PARENTHOOD AND THE CAREER LADDER: EVIDENCE FROM ACADEMIA

Sofie Cairo Ria Ivandić Anne Sophie Lassen Valentina Tartari*

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Abstract

Persistent gender gaps in the labor market are largely driven by the underrepresentation of women at the top of most professions. We study how parenthood shapes gender gaps in academic careers using population-wide administrative and survey data linked to productivity and promotion records. Parenthood marks a sharp divergence in academic careers: one in three women exit academia following motherhood. Men also experience a decline in academic employment after fatherhood, but the effects are substantially smaller. For mothers, childbirth leads to a persistent decline in both tenure attainment and research output, while men's trajectories on these margins are unaffected by parenthood. The child penalty on tenure is driven primarily by women's higher exit rates from academia. Gender differences in career aspirations do not explain these findings; instead, childcare and mobility constraints play a central role. Child penalties are exacerbated in highly competitive environments and environments without senior female role models.

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*Cairo: Copenhagen Business School and University of Zürich, sc.si@cbs.dk, Lassen: Copenhagen Business School and WZB-Berlin, anne.sophie.lassen@wzb.eu. Ivandic: University of Zagreb and the London School of Economics (LSE), r.ivandic@lse.ac.uk, Tartari: Stockholm School of Economics and Copenhagen Business School, valentina.tartari@hhs.se.
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1 Introduction

Women continue to be under-represented among senior researchers and professors in academia (Auriol et al., 2022). This pattern mirrors broader labor market disparities, where a persistent gender pay gap continues to favor men (Blau & Kahn, 2017), largely driven by women's under-representation at the top of most professions (Bertrand, 2018). Children have been identified as a key driver of the remaining labor-market inequality (Goldin, 2021; Bertrand, 2020), with a large body of literature showing child penalties globally (Waldfogel, 1998; Angelov et al., 2016; Kleven et al., 2019, 2024). However, the extent to which these penalties shape career trajectories in the upper echelons, including academia, has received limited attention. Academia has significant spillover effects on society at large. As women's under-representation affects both the quality and the direction of science (Hsieh et al., 2019; Antman et al., 2024), it is a particularly relevant profession to study.

In this paper, we study how parenthood affects every step of the academic career ladder. Any study of parenthood and career trajectories faces several empirical challenges. First, we need credible, detailed information on promotions and productivity, which are particularly rare for high-skilled professions. Second, we need to observe the talent pipeline into the profession. Third, we need precise information on the timing of parenthood for both women and men. We overcome these challenges by linking novel data sources on promotion and productivity to Danish administrative data covering the universe of individuals who have ever enrolled in a PhD program. We first estimate the effects of motherhood and fatherhood on staying in academia. Next, we focus on the impact of parenthood on career advancement within academia, the likelihood of having tenure, and consider both retention and publication records as mitigating factors. Finally, leveraging the richness of administrative data and a unique survey to elicit the aspirations and family constraints of academics and PhD students, we uncover the mechanisms.

We estimate child penalties on academic career outcomes - defined as the differential effects of parenthood on women's and men's likelihood of staying in academia, and having tenure. Our estimation relies on an event-study design that traces the dynamics of these outcomes from four years before to eight years after the birth of the first child, using a sample of researchers, starting from their PhD, who become parents. This

design follows the standard approach in the child-penalty literature and assumes, although the timing of childbirth is not exogenous, that the arrival of a child induces a discrete change in outcomes that is orthogonal to smoothly evolving unobserved factors. Following the recent methodological literature, we document that our results are stable whether we use individuals who never become parents or the not-yet-treated cohorts of parents as controls.

We find that career trajectories for women and men evolve similarly until the birth of their first child; afterwards, women and men diverge. Following motherhood, 1 in 3 women leave academia. This translates into a long-run child penalty of 15 percent on academic employment. This gap is not driven by women moving to the broader research sector, pursuing academic careers abroad, or exiting the labor market entirely. Women's likelihood of having a tenured position, defined as an associate or full professorship, drops after motherhood and remains 23 percent lower than men's eight years later. Fatherhood has no detectable effect on men's likelihood of tenure. Using a sample of PhD graduates who secured academic employment prior to the birth of their first child, we find smaller but still substantial penalties for mothers. To quantify the size of the effects on attrition and tenure, we follow Kleven et al. (2024) and find that child penalties explain around 70% of the observed gender gap in academic employment and around 40% of the gender gap in tenure.

Four additional results uncover the mechanisms behind women's persistent underrepresentation in senior positions. Gender gaps at the top of academia emerge because women are disproportionately leaving the profession. While we find stark gender differences in research output following parenthood, the decline in research output along with changes in labor supply and time taken for parental leave play a minor role. Second, we use novel survey data and show that the results are not driven by gender differences in aspirations among PhD students and that men and women place comparable value on key job attributes such as career advancement and job security. Third, we document that after becoming parents, women in academia adjust their behavior substantially more than men: they report significantly fewer working hours when children are young and assume five times as many childcare responsibilities as their male counterparts. The gender differences in childcare are particularly pronounced for care with unpredictable timing that constrains working ability, such as doctors' visits, sick days, and nighttime childcare. We find that women experience similar child penalties

regardless of whether their partner has a PhD or takes up paternity leave. The availability of grandmaternal childcare, captured by retired grandmothers, also does not mitigate the penalties. These patterns provide evidence on sources of the first significant leak of the academic pipeline, highlighting the childcare constraints women face due to motherhood.

Fourth, we document how different work environments affect the size of penalties. We find that different scientific fields, despite varying workplace flexibilities, yield the same child penalties, suggesting that factors common across fields are the key drivers of survival in academia. Consistent with findings in the existing literature on female role models (Porter & Serra, 2020; Rose et al., 2022; Kjelsrud & Parsa, 2024), we find that women trained in departments without senior women and in highly productive, competitive departments face larger child penalties. This speaks to a barrier that contributes to the leaky pipeline of women - a lack of role models and a competitive work environment that negatively interacts with childcare responsibilities.

Our paper contributes to the literature on the drivers of the persistent gender inequality in academia. Prior research has identified obstacles faced by women in academia, including biased peer recognition (Card et al., 2022; Sarsons et al., 2021; Hengel, 2022; Eberhardt et al., 2023), hostile environments (Dupas et al., 2026), and fewer role models (Porter & Serra, 2020; Rose et al., 2022; Kjelsrud & Parsa, 2024). The unequal role of childcare has been proposed as an additional explanation (Myers et al., 2020), with two recent studies estimating child penalties on research productivity following marriage and parenthood (Kim & Moser, 2025; Cairo & Tartari, 2025). Compared with the literature on productivity, our paper is the first to quantify the direct effects of parenthood on the likelihood of remaining in academia and the determinants of advancing up the academic ladder. A key innovation of our study is the ability to merge publication data with comprehensive administrative records on the whole population while identifying promotions. This allows us to jointly track researchers' productivity, career progression, and family formation within the same framework. Moreover, by observing the early pipeline from PhD enrollment into the profession, we can examine what Buckles (2019, p. 47) calls "the first significant leak in the academic pipeline... from graduate programs to assistant professorships."

Our results offer comparative insights relevant beyond academia by contributing to the broader literature on gender gaps in "greedy" occupations, characterized by time

pressure, limited substitutability among workers, and the establishment and maintenance of interpersonal contact (Goldin, 2014). Aspects of academia, such as flexible schedules, might alleviate some of the constraints usually associated with motherhood (Mas & Pallais, 2017; Harrington & Kahn, 2025). However, we show that work environments that allow more flexible research schedules do not lead to lower career costs of motherhood than those that demand physical presence. Most closely related to our study are the works by Fiva & King (2023) and Bonney et al. (2025), which document sizable child penalties for politicians and entrepreneurs. Our study, for the first time, quantifies the mechanisms behind the impact of parenthood in "greedy" occupations. We show that child penalties operate mainly through women never entering and leaving elite professional tracks, rather than within-career slowdowns. Penalties are not a result of women's lower aspirations, but are driven by unequal care responsibilities. The penalties are further exacerbated in competitive environments and in environments with few female role models.

The paper proceeds as follows. Section 2 provides institutional background and describes the data. Section 3 presents the empirical strategy. Section 4 reports the main findings. Sections 5 and 6 present complementary evidence on the mechanisms. Section 7 concludes.

2 Institutional Context and Data

This section describes the institutional context of the Danish academic system and the data used in our analysis. Before turning to these specifics, we first situate Denmark relative to other countries along institutional characteristics relevant for interpreting our findings externally. A common stereotype in international media portrays Danish families as having relatively many children born to young parents, but empirical fertility data does not support this view. In fact, fertility patterns in Denmark have evolved in parallel to the European average. The fertility rate in Denmark (1.5) is only slightly above the EU-27 average (1.38) (Eurostat, 2023b), and the average age of women at first birth is the same as the EU average (31.8 years in Denmark versus 31.2 in the EU-27) (Eurostat, 2023a). These patterns are also broadly consistent with trends in the United States, where women have on average 1.62 children and the mean

age at first birth is 27.5 years (Osterman et al., 2025). Danish family leave policies ensure employment protection for more than one year with wage replacement, and universal childcare covers care between 7am and 5pm from the age of six months until school age. However, these generous policies don't translate into different fertility patterns in Denmark, as also found in the literature (Dahl et al., 2016). The gender pay gap in Denmark (14%) is slightly higher than the EU average (12%) (Eurostat, 2025) and comparable to that in the United States (16%; Bureau of Labor Statistics (2024)). Although child-related penalties in labor force participation are smaller in Denmark than in most other middle- and high-income countries (Kleven et al., 2024), gender gaps in academia do not appear to correlate with female labor force participation (Iaria et al., 2022). In Denmark, the share of women among full professors is 23 % and lies between the continental European average of roughly 30 percent and the U.S. average of about 20 percent (Auriol et al., 2022; Danish Ministry of Higher Education and Science, 2019). The largest research fields in Denmark are medicine and STEM, areas in which Danish research is internationally renowned (ShanghaiRanking, 2025).

2.1 Academia in Denmark

The academic career in Denmark is similar to that in other European and Anglo-Saxon countries, and no major changes have occurred within the period we consider. The position equivalent to assistant professors (*adjunkt*) precedes the associate professorship (*lektor*), which is equivalent to having tenure. A full professorship is the final step in the career path. As of 2024, the majority of full professors are Danes and/or obtained their PhD from a Danish university. While teaching loads vary across departments, pure teaching positions are rare. The vast majority of the teaching at Danish universities is carried out by research faculty. The most common type of lecturer, aside from research faculty, is the external lecturer, who works full-time in another job and teaches a course on their area of professional expertise.

PhD programs are three to four years long and admission criteria include a relevant and qualifying two-year Master's. Most PhD students are employed at the university with earnings equivalent to a junior civil servant, set via collective bargaining. Both faculty and PhD students have the right to paid parental leave. Throughout the period we consider, generous maternity and parental leave have been in place. The duration

of wage replacement is also set via collective bargaining. Mothers working at universities are offered full wage replacement for half a year, and fathers are offered full wage replacement for up to three months of parental. After this period is exhausted, individuals can receive benefits corresponding to unemployment insurance while on job-protected leave for an additional three to six months. Contracts of individuals on temporary contracts are automatically extended for the duration of parental leave.

2.2 Data

Our analysis is based on the merge of administrative registers for the full Danish population with three newly constructed datasets describing the population of researchers from 1996 to 2022. At the individual level, we merge information from the demographic and family administrative registers (containing information on partners and children), labor market information (industry and sector of employment, earnings, employment status, labor supply, parental leave duration, and many other variables), and educational registers (Master's fields, date of PhD enrollment and graduation).

Crucially, we incorporate three additional data sources that allow us to track researcher productivity and career progression, and whose key advantage lies in their ability to be linked to administrative population registers. First, we add bibliometric indicators from the Elsevier *Scopus* database, a comprehensive abstract and citation database indexing over 25,000 peer-reviewed journals, conference proceedings, and other scholarly literature across all academic disciplines. Our dataset from *Scopus* contains granular data on individual researchers' annual scientific publication records, which we merge with anonymised individual-level administrative data. *Scopus* data captures the full set of published scientific researchers with a Danish affiliation on at least one of their publications from 1996 to 2018.[1] We obtain a count of annual publications, as well as a quality-adjusted count of annual publications of each researcher.[2]

Second, we add newly hand-collected archival data on collective bargaining agree-

[1] Information from *Scopus* is matched with the administrative data of residents in Denmark by Statistics Denmark. This procedure relies on researchers' names and academic employers to match individuals in the administrative records with entries in *Scopus*. Subsequently, the information is anonymized.

[2] The quality-adjusted publication count is calculated by multiplying each publication by $1 + JIF$, where JIF is the journal-impact-factor from the Reliance On Science data (Marx & Fuegi, 2020).

ments from the Danish union of academics (*Dansk Magister Forening*), extending the work of Lassen & Ivandić (2024). Earnings for all academics at universities and public research institutes are determined by centralized collective bargaining, using a formula consisting of a base salary adjusted for years of experience (*grundløn*) and an allowance reflecting the position (*tillæg*), described in more detail in Subsection A.1. The collective agreements translate into annual earnings floors for each academic position (PhD Fellow, Assistant Professor, Associate Professor, and Full Professor) for the period from 1997 to 2022. Variation in pay within a position mostly stems from years of experience, especially early in the career. We validate our measure of academic position with high accuracy against titles from pay slips spanning 2017 to 2022.[3]

Finally, we complement the administrative data with a unique cross-sectional survey on the full population of academics at Danish universities in 2017. The survey resulted in 3,700 responses from academics and 2,500 responses from PhD students representative across fields, seniority, and gender. The survey covered a wide range of themes related to the professional lives, motivations, aspirations, and behaviors of academic researchers and PhD students, including their work–life balance and the allocation of childcare responsibilities. It asked researchers to self-report hours spent on working, allowing us to have a distinct individual measure of hours worked beyond contracted hours reported in the registers, particularly relevant for careers with non-linear returns to hours. Researchers were asked to report their own and their partner's contribution to a number of childcare-related responsibilities, such as getting up at night, bringing and picking up children from daycare, providing sick care, and bringing the child to a doctor's appointment. Finally, PhD students were asked about their preferred career choice after PhD graduation.

Our main event study analysis is based on a sample of parents enrolled in a PhD program at a Danish university from 1996 to 2017 who had their first child after the first year of PhD. Our estimation sample consists of 13,347 individuals, observed from at least one year prior to the first birth to at least four years after.

Our first outcome of interest is *main employment in university*, with sectoral employ-

[3]The measure of academic position obtained from collective bargaining over-estimates tenure rates by 6.7%, but importantly for our research design, there are no significant gender differences in the measurement error, and the measurement error is uncorrelated with time to parenthood. This is reported in the Appendix Subsection A2. We also document that gender differences in misclassifications as a tenured academic in the years before tenure are minor and not statistically significant.

ment reported by the industry code.[4] We define university employment as employment after PhD graduation. Our second outcome of interest is the academic position of the university-employed academics. To infer the position of a tenured academic, we compare their annual earnings with the annual earnings floor for senior employment from the collective agreements to determine their academic seniority. To be classified as a tenured senior academic (associate professor or higher), an individual must have their main employment in the university sector, have graduated their PhD, and have earnings at or above the earnings floor of an associate professor, which is proportionally adjusted if the individual works part-time. Following Adams et al. (2024) and Danish job protection laws, we do not allow an academic who was tenured the year prior to parenthood to revert to a non-tenured position in the year of parenthood.

3 Research Design

To investigate the impact of parenthood on academic retention, promotion, and research output, we adopt an event study design. The event study design exploits the fact that parenthood generates sharp changes in career outcomes, while other determinants evolve more smoothly over time (Kleven et al., 2019). A causal interpretation relies on the assumption that the effect of children is orthogonal to unobserved determinants of career outcomes, conditional on age, year, and career stage. The event study approach allows us to trace out the full dynamic trajectory of parenthood effects.

We run the specification separately for mothers and fathers using a panel of employment and positions from year 4 before to year 8 after birth:

$$Y_{ist}^{g} = \sum_{j \neq -1} \alpha_j^g * 1[j = t] + \sum_k \beta_k^g * 1[k = age_{is}] + \sum_y \gamma_y^g * 1[y = s] + \sum_p \delta_p^g * 1[p = PhDage_{is}] + \eta_{ist}^g \quad (1)$$

Let $t = 0$ denote the year of childbirth, and index time relative to this event. The dependent variable Y_{ist}^{g} is an indicator for employment status (or academic position) of

[4]For individuals with more than one employment relationship in a year, we use the one with the largest contribution to the mandatory pension scheme, *ATP*.

individual i in calendar year s, at event time t, and for gender g. The main coefficients of interest are α_j^g, which capture the effect of parenthood at event time j, relative to the baseline year $t = -1$ (the year before childbirth). The specification includes the following fixed effects: age fixed effects β_k^g that control for age-specific trends in outcomes, year fixed effects γ_y^g that control for calendar year shocks common to all individuals and PhD-age fixed effects δ_p^g that control for time since PhD start, capturing career-stage effects. All control variables are included nonparametrically to account for life-cycle and career-stage patterns in employment or academic position. The residual term η_{ist}^g captures unexplained variation.

We then calculate the proportion of individuals in employment/position at time t as a percentage of the counterfactual proportion in the absence of parenthood $\widetilde{Y}_{ist}^g$:

$$\widetilde{Y}_{ist}^g = \sum_k \beta_k^g * 1[k = age_{is}] + \sum_y \gamma_y^g * 1[y = s] + \sum_p \delta_p^g * 1[p = PhDage_{is}] \tag{2}$$

$$P_t^g = \frac{\hat{\alpha}_t^g}{E[\widetilde{Y}_{ist}^g | t]} \tag{3}$$

The motherhood penalty is therefore P_t^w and the fatherhood penalty P_t^m. The child penalty is the difference between the change in academic employment proportions for mothers and fathers: $P_t = P_t^w - P_t^m$. It measures the percentage by which women's outcomes change relative to men's as a result of having a child at event time t. Our long-run child penalty estimates include the impact of all the children born in the eight years after the first childbirth.

Threats to Identification The causal identification of child penalties relies on the smoothness assumption, namely that other determinants of academic outcomes evolve smoothly over time around the birth of the first child. As is standard in event studies, estimates on the periods before childbirth are indicative of whether there are differential trends in outcomes between the treated group and the not-yet-treated group. Adams et al. (2024) show that fertility patterns and age at first birth vary across educational levels which in turn affect earnings through parental leave. Melentyeva & Riedel (2023) argue that child penalty estimates are sensitive to heterogeneity by age at

first birth. In this research, the sample is highly homogeneous with respect to skill levels. Similarly, the age distribution in our sample is more tightly concentrated around its mean than in the average population, with around 80% of mothers having their first child between 28 and 35 years old. To further address such concerns, we include $PhD - age$ fixed effects that control for career-stage dynamics, and we don't allow a tenured academic to revert to a non-tenured position in the year of parenthood. This mitigates the risk of overestimating penalties, as highlighted by Adams et al. (2024).

Another threat to identification could be that there is strategic fertility planning in response to career prospects (a form of anticipation effects), for example, that upon satisfying the conditions for tenure (but not yet being granted it), individuals are likelier to have their first child. On the other hand, an individual who perceives themselves as unlikely to secure academic employment or tenure in the near future could decide to have a child just before leaving academia. Our granular data on research productivity, namely the number of publications and the quality-adjusted measure of the number of publications, allow us to empirically check whether the first childbirth follows a jump in productivity indicative of a tenure prospect or a slowdown in productivity. We can directly assess the extent to which individuals postpone parenthood until tenure, and do not find any clear patterns. In the estimating sample, 3.2% of women and 5.3% of men have a first child in the year before, during, or just after tenure. For the full population of PhD students, these numbers are even lower (1.1% and 1.5%, respectively, for women and men). Finally, we conduct additional analyses. First, we compare parents to a control group of never-parents to additionally mitigate concerns about selection into parenthood in response to career prospects. To allow for heterogeneous treatment effects by age at first birth Melentyeva & Riedel (2023), we estimate the treatment effects separately by four age-at-first-birth cohorts, and we report the weighted average of the age-at-birth-specific estimates. Finally, we use the Sun & Abraham (2021) alternative estimator to address concerns of heterogeneous treatment effects across cohorts.

Adjusted Kitagawa–Oaxaca–Blinder Decomposition To speak to the literature on the lack of women at the top of the academic profession, we investigated the impact of parenthood on promotion. Yet, the likelihood of promotion is a function of academic employment in the first instance, but also of labor supply and research output which are affected by parenthood. Hence, we are interested in how much of the magnitude of the child penalty on promotions in academia can be attributed to academic employ-

ment (or the lack of), labor supply (part-time or full-time work), and research output (a researcher's publication record). This framework allows us to attribute the estimated gender gap in promotion due to parenthood into the part explained by observable differences and their different returns in employment, labor supply and research output, and the part that remains unexplained. In additional analyses, we extend the covariates to include measures of parental leave and measures of the field of the academic.

To do this, we adjust the Kitagawa–Oaxaca–Blinder decomposition. We first run a specification on the panel of researchers from 4 years before to 8 years after birth where the dependent variable is an indicator for the senior position of the researcher i in calendar year s at event time t (Y_{ist}) on the fixed effects used in our event study specification: age fixed effects β_k, year fixed effects γ_y, and PhD-age fixed effects δ_p. We do this first step to obtain the variation in the senior position once life-cycle and career-stage patterns are accounted for, captured in the the residual term $\hat{\text{t}}_{ist}$.

$$Y_{ist} = \sum_k \beta_k * 1[k = age_{is}] + \sum_y \gamma_y * 1[y = s] + \sum_p \delta_p * 1[p = PhDage_{is}] + t_{ist}$$

Let $\hat{t}$ denote the estimated residualised tenure outcome, $pubs$ the continuous number of quality-adjusted publications,pt an indicator for part-time work, and uni an indicator for working at a university. For each group $g \in \{m, f\}$ (men, women), consider the linear model:

$$\hat{t}^g_{ist} = \beta^g_0 + \beta^g_{\text{pubs}}\, pubs + \beta^g_{\text{pt}}\, pt + \beta^g_{\text{uni}}\, uni \tag{4}$$

Let $\bar{\hat{t}}_g$ denote the sample mean of residualised measure of tenure in group g, and let $\overline{pubs}_g$, $\overline{pt}_g$, and $\overline{uni}_g$ denote the group means of the covariates.

The difference in mean residualised tenure between men and women using the Kitagawa–Oaxaca–Blinder decomposition can be written as:

$$\bar{\hat{t}}_m - \bar{\hat{t}}_f = \underbrace{(\bar{X}_m - \bar{X}_f)'\hat{\beta}_f}_{\text{Explained}} + \underbrace{\bar{X}'_m(\hat{\beta}_m - \hat{\beta}_f)}_{\text{Unexplained}}. \tag{5}$$

The explained component measures how much of the gender gap in promotions can

be attributed to men and women differing in their research output, part-time employment, and university employment, evaluated at the female returns. Expanding it by covariates it can be written out as:

$$(\overline{pubs}_m - \overline{pubs}_f)\hat{\beta}_{\text{pubs},f} + (\overline{pt}_m - \overline{pt}_f)\hat{\beta}_{\text{pt},f} + (\overline{uni}_m - \overline{uni}_f)\hat{\beta}_{\text{uni},f}, \tag{6}$$

The unexplained component captures how much of the estimated gap is due to differences in the promotion to tenure "returns" to the same observable characteristics (academic employment, part-time employment and research output).

$$\overline{pubs}_m\left(\hat{\beta}_{\text{pubs},m} - \hat{\beta}_{\text{pubs},f}\right) + \overline{pt}_m\left(\hat{\beta}_{\text{pt},m} - \hat{\beta}_{\text{pt},f}\right) + \overline{uni}_m\left(\hat{\beta}_{\text{uni},m} - \hat{\beta}_{\text{uni},f}\right) + \left(\hat{\beta}_{0,m} - \hat{\beta}_{0,f}\right) \tag{7}$$

The decomposition allows us to quantify what share of the gender gap in tenure among parents, relative to time to parenthood, operates through women leaving academia overall, women publishing less, and women being more likely to work part-time, and what share reflects that even conditional on equal publications, employment status, and affiliation, women and men face different returns on these in terms of promotion.

Descriptives on the Sample of Researchers In Table A1, we present summary statistics of both the full population of academics and the estimating sample, i.e., individuals who become parents after PhD enrollment. In our estimating sample, individuals enroll in the PhD at age 27 and, on average, become parents 5 years later with small gender differences. 53% of the estimating sample holds a Master's degree in STEM, with the remaining split between medicine, social sciences, and humanities. Women are over-represented in medicine and under-represented in STEM with gender-balance in humanities and the social sciences. Over the course of their career, 42% of men in the estimating sample are observed with at least one year of university employment, while this figure is 38% for women. For tenured positions, the gender gap is larger: 26% of men have ever held a tenured position, compared with 19% of women, while 54% of men and 49% of women have ever published. In Table A2, the fertility patterns of individuals working at universities are compared to those who leave academia after at five, ten, and fifteen years after starting the PhD. There are no empirical differences in the age of first birth or the total number of children between those who stay and those who leave academia, which provides supportive evidence that parenthood isn't

a strategic response to career prospects. Ten years after PhD enrollment, on average 78-83% of men and women working at universities have at least one child, compared with 70-78% of men and women working in other sectors. In comparison, Cheng (2020) reports that, among US academics, 73% of women and 71% of men have their first child within 10 years of PhD enrollment. The average age at motherhood in our sample is 2.8 years higher than that of all tertiary educated women in Denmark in recent cohorts (Leung et al., 2016), but observed full fertility is similar to the population average of 1.5 children per woman (Eurostat, 2023b).

4 Impact of Children on Academic Outcomes

Does becoming a parent affect academic trajectories? The short answer is yes. In Figure 1, we show the effect of parenthood of mothers and fathers on two academic career outcomes: the extensive margins of being employed at a university (panel A) and having tenure (panel B). Once life-cycle and calendar-time trends are accounted for, men's and women's academic careers evolve in parallel prior to parenthood across all outcomes. Following the birth of the first child, however, their trajectories diverge sharply. Panel A shows that fathers experience a modest but persistent decline in university employment: relative to their counterfactual, their employment probability drops by 9 percent in the period after birth and stabilizes at roughly 14 percent lower eight years later. For mothers, the effects are substantially larger. After women become mothers, their likelihood of being employed at a university declines of 23 percent in the period as compared to their counterfactual, and 8 years after becoming mothers, they are 29 percent less likely to be employed at a university. Put differently, one in three women exits academia following motherhood. These patterns imply a long-run child penalty in university employment of 15 percent.

Turning to being tenured, the key promotion milestone in the academic career, men exhibit no discernible change in their probability of being tenured after becoming fathers. In contrast, women experience an immediate and pronounced decline. Their tenure probability falls most sharply three to four years after birth, reaching roughly 35 percent below the counterfactual, and remains about 23 percent lower eight years

after motherhood.[5] In panels C and D, we document the effect on research output, a mitigating factor in career development. Men's research output, measured by annual publications and quality-adjusted output, is unaffected by parenthood. For women, research output declines sharply after birth and continues to decline over time, stabilizing eight years later at levels approximately 31 percent lower than those of fathers for publications and 35 percent lower for quality-adjusted publications.[6]

How much of the under-representation of women across academic and tenured positions can be attributed to child penalties? To answer this, we use back-of-the-envelope calculations described in Kleven et al. (2024) that scale the child penalty estimates by the share of women who are mothers, and express them relative to the raw gender gap. We find that child penalties explain around 70% of the observed gender gap in academic employment and around 40% of the gender gap in tenure.

A question is whether women leave academia to pursue better opportunities in the general labor market. To investigate this, Figure A4 visualizes the effect of parenthