earnings gap, for example, increases from 3.8 percent after five years to 10.1 percent after ten years.[11]

Estimating Eq. (1) without individual fixed effects yields similar grandchild penalties. The grandchild penalty in earnings is 3.9 without individual fixed effects compared to 3.8 with individual fixed effects. The differences between penalties estimated with and without individual fixed effects are equally small for the other outcomes.[12]

As another robustness check, panels (a) to (e) of Fig. C.1 reports grandparent penalty estimates using a DiD event study model, which can be interpreted as the percentage by which grandmothers (grandfathers) fall behind women (men) without grandchildren. The DiD event study thus compares women to women and men to men, as opposed to our gender gap estimates comparing women to men. The results are qualitatively the same.

Overall, our results are close to the lower range of estimates reported in the literature on labor supply adjustments following the birth of a grandchild. Backhaus and Barslund (2021) find reductions in grandmothers' labor supply of 30 percent using cross-country data from SHARE. Using PSID data for the U.S, Rupert and Zanella (2018) show reductions in hours of work as high as 36 percent. Also using PSID data, Wang and Marcotte (2007) find that grandparents increase their labor supply when they live in the same household as their grandchildren. Hinting, that the arrival of a grandchild has differential effects on a grandparent's labor market outcomes depending on the social context.[13] While Backhaus and Barslund (2021) and Rupert and Zanella (2018) identify local average treatment effects, our identification strategy yields estimates that are more directly comparable with those reported in Frimmel et al. (2020) and Karademir et al. (forthcoming). Frimmel et al. (2020) find that grandmothers' probability of leaving the labor market increases by 8.5 percentage points, which are in line with our results on labor force participation. Moreover, the magnitude of our results are in line with the results by Karademir et al. (forthcoming), who find that grandmothers' (grandfathers') earnings dropped by 16 (15) percent ten years after the arrival of the first grandchild.[14]

The grandchild penalties documented here are relatively large compared to the child penalties in Denmark documented in Kleven et al. (2019b). Kleven et al. (2019b) find a child penalty in parental earnings of around 20 percent on average, whereas we find a grandchild penalty of 3.8 percent five years after the first grandchild. This figure corresponds to about one fifth of the child penalty incurred by parents. The mechanisms driving the child penalties for parents and grandparents are also different. While grandchild penalties on hours worked and participation rates are both substantial, there is no grandchild penalty on wage rates, indicating that grandparents do not adjust by selecting into other occupations, sectors or firms sacrificing wage premium for flexibility at this point in their career.

4.1. Grandparents providing flexibility for their offspring

The economics literature on gender gaps over the life cycle has identified an important role for job amenities, and in particular employer demands for high employee flexibility in certain professions (Goldin, 2014; Goldin et al., 2022; Blau and Kahn, 2017). These so-called "greedy" professions pay disproportionately more for long hours and weekend work, which are difficult to reconcile with family life. Consequently, gender pay gaps emerge because of differences in male and female preferences for greedy and flexible employment (Goldin, 2021). In the Danish setting, Kleven et al. (2019b) show that one-third of the child penalty stems from reductions in wage rates because mothers move to sectors with more flexibility but lower wages. While we find no change in wage rates upon the arrival of the first grandchild, the drops we observe in grandparents' earnings and labor supply may arise because they provide some flexibility to young parents for them to reconcile family and career.

The degree to which such flexibility is needed and provided varies across time periods, household types, and institutional and social contexts for parents and grandparents. Fig. 3, panels (a)–(f), shows the heterogeneity in the event study coefficients for earnings along six dimensions: (a) time period (before/after 2002-extension of parental leave), (b) cohorts of grandparents born before and after pension reform, (c) daycare enrollment rate in the municipality where the grandchild lives, (d) proximity between grandchild and grandparents in terms of travel time, (e) gender of the parent of the grandchild, and (f) cohabitation/marital status of grandparents. Figs. D.1–D.6 in the Appendix show the heterogeneous effects for all labor market outcomes.

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[10] Given that our sample of grandparents are older and nearing retirement, following up on labor supply effects beyond ten years after becoming a grandparent runs into precision problems due to retirement and attrition due to mortality.

[11] Specifically, while grandmothers earn 17.5 percent less ten years later compared to the year before the arrival of the first grandchild, grandfathers' earnings only fall by 7.5 percent. For both grandmothers and grandfathers, labor force participation decreases gradually after the birth of the first grandchild such that ten years after the birth of the first grandchild, participation is 13.5 and 9 percent lower for grandmothers and grandfathers, respectively.

[12] Estimating Eq. (1) without individual fixed effects and constructing the child penalties in Eq. (2) based on these estimates we find similar grandchild penalties; for earnings the penalty is 3.9, for labor force participation the penalty is 3.4, for hours of work the penalty is 4.7, for full time employment the penalty is 4.8, and for wage rate the penalty is −0.4.

[13] Using a longitudinal survey from China, Meng et al. (2023) find only temporary effects on mothers' labor force participation, while grandmothers' labor force participation drop by 18 percentage points immediately after the arrival of the first grandchild and continues hereafter at this level.

[14] For employment, they find drops of 8 percent and 6 percent for grandmothers and grandfathers, respectively. While these results are similar to our results, it is noteworthy that their results hardly differ by gender.
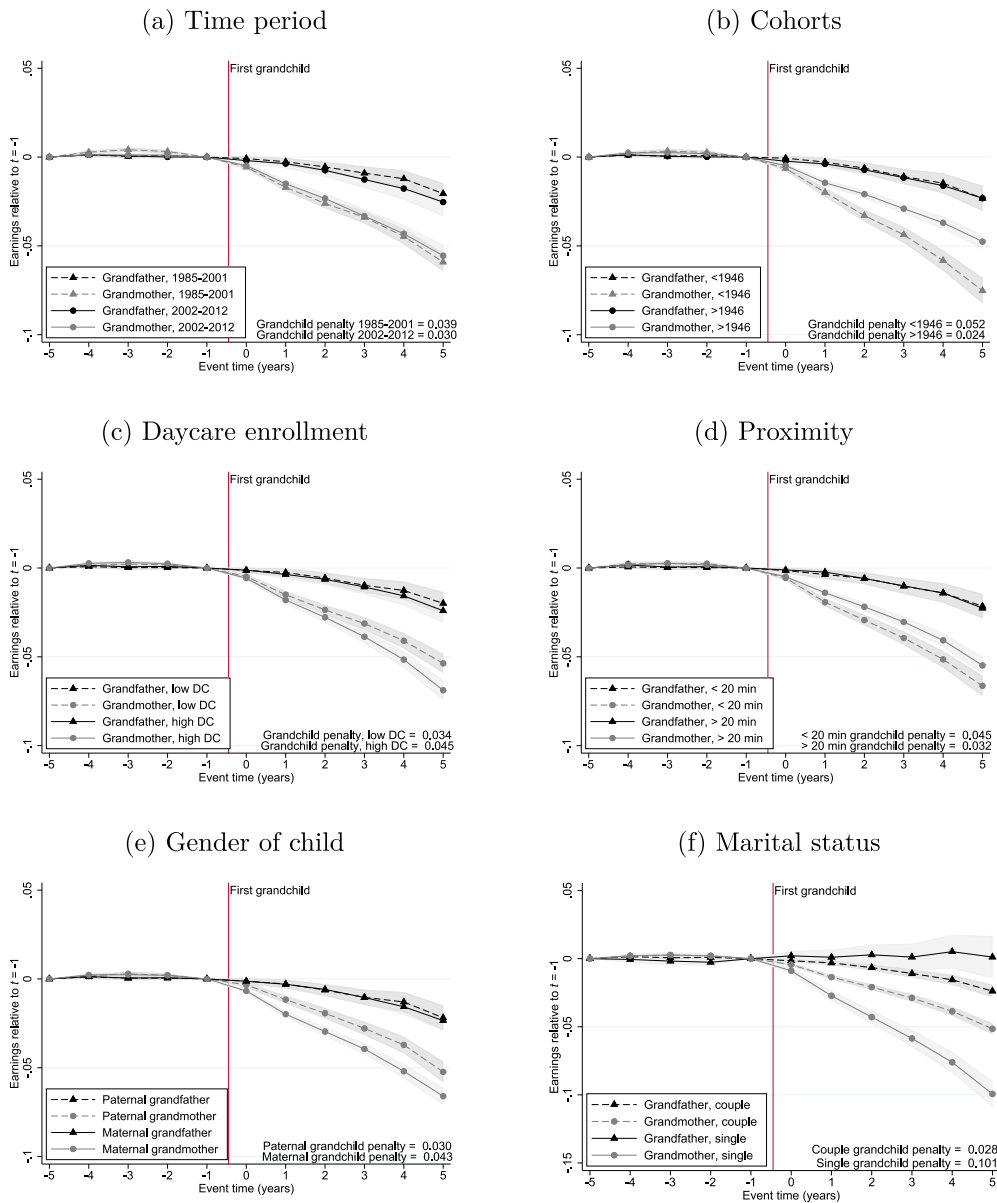
Fig. 3. Heterogeneity in the impact of grandchildren. Note—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp} / \mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers separately for earnings. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Eq. (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 shaded 95 percent confidence intervals are based on cluster robust standard errors.

4.1.1. Differences across time periods

In panel (a) of Fig. 3 we subdivide our sample into two main time periods, 1985–2001 and 2002–2012, respectively. Policy-wise, these two periods differ with respect to three important policy dimensions: (1) The length of parental leave periods, (2) access to early retirement, and (3) access to formal daycare. First, while parents of children born in the sub-period 1985–2001 were entitled to 26 weeks of parental leave after the birth of a child, parents of the children born 2002–2012 were entitled to 52 weeks of leave. Second, while the first period was characterized by a relatively low retirement age and relatively low labor force participation of older women, retirement reforms in the late 1990's reduced access to early retirement. Third, availability of formal subsidized daycare – especially for children younger than three – was lower in the earlier period. Despite these policy differences across time periods, panel (a) of Fig. 3 shows very small differences in the grandchild penalty across the two periods studied.

4.1.2. Differences across birth cohorts of grandparents

In panel (b) of Fig. 3, we explore the significance of pension reforms further by subdividing the sample into two groups of grandmothers and grandfathers who were born in or before 1946 versus after 1946. While individuals born in or before 1946 could leave the labor market at age 50 through early retirement options, cohorts born in 1947 and hereafter had to wait until age 60 before they could retire. Fig. 3, panel (b), shows significant differences across these cohorts of grandmothers: while the earlier cohorts of grandmothers experienced an earnings penalty of 5.2 percent, later cohorts of grandmothers experienced an earnings penalty of 2.4 percent.

4.1.3. Differences by daycare enrollment

We next explore how variation in daycare access across municipalities is related to grandchild penalties.[15] Daycare availability may impact grandparental involvement in the care for grandchildren in two directions. On the one hand, parents in areas with *low* daycare enrollment may rely on child care provided by grandparents as a *substitute* for formal daycare. On the other hand, parents in areas with *high* daycare enrollment may benefit from grandparental care outside the opening hours of the child care center, suggesting that formal daycare and grandparental care may be *complements*. To investigate this channel, we stratify the sample according to high and low daycare coverage for 0–2 year-old children in the municipality where the firstborn grandchild lived at birth. Panel (c) of Fig. 3 shows that grandmothers' earnings decline relatively more when the grandchild lives in a municipality with high daycare coverage, suggesting that grandmothers' child care time is complementary rather than a substitute to formal daycare. We examine this question further in Section 4.2.

4.1.4. Proximity to grandchildren

Grandparents who live closer to their grandchildren experience a lower opportunity cost (via lower travel time and transportation costs) when going to see their grandchildren and may thus be more inclined to provide child care.[16] In order to examine if grandparents' proximity affects the grandchild penalty, we stratified the sample according to whether commuting time is more or less than 20 min between the municipalities where the grandparents and the firstborn grandchild lived in the first year of the grandchild's life.[17] Importantly, the decision for the generations to live close to each other is evidently an endogenous choice that reflects preferences for interaction across generations. This concern is, however, somewhat alleviated by the fact that we compare grandmothers and grandfathers, who are both subject to the same location choice. Panel (d) of Fig. 3 shows that grandmothers who live less than 20 min away from their grandchild experience a slightly higher grandchild penalty than grandmothers who live further away, suggesting that grandmothers having lower commuting costs may be more easily available for child care, and/or may have preferences for being close to their family. There is no difference in earnings for grandfathers depending on travel time.

In the Appendix, we explore whether commuting time and distance between grandparents and parents change following the birth of a grandchild (because grandparents move closer to their children or the children move closer to the grandparents). Using our event time method with the dependent variable being commuting time and commuting distance between grandparents and parents, respectively, we show (in Fig. D.7) a small reduction in both commuting time and commuting distance between grandparents and children following the birth of a grandchild. This effect is larger if the parent of the firstborn grandchild is a daughter rather than a son, suggesting that maternal grandparents and their daughters move closer to each other after the birth of the first grandchild.[18]

4.1.5. Gender of the parent - Differences between daughters and sons

We next investigate if the drop in grandparents' earnings depend on whether their first grandchild is the child of their daughter or their son, as previous research have shown that the exchange of time and services across generations is stronger on the mother's side of the family than the father's side (Brunello and Yamamura, 2023). We define a maternal (paternal) grandparent as a grandparent to a grandchild born by the grandparents' daughter (son). Panel (e) of Fig. 3 shows that the maternal grandchild penalty in earnings is larger than the paternal grandchild penalty.[19] This evidence confirms past findings; Frimmel et al. (2020), e.g., find that labor market exits are substantially higher if the grandchild is a daughter's child compared to a son's child. This hints that the matrilineal advantage, i.e., that maternal grandmothers have closer ties to their grandchildren than paternal grandmothers (Brunello and Yamamura, 2023; Chan and Elder, 2000), may come at a price.

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[15] During the 1960s and 70 s female employment and daycare enrollment increased simultaneously. Today, the majority of Danish children enroll in center-based daycare before they start school. However, there exist variations in the take-up across areas.

[16] Using U.S. Census data and the National Survey of Families and Households, Compton and Pollak (2014) find 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 points.

[17] 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 2000 inhabitants to Copenhagen with more than 600,000 inhabitants in recent years. The average commuting time between parents and grandparents is 54 min and 40 percent of our sample lives less than 20 min away from each other.

[18] Similarly, Rutigliano et al. (2023) show that daughters are more likely to move closer to their mothers during their first pregnancy and that mothers are more likely to move closer to their daughters when the daughters' children are older than 2.5 years.

[19] In Fig. D.8 we examine the labor market dynamic of grandparents in families with no maternal grandmother and find qualitative similar results.
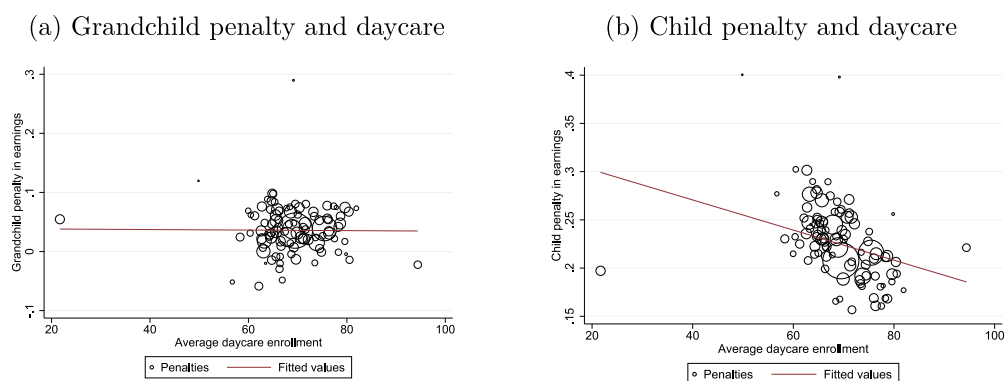
(a) Grandchild penalty and daycare   (b) Child penalty and daycare

Fig. 4. Spatial variation in the impact of grandchildren and children. Note—The figure plots the "grandchild penalty" in panel (a) and the "child penalty" in panel (b) against average daycare enrollment for each municipality. The size of the circles indicate the size of the population in the municipality. The fitted lines are weighted by population size. 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 and the parents of their first grandchild.

4.1.6. Differences depending on cohabitation/marital status of grandparents

Panel (f) in Fig. 3 shows the effects of the first grandchild on earnings, depending on cohabitation/marital status of the grandparent. Single grandmothers experience the largest grandchild penalty, in terms of a drop in earnings of 10.1 percent, compared to single grandfathers.[20] While this finding may seem surprising, descriptive statistics on single versus married/cohabiting grandmothers suggest that grandmothers in single-headed households were different from grandmothers in cohabiting households already before the arrival of the first grandchild: They were slightly older, their initial labor supply was lower (labor force participation was 0.66 versus 0.75 for married/cohabiting grandmothers), and they had lower earnings. This suggests that single grandmothers may face a smaller time-cost of grandparenting in terms of the difference in disposable income between working and not working than married/cohabiting grandmothers. 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., 2021) and coordinate their retirement in old age (Bingley and Lanot, 2007; García-Miralles and Leganza, 2024).

4.2. Evidence from spatial variation in access to daycare

To shed more light on the degree to which grandparental care works as a substitute or complement to formal daycare, we estimate child penalties and grandchild penalties in earnings separately for each municipality in Denmark and relate these penalties to spatial variation in the take-up of formal daycare. To this end, we divide the sample into 98 sub-samples on the basis of the municipality of residence of the firstborn grandchild in its birth year. Fig. 4 plots the "grandchild penalty" in earnings in panel (a) and the "child penalty" in earnings in panel (b) against the average daycare enrollment for each of the 98 municipalities in Denmark. The size of the circles indicate the size of the population in the different municipalities and the fitted line is weighted by population size. Panel (a) shows that the grandchild penalties in earnings are similar across municipalities and thus uncorrelated with take-up of formal daycare in the municipalities. In contrast, panel (b) shows some evidence that the child penalties in earnings are larger in municipalities with relatively low take-up of formal daycare. While Kleven et al. (2024) find no impact of daycare availability on the child penalty in Austria, Andresen and Nix (2022) show that increasing daycare availability reduces the child penalty in Norway, and Karademir et al. (forthcoming) confirm this result for Canada. In addition, Karademir et al. (forthcoming) find that formal daycare works as a substitute for regular care provided by grandmothers but as a complement to low-intensity informal care by grandmothers. Given the relatively high take-up of formal daycare in Denmark, the evidence in Fig. 4 suggests that the child care provided by grandparents works more as a complement than a substitute for enrollment in formal daycare. In Section 4.3, we investigate if grandparents do more child care during specific hours of day to better understand if grandparents, e.g., are supporting flexibility in their children's work schedules by providing care outside the openings hours of daycare centers.

4.3. Grandparents' child care time and the flexibility it provides

We documented that the impact of grandchildren is larger for grandmothers than grandfathers, resulting in a substantial grandchild earnings penalty. Moreover, we found no evidence that grandmothers' care is substituting for formal child care centers. In this section, we pull together additional information from Danish time use surveys and SHARE to show that the nature of the

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[20] While single grandfathers do not adjust labor supply, our findings may reflect that single grandfathers contribute towards the younger generation by transferring money, while single grandmothers and grandparents in a couple contribute time.

Table 2

Grandparents doing child care activities.

Source: Danish Time Use Surveys from 1987, 2001, and 2008 linked to register data. SHARE data linked to register data.

	(1) Grandmother	(2) Grandfather
Panel A: Time use data		
Fraction doing child care on one of the diary days		
Doing child care	0.116	0.108
	(0.321)	(0.311)
Observations	1274	1172
Child care conditional on doing some child care		
Child care time (minutes per day)	147.4	137.5
	(138.0)	(124.9)
Joint child care time (minutes per day)	61.37	89.33
	(115.9)	(110.7)
Fraction of child care time done jointly with spouse	0.347	0.636
	(0.445)	(0.458)
Observations	238	126
Panel B: SHARE data		
How many hours did you care last month	8.652	6.221
	(40.61)	(36.95)
Fraction who care daily or weekly	0.163	0.130
	(0.369)	(0.336)
Observations	1720	1508

Note—Panel A shows means and standard deviations of a dummy for doing some child care, the time in child care activities conditional on doing some child care, and the time in child care done with the spouse present (joint child care) separately for grandmothers and grandfathers.

childcare that grandmothers and grandfathers provide is consistent with a larger drop in earnings for grandmothers relative to grandfathers, as documented in Fig. 2.

Table 2 shows that 11.6 percent of the grandmothers and 10.8 percent of the grandfathers report doing some child care on at least one of the diary days. These numbers are comparable with the child care numbers reported in SHARE, where 16 percent of grandmothers and 13 percent of grandfathers report doing child care at least once a week.[21] Conditional on doing some child care, grandmothers spend 163 min (2.7 h) per day while grandfathers spend 131 min (2.2 h) per day doing child care activities.

Our analysis of time use data reveals several interesting insights into the nature of grandparental caregiving. First, despite similar time spent doing childcare, the details of time use diaries reveal that grandfathers and grandmothers probably have different responsibilities when looking after grandchildren. Using the *with whom* information in the diaries, we uncover that one-third of grandmothers' child care time occurs with their spouse present, whereas two-thirds of grandfathers' child care time happens with their spouse present. This discrepancy suggests that while grandmothers and grandfathers are about as likely to do some child care, the burden in terms of volume, intensity and possibly responsibility disproportionately falls on the grandmothers.

Secondly, we uncover that grandmothers tend to do more complex and mentally intense childcare, which likely explains the larger drop in earnings compared to grandfathers upon the arrival of a grandchild. To understand how the complexity of time with grandchildren differs for grandmothers and grandfathers, we document in Fig. 5(a) that grandmothers spend more time doing child care when their firstborn grandchild is 3–5 years old, and that child care time of grandmothers and grandfathers, respectively, converges when their firstborn grandchild is 9–11 years old. Grandmothers whose first grandchild is 3–5 years old spend on average about 3 h per day doing child care. This indicates that grandmothers play a more active role than grandfathers when their grandchild is younger and needs more care (and hence when the grandmother herself is younger), and that grandfathers become more involved in child care once the grandchild is older and less dependent on primary care.

Thirdly, we show that grandmothers may provide flexibility to those parents with inflexible jobs by providing child care in the afternoons. Using the specifics of the time spells in the diaries, we examine if grandparents provide child care for their grandchildren more frequently at some points of the day (e.g., in the afternoon when formal daycare institutions close for the day). Fig. 5(b) shows the average minutes per hour in child care activities by hour of the day. The grandparents' child care time increases gradually from 7 in the morning and peaks between 15–17 in the afternoon, reflecting perhaps that grandparents help their offspring by picking up grandchildren from daycare in the afternoon.[22] While the majority of grandparents time in child care activities are during the

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[21] The numbers for grandparents' time with grandchildren is comparable with studies from other countries. Using numbers from the American Time Use Surveys (ATUS), Rupert and Zanella (2018) report that 16 percent of women and 11 percent of men in the age range 50–64 spend time in primary child care activities with annual hours of child care being 657.1 for women (around 1.8 h per day) and 500.9 for men (around 1.4 h per day) among those who do report at least some child care time.

[22] Most daycare institutions close at 17:00 Monday–Thursday and at 16:00 on Fridays.

(a) Child care time by age of first grand-child for grandmothers and grandfathers
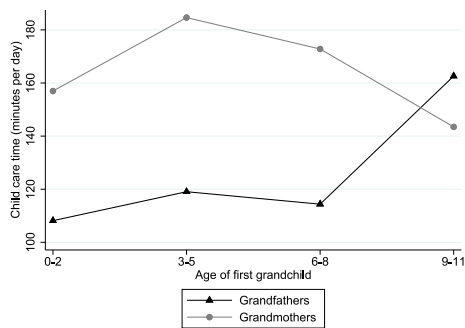
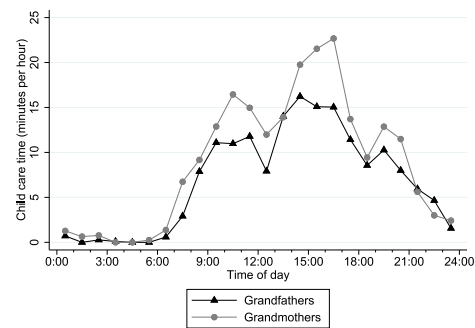(b) Child care time by time of day for grandmothers and grandfathers

Fig. 5. Time in child care activities by age of first grandchild and time of day. NOTE—The figure shows the time grandparents report doing child care in the time use surveys by age of first grandchild (panel a) and by time of day (panel b) for those grandparents who report at least some child care time. Panel (a) shows the average minutes per day in child care activities by age of the first grandchild for grandmothers and grandfathers separately. Panel (b) shows the average minutes per hour in child care activities by hour of the day for grandmothers and grandfathers separately.
Source: Danish Time Use Surveys from 1987, 2001, and 2008 linked to register data.

work day, time use data suggest that the amount of grandparental care is not a daily activity, instead grandparents especially grandmothers, may step in when children are sick or on public holidays when daycare centers are closed to offer a flexible and reliable supplement to formal child care. Table E.1, which reports differences in child care time across the dimensions of our heterogeneity analysis, reinforces the conclusion that flexible child care is the driving mechanism behind the grandchild penalties observed in Section 4.1.

All in all, our results suggest that grandmothers' care complements rather than substitutes formal daycare services, whereas grandfathers play a subsidiary role. This explains our findings of larger drops in labor market outcomes for grandmothers than for grandfathers observed in Fig. 2.

4.4. Gender norms for work

The economic literature on the effects of childbirth on women's labor supply emphasizes the role of social norms related to gender in families' division of work in the household and in the market (Bertrand, 2011). Traditional as well as non-traditional gender norms have been shown to spill over across generations (Kleven et al., 2019a; Moriconi and Rodríguez-Planas, 2021), and individual beliefs are sensitive to information on social norms of their peers, despite evidence suggesting that most people overestimate how gender conservative their peers are (Cortés et al., 2022).

We hypothesize that labor supply responses of grandparents following the birth of the first grandchild are guided by attitudes towards both young parents' (mothers') labor force participation and towards elderly workers work and retirement age. In the Appendix, we present the results of an exploration into the gender and age gaps in norms for working as a young parent and in old age, using data from the Danish parts of the European Value Survey (EVS) wave 4 from 2008 and the European Social Survey wave 3 from 2006. We find that there is a gender gap among older cohorts in their views on fathers' and mothers' skills and responsibilities in terms of parenting for young children. This gender gap is illustrated in Fig. F.1. Fig. F.2 shows that there is also a gender gap in how men and women view when it is most appropriate for men and women, respectively, to retire from working. This gender gap is increasing in age, possibly reflecting both gendered attitudes to aging and preferences for joint retirement (Browning et al., 2021; García-Miralles and Leganza, 2024).

Overall, the previous literature in combination with our findings discussed in Appendix F point to some strong gender differences that we ascribe to social norms on women's work in different stages in life, which likely also play a role in the labor market gender gaps opening up at grandparenthood.

5. Conclusion

Recent research documents a sizable and persistent child penalty as measured by a drop in earnings for women compared to men after the birth of the first child (Kleven et al., 2019a,b; Sieppi and Pehkonen, 2019). The child penalty, which is found across several developed countries, contributes to gender inequality over the work life. Decades of child care subsidies and maternity leave policies seem to have achieved little in terms of closing the gender earnings gap (Kleven et al., 2024; Olivetti and Petrongolo, 2017; Rossin-Slater, 2017). The availability of grandparental care can be an important factor—grandmothers transfer a substantial amount

of time to their children, and this positively affects maternal labor supply among young mothers (Del Boca, 2002; Bratti et al., 2018; Zamarro, 2020).

Our paper extends this literature by documenting that the gender gap is further carried on 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 allows us to document the dynamic trajectories on earnings, wage rate, labor force participation, full time employment, and hours of work. We show that after the arrival of the first grandchild, female earnings start dropping in comparison to male earnings, which are largely unaffected when we control for year, age and individual effects. Five years after the arrival of the first grandchild, the gender gap in earnings has widened by 3.8 percent. This effect is almost entirely driven by reductions in full time employment. Thus, the child penalty due to fertility strikes again when women enter grandparenthood, although to a smaller extent. We also explore the long-run effects 10 years into grandparenthood, estimating an earnings penalty of 10.1 percent and a gender gap in labor force participation of 4.5 percent 10 years after the birth of the first grandchild.

Our main results are robust to the specification of the event study. Comparisons of our event study estimates of the gender gap in labor market outcomes to a DiD event study design and to a specification without individual fixed effects confirm our main results.

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 sub-periods, 1985–2001 and 2002–2012. We show that the gender earnings gap is somewhat stronger for the earlier period, in which parental leave was remarkable shorter, options for early retirement were much more generous, and daycare availability more scarce than in later periods. At the same time, female labor supply was generally lower and part time work more prevalent for women becoming grandmothers in this period. Second, we find larger grandchild penalties for cohorts of grandparents who had access to more generous early retirement routes. Third, we find slightly larger grandchild penalties for grandmothers whose firstborn grandchild lives in a municipality with relatively high coverage of formal daycare. This result, in combination with the results on reductions in full time employment, suggest that grandmothers reduce their work hours to provide informal flexible child care for their grandchildren as a complement to the care received in formal daycare centers. Fourth, we find that labor market effects for grandparents are stronger if grandparents and children live closer by. Fifth, 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. Finally, 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. For couples, the labor market outcomes move more closely together, but the grandchild penalty is still substantial.

We further explore whether family policies interact with the child care burden across generations. Using a combination of child and grandchild penalties estimated on our sample, we investigate how these penalties correlate across daycare coverage. Our findings suggest that daycare coverage plays a large role for child penalties, but not for grandchild penalties. Our analysis of time use data reveals several key insights into the nature of grandparental caregiving. Despite similar time spent doing childcare, the details of time use diaries reveal that grandfathers and grandmothers have different responsibilities when looking after grandchildren. The *with whom* information in the diaries, allow us to uncover that one-third of grandmothers' child care time occurs with their spouse present, whereas two-thirds of grandfathers' child care time happens with their spouse present. Our ability to link the time use data with administrative data enables us to show that grandmothers are doing more child care when their grandchildren are younger and needs more care. Moreover, we show that grandparents provide most childcare in the mornings and late afternoons, suggesting that grandparents' childcare complements formal daycare. These discrepancies suggests that while grandmothers and grandfathers are about as likely to do some child care, the burden in terms of volume, intensity and responsibility disproportionately falls on the grandmothers.

Finally, using data from European Value Survey and European Social Survey, we investigate how norms related to women's and men's work and child care vary across men and women and over age groups. From responses in European Value Survey from 2008, we find that the gender gap in attitudes towards young mother's work opens up after the age of 50, indicating that men above 50 are more critical than women above age 50 towards mothers of young children working. Furthermore, we observe clear gender gaps in the views on older women's work.

Our results point to several policy relevant insights. We establish that it is crucial to take a broader family perspective that recognizes the provision of grandparental child care in order to reduce gender inequalities in the labor market that open up at first childbirth, expand at the arrival of the first grandchild, and persist into retirement. Eliciting how gender gaps in grandparenting contribute to inequality in old age is important as women's pension savings still fall behind men's by more than 20 percent (Fuglsbjerg et al., 2020). After decades of reductions in the gender gap in education and increasing female labor supply, grandmothers' time is no longer an unused resource to the same extent as it was perhaps 30 years ago. Pension reforms intended to postpone retirement contribute to this picture. Our research documents that trade-offs between mothers' and grandmothers' labor supply abound. Thus family policies such as subsidized formal daycare may not yield the intended payoffs if such trade-off are neglected (Havnes and Mogstad, 2011). This calls for policies that sustain grandparents' stay in the labor force while supporting young parents' labor market attachment.
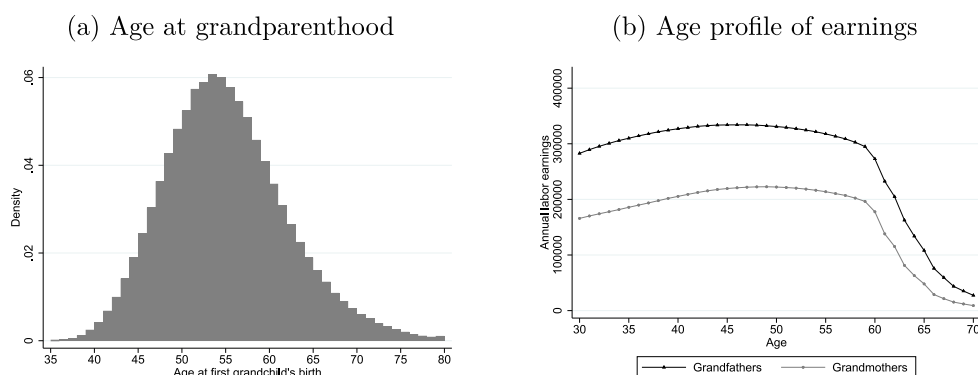
(a) Age at grandparenthood   (b) Age profile of earnings

Fig. A.1. Age at grandparenthood and earnings across age. NOTE—Panel (a) shows the distribution of age at the birth of the first grandchild for all grandparents in Denmark. Panel (b) shows annual earnings between age 30 and 70 for individuals who at some point in their live become grandparents.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Grandparenthood and age

See Fig. A.1.

Appendix B. Long-run impact of grandchildren

See Fig. B.1.

Appendix C. Difference-in-differences

We additionally implement a DiD event study design to validate the results from the event study in Eq. (1). The DiD event study allows us to analyze the effect of having grandchildren per se, 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 1930–1977 who have at least one child above age 19 but no grandchildren. To achieve a suitable control group, we mimic 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 1,550,960 individuals, adding 357,214 people without grandchildren to our sample of grandparents. The DiD analysis thus compares 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:

$$E[Y_{i,t>0} - Y_{i,t<0}|gc_i > 0] - E[Y_{i,t>0} - Y_{i,t<0}|gc_i = 0], \tag{C.1}$$

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 Eq. (C.1) relies on the usual parallel trends assumption, which we validate 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
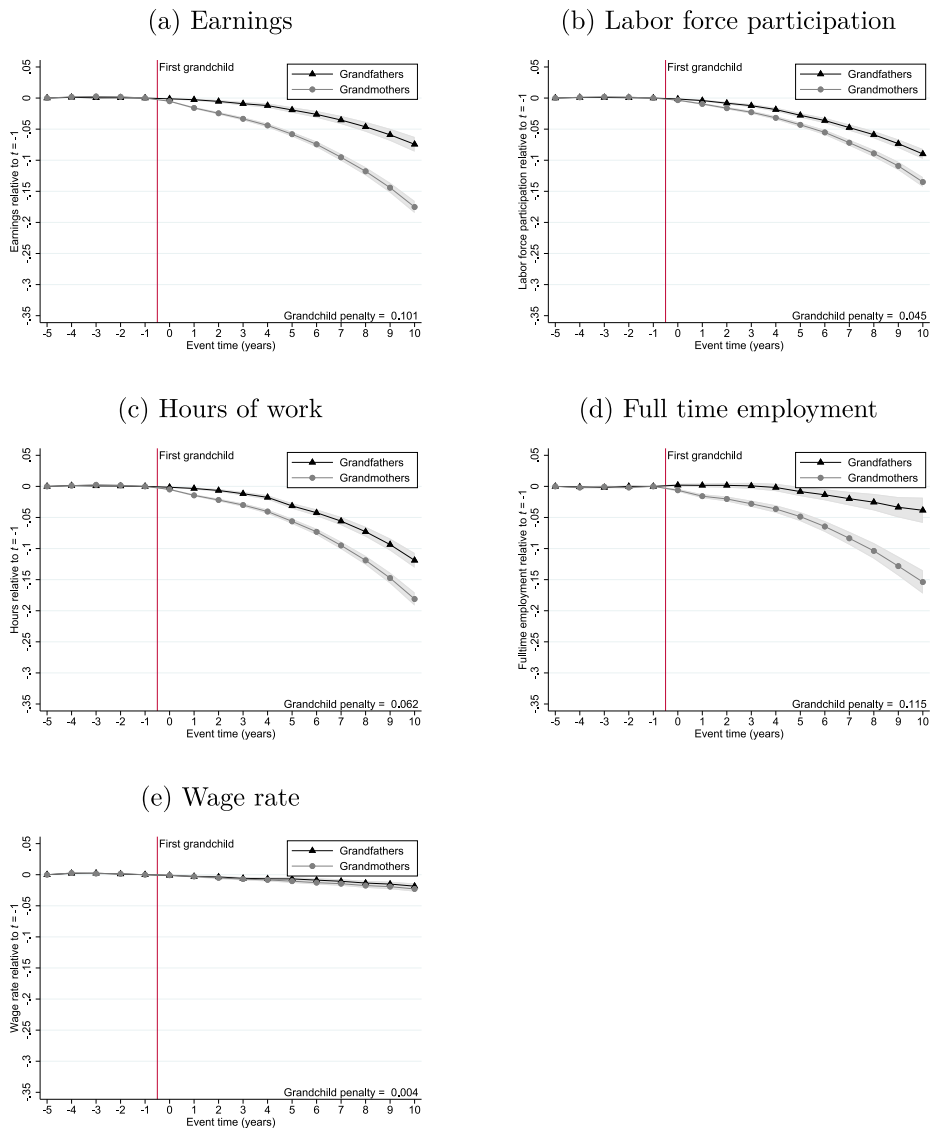
Fig. B.1. The long-run impact of grandchildren. Nᴏᴛᴇ—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome absent grandchildren for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a long-run "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, measured at event time 10. The wage effects are estimated conditional on participation. The shaded 95 percent confidence intervals are based on cluster robust standard errors.

arrival of a grandchild at event time *t*:

$$P_t \equiv \frac{\hat{\alpha}_t^{ngp}}{\mathbb{E}[\tilde{Y}_{ist}^{ngp}|t]} - \frac{\hat{\alpha}_t^{gp}}{\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]}, \tag{C.2}$$

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

Appendix D. Heterogeneity in responses to grandparenthood

See Figs. D.1–D.8.

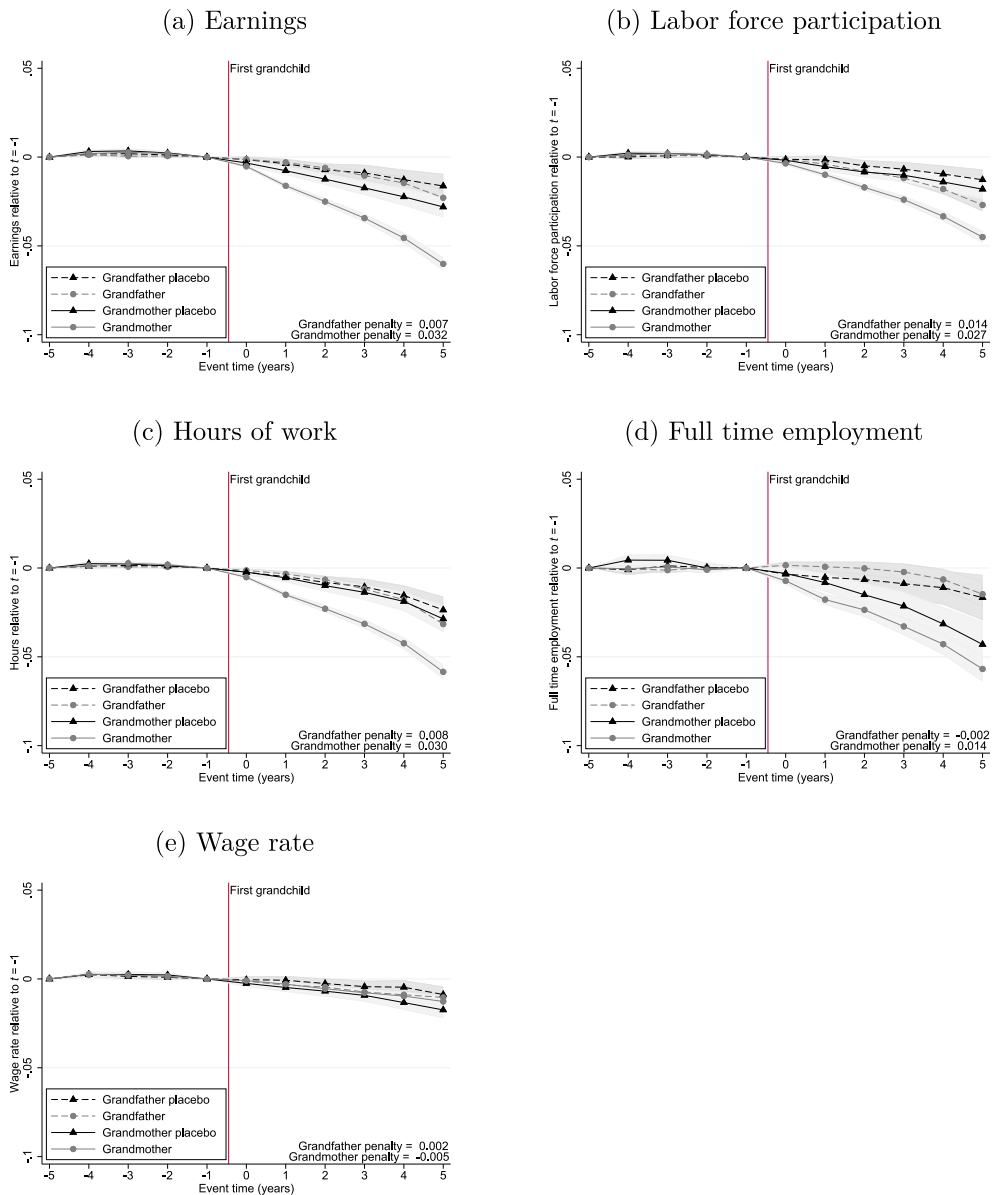## Appendix E. Grandparents and child care time

See Table E.1.

16

Fig. C.1. DiD event study of the impact of grandchildren. NoTE—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome absent grandchildren for men and women with and without grandchildren separately and for different outcomes. Each panel also reports a "grandchild penalty", as defined in Eq. (C.2) 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 wage effects are estimated conditional on participation. The shaded 95 percent confidence intervals are based on cluster robust standard errors.

Appendix F. Age and gender profiles of attitudes for work and childcare

We analyze the general attitudes towards young mothers working, fathers childcare, and elderly women's and men's work using data from the Danish parts of the European Value Survey (EVS) wave 4 from 2008 and European Social Survey wave 3 from 2006. First, we look at attitudes towards parenting while working as a woman and the perception of men's ability to provide childcare. We find that there is a gender gap among older cohorts in their views on fathers' and mothers' skills and responsibilities in terms of parenting for young children. This gender gap is illustrated in Fig. F.1, which shows the percentages of men and women who agree with the following two statements the EVS: (a) *It is harmful for a preschool child if the mother works* and (b) *Fathers are generally just as fit to care for their children as mothers*. While there is little difference in the shares of men and women below age 50 who agree with these two statements, a gender gap in responses open up after age 50. The share of men above age 50 agreeing with statement
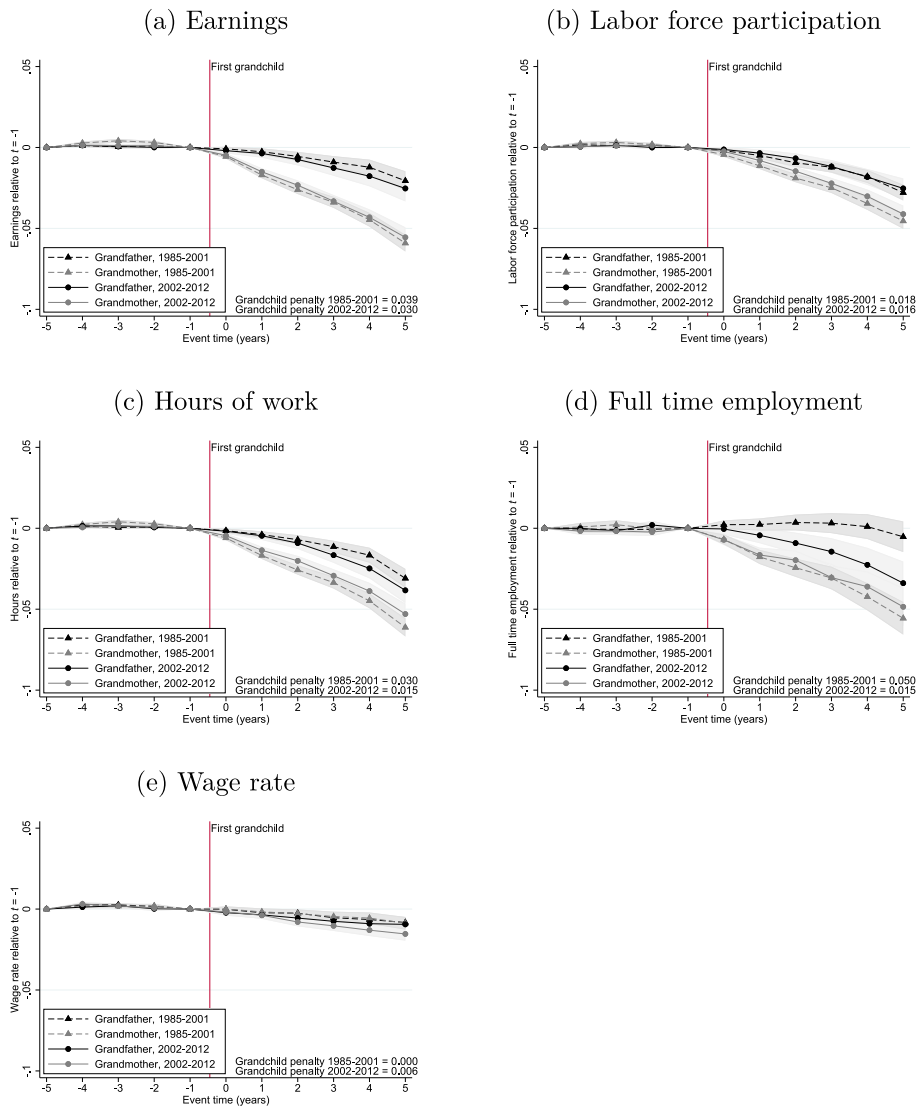
Fig. D.1. The impact of grandchildren by different time periods. NOTE—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome absent grandchildren for grandfathers and grandmothers separately and for different outcomes. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren measured at event time 5, as defined in Eq. (2). All of these statistics are estimated on a balanced sample of grandparents who have their first grandchild between 1985–2000 or 2001–2012. The effects on wage rates are estimated conditional on participation. The shaded 95 percent confidence intervals are based on cluster robust standard errors.

(a) – claiming that it is harmful for children if their mothers work – is significantly higher than the share of women above age 50 agreeing with the statement. Similarly for statement (b), a gender divergence opens up after age 50 in the percentage of people who agree with the statement that fathers are just as good caregivers as mothers. This may reflect that potential grandfathers are less supportive of their daughters or daughters-in-law working in the labor market (panel a), and that they may themselves be reluctant or hesitant to take care of young children in the capacity of being grandfathers (panel b). While current cohorts of elderly may have gendered views on child care, this could change for future generations. It should also be noted that while Fig. F.1 tells us something about gendered views among elderly individuals as such, these views may not necessarily be reflected entirely among those who have become grandparents. In particular, such views may change upon grandparenthood. Interestingly, there is no strong age gradient in women's attitudes to mothers working, which may explain why grandmothers are willing to adjust their own labor supply to assist their children's career by caring for their grandchildren.
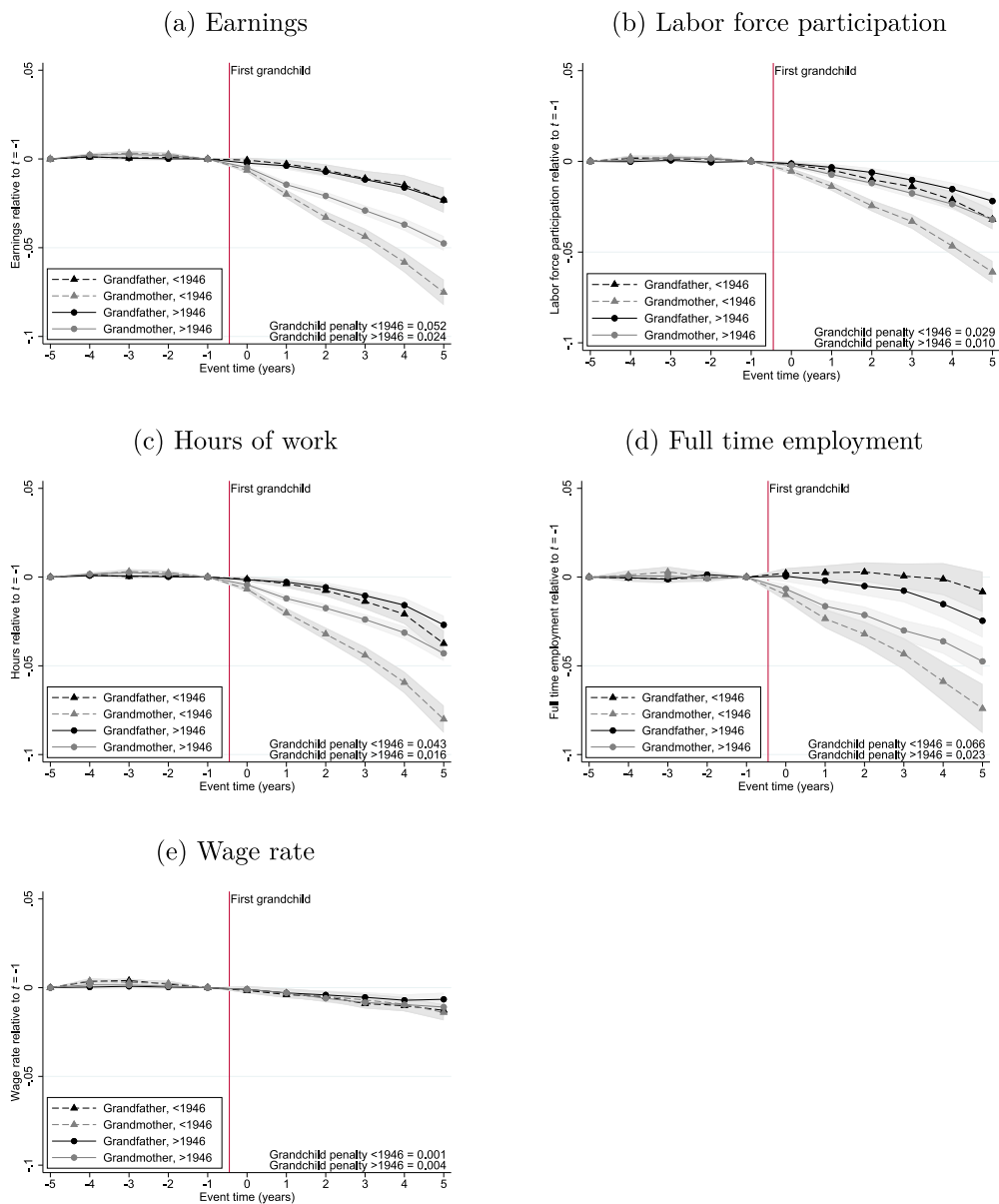
(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

Fig. D.2. The impact of grandchildren by birth cohorts. NOTE—The figure shows event time coefficients estimated from Eq. (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 Eq. (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 cluster robust standard errors.

We explore how gender roles for elderly women may impact their labor market participation when becoming grandmothers. European Social Survey wave 3 from 2006 asks: *At what age are men/women too old to work more than half-time?*. Fig. F.2 shows the age that men (panel a) and women (panel b) find that a man and a woman, respectively, are too old to work more than half-time. Panel (a) suggests that men find that men can be working more than half-time until a higher age than what they think is appropriate for women. At respondent age 50, the difference in years is more than 10 percent. We also observe that while male respondents reported that men can be somewhat older than women and still keep working, female respondents did not express similar responses in terms of working ages (cf. panel b).
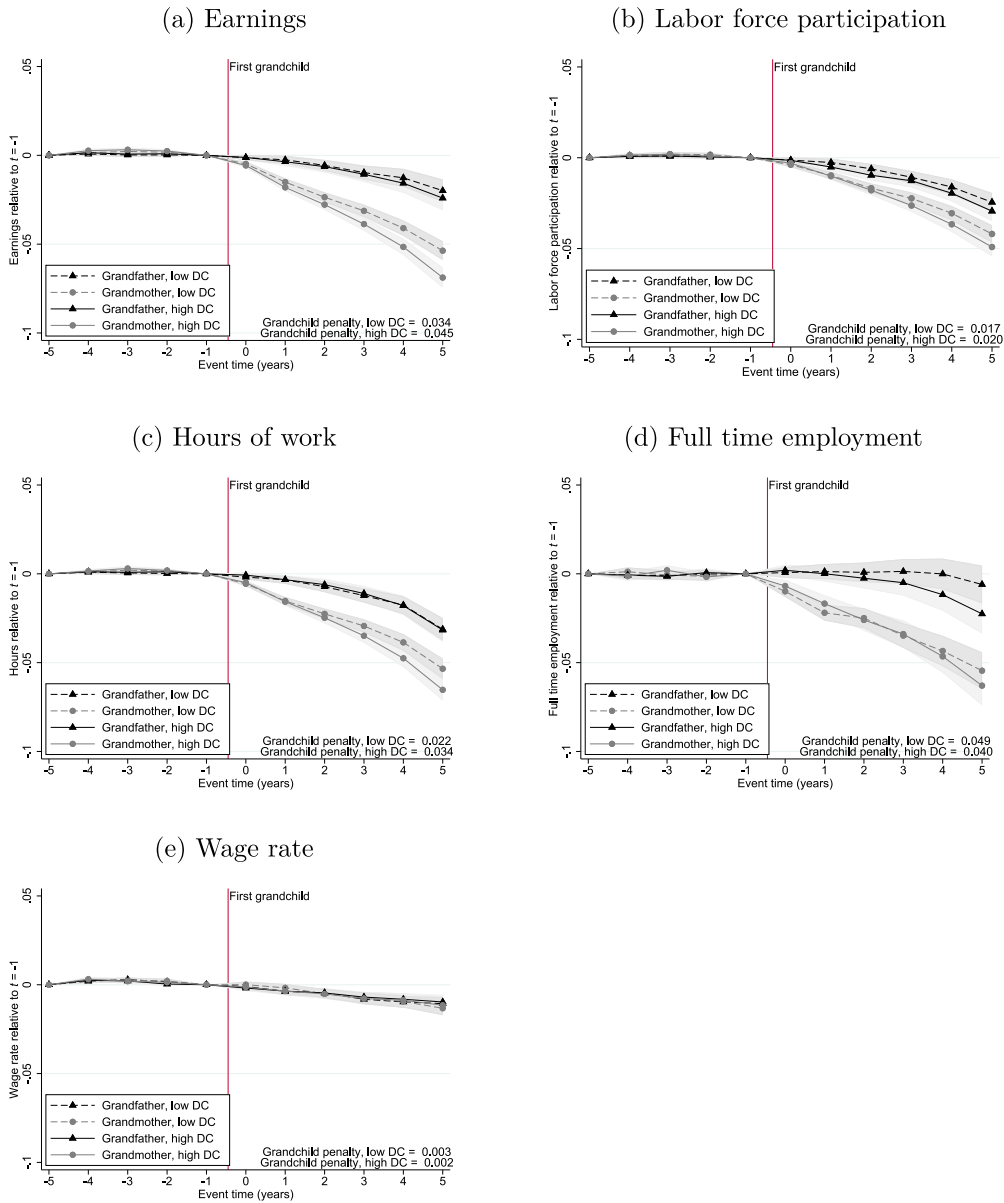
Fig. D.3. The impact of grandchildren by daycare availability. Nᴏᴛᴇ—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and 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 Eq. (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 cluster robust standard errors.
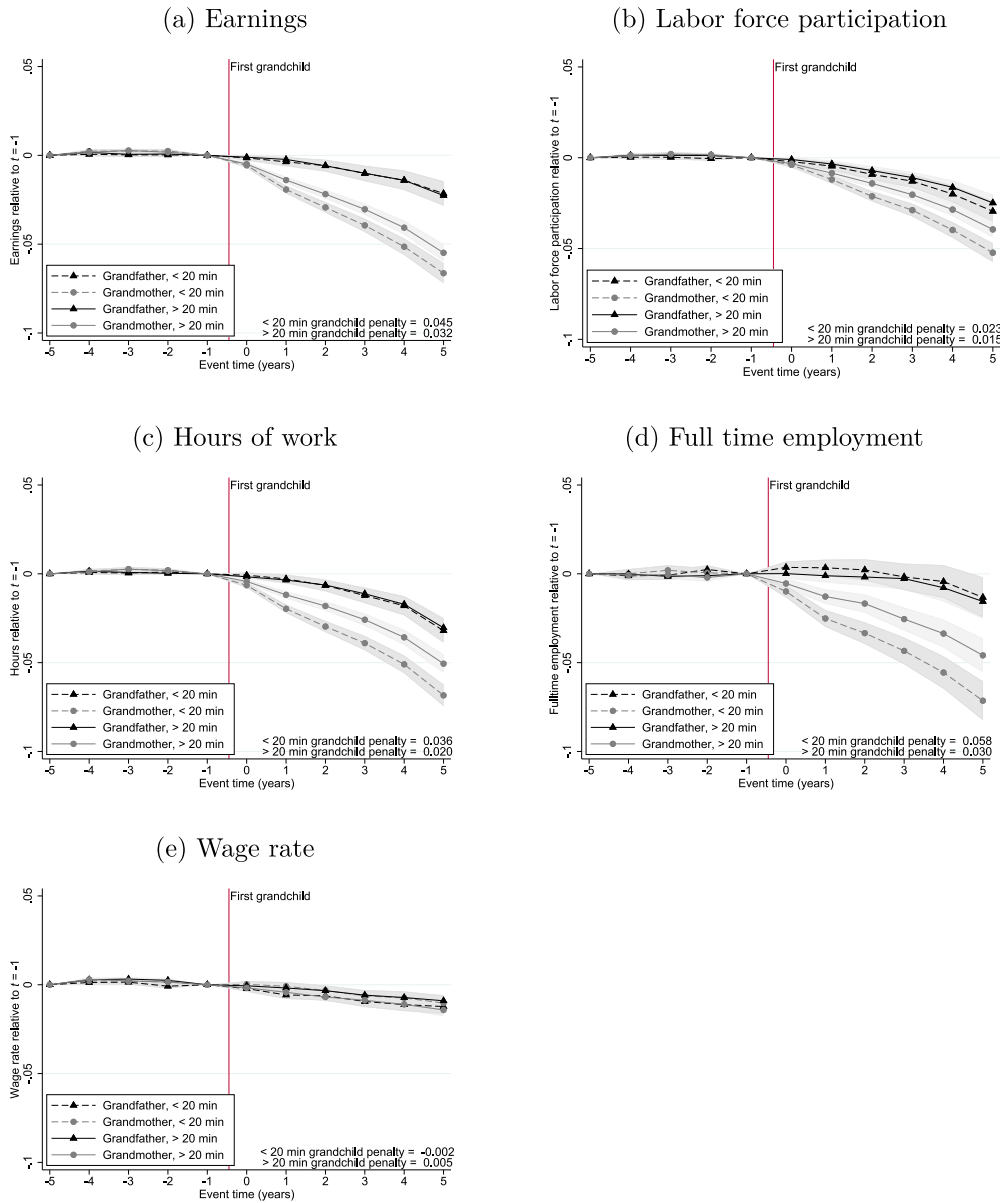
(a) Earnings

(b) Labor force participation

(c) Hours of work

(d) Full time employment

(e) Wage rate

Fig. D.4. The impact of grandchildren by commuting time. Note—The figure shows event time coefficients estimated from Eq. (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 Eq. (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 cluster robust standard errors.
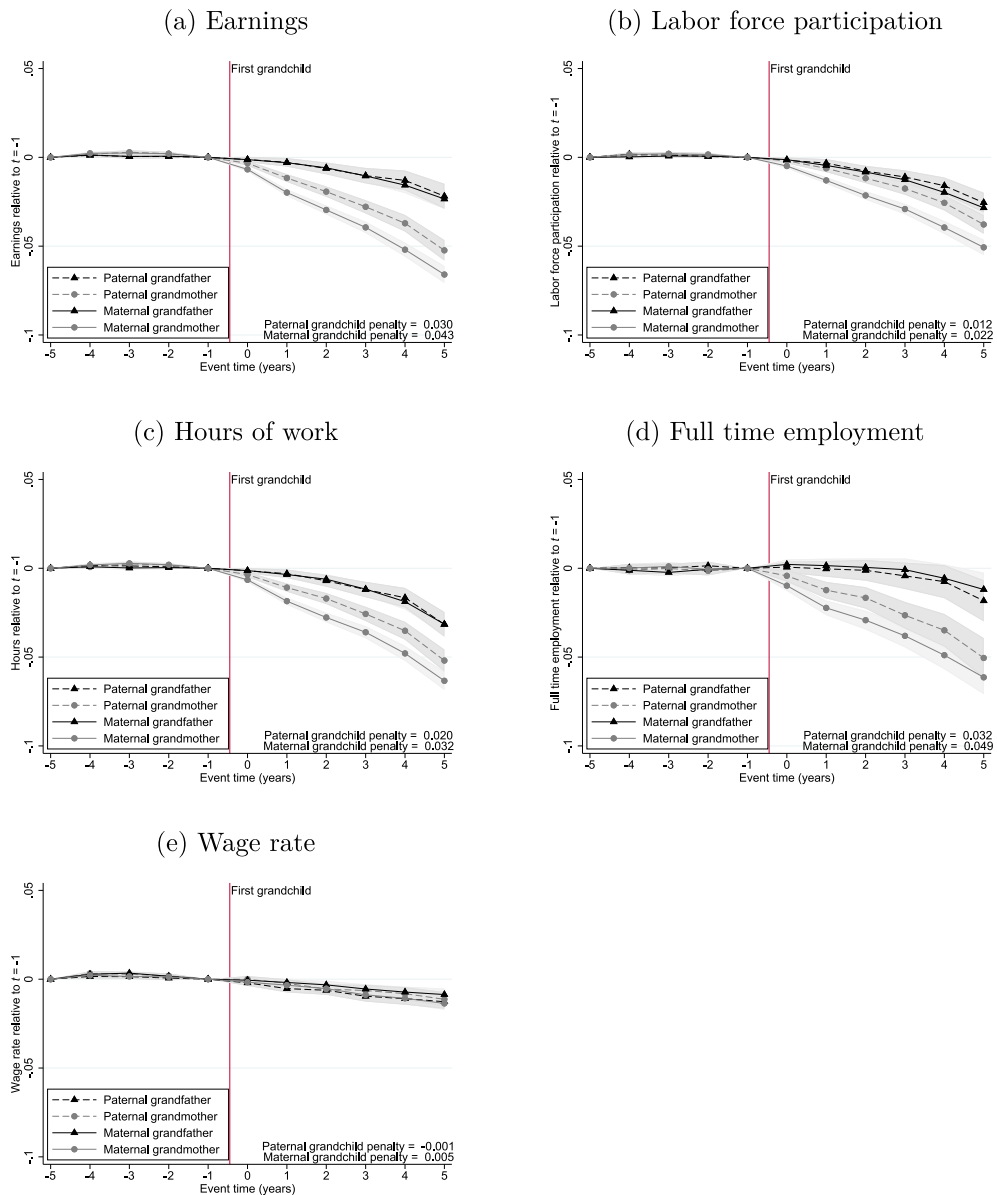
Fig. D.5. The impact of grandchildren by gender of child. Nᴏᴛᴇ—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp}/\mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers 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 Eq. (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 cluster robust standard errors.
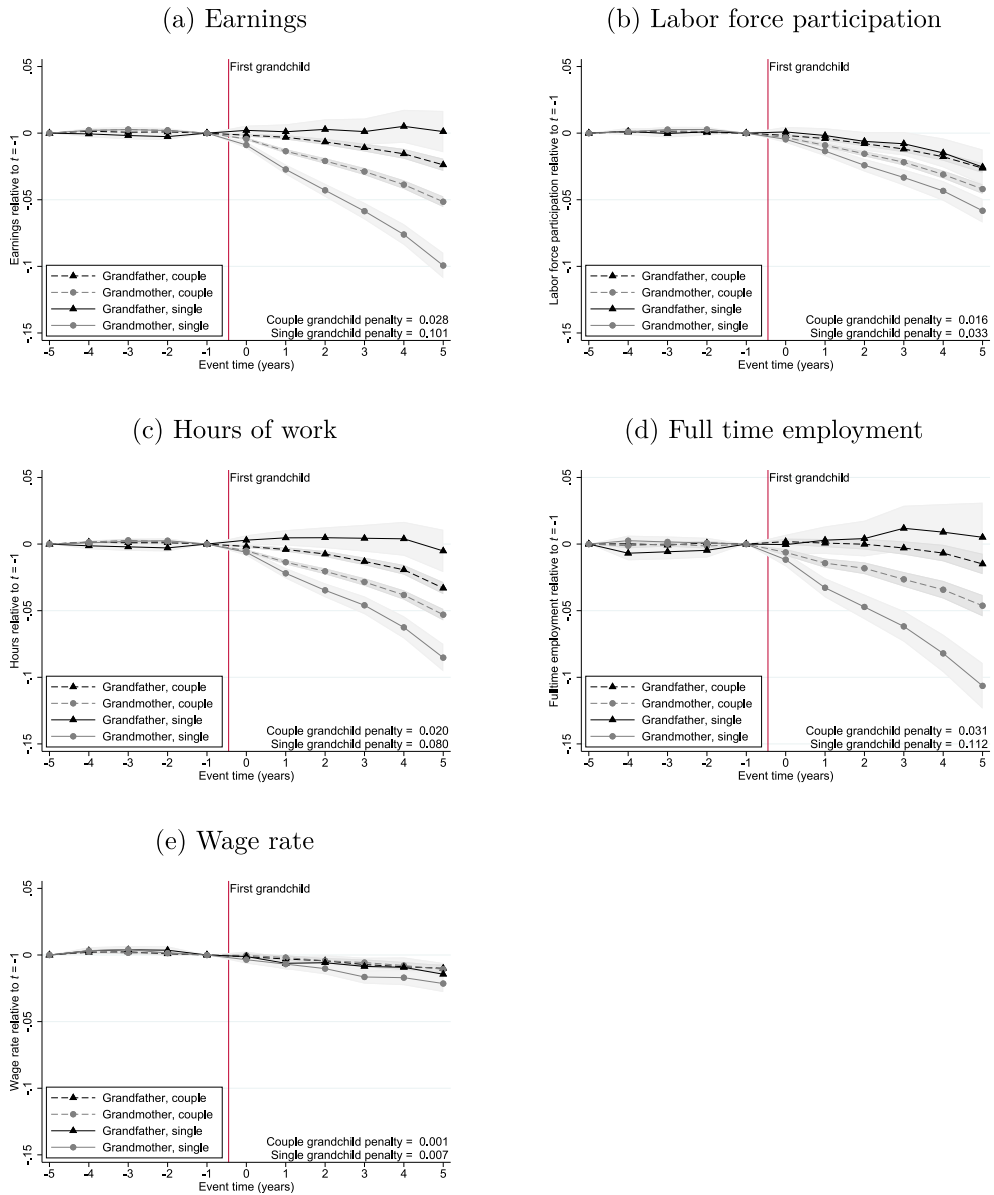
Fig. D.6. The impact of grandchildren by marital status. NOTE—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome, absent grandchildren (i.e., $P_t^{gp} \equiv \hat{\alpha}_t^{gp} / \mathbb{E}[\tilde{Y}_{ist}^{gp}|t]$) for grandfathers and grandmothers 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 Eq. (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 cluster robust standard errors.
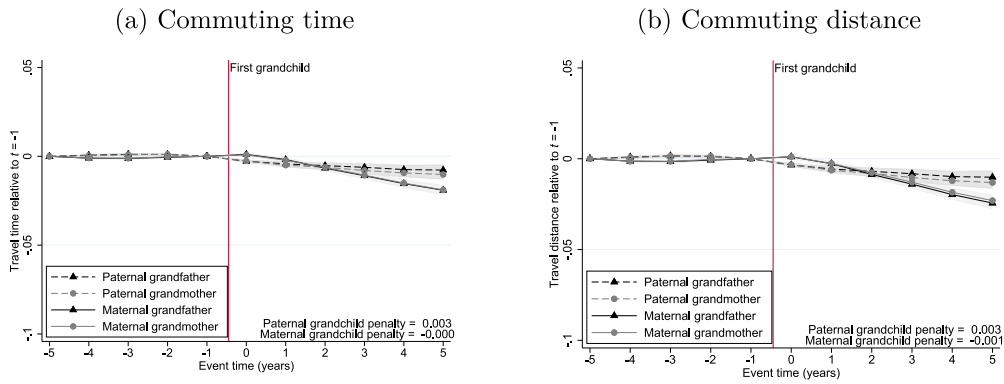
(a) Commuting time

(b) Commuting distance

Fig. D.7. The impact of grandchildren on commuting time and distance between parents and grandparents. Note—The figure shows event time coefficients estimated from Eq. (1) for maternal and paternal grandfathers and grandmothers separately and for two different outcomes; log commuting time and log commuting distance. Each panel also reports a "grandchild penalty", the percentage by which grandmothers are falling behind grandfathers due to grandchildren, as defined in Eq. (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 shaded 95 percent confidence intervals are based on cluster robust standard errors.

Table E.1

Summary statistics of time in child care activities.

Source: Danish Time Use Surveys from 1987, 2001, and 2008.

	(1)	(2)	(3)
Gender	Grandmother	Grandfather	Difference
Child care time	11.54	5.838	5.701***
	(56.45)	(36.85)	(4.22)
Observations	2688	2423	5111
Maternal	Grandmother	Grandfather	Difference
Child care time	12.19	10.71	1.484
	(59.07)	(52.98)	(0.68)
Observations	1499	1189	2688
Paternal	Grandmother	Grandfather	Difference
Child care time	6.185	5.407	0.778
	(35.63)	(38.31)	(0.52)
Observations	1342	1081	2423
Grandchild born	1985–2001	2002–2012	Difference
Child care time	7.907	10.39	−2.486*
	(44.97)	(53.26)	(−1.78)
Observations	3201	1910	5111
Cohabitation	Single	Couple	Difference
Child care time	11.19	8.629	2.557
	(61.98)	(46.85)	(1.03)
Observations	413	4698	5111
Grandparent born	Before or in 1946	1947 or after	Difference
Child care time	9.014	8.637	0.377
	(50.21)	(45.96)	(0.28)
Observations	2697	2414	5111
Daycare	Low	High	Difference
Child care time	8.172	9.656	−1.484
	(45.44)	(51.50)	(−1.09)
Observations	2826	2285	5111
Commute	Less than 20 min	More than 20 min	Difference
Child care time	8.718	8.906	−0.188
	(47.44)	(48.73)	(−0.14)
Observations	1915	3196	5111
Time of week	Week day	Weekend	Difference
Child care time	8.277	9.408	−1.132
	(47.79)	(48.71)	(−0.84)
Observations	2585	2526	5111

Note—The table shows mean and standard deviation in parenthesis of time in child care activities measured in minutes per day for subgroups of the sample. The stars indicate significant *t*-statistics of the difference between columns (1) and (2), * 10%, ** 5%, and *** 1%.
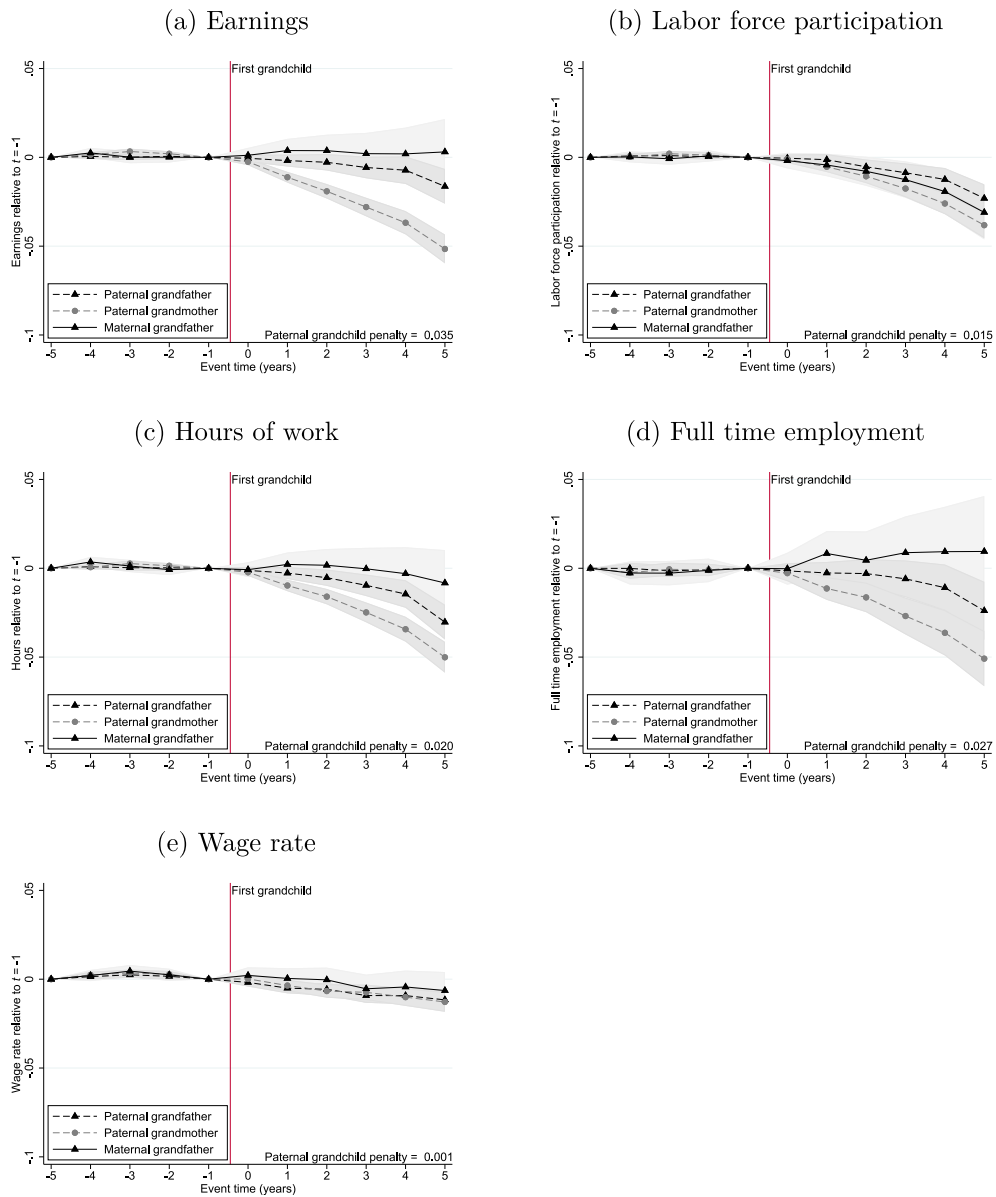
Fig. D.8. The impact of grandchildren in families with no maternal grandmother. NOTE—The figure shows event time coefficients estimated from Eq. (1) as a percentage of the counterfactual outcome absent grandchildren for maternal and paternal grandfathers and paternal grandmothers separately and for different outcomes. Each panel also reports a "paternal grandchild penalty", the percentage by which paternal grandmothers are falling behind paternal grandfathers due to grandchildren, measured at event time 5. The wage effects are estimated conditional on participation. The shaded 95 percent confidence intervals are based on cluster robust standard errors.
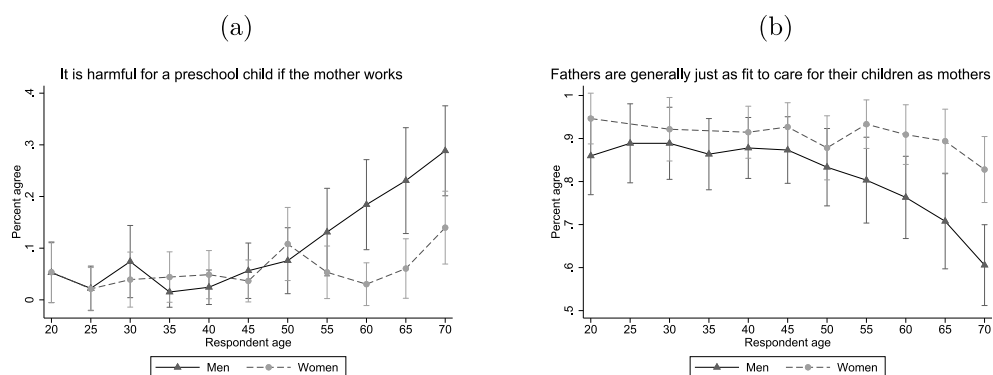
(a)   (b)

It is harmful for a preschool child if the mother works   Fathers are generally just as fit to care for their children as mothers

Fig. F.1. Social norms for mothers working and fathers caring for children. NOTE— The figures show responses to two statements in the European Value Survey from 2008: (a) It is harmful for a preschool child if the mother works, and (b) Fathers are generally just as fit to care for their children as mothers. The figures show margins plots of estimated marginal effects from a regression of survey responses by respondent gender and age. The bars indicate 95 percent confidence intervals from a t-test.
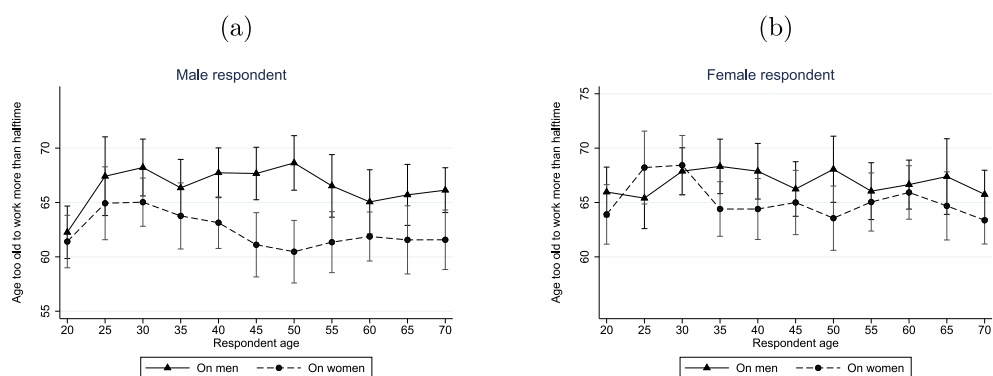*Source:* European Value Survey wave 4, 2008.

(a)   (b)

Male respondent   Female respondent

Fig. F.2. Age of being too old to work more than halftime. NOTE—The figures show responses to a question in the European Social Survey from 2006: "At what age are men/women too old to work more than half-time?". The figures show margins plots of estimated marginal effects from two separate regressions of male and female responses to the survey question estimated on respondent. The bars indicate 95 percent confidence intervals from a t-test.
Source: European Social Survey wave 3, 2006.

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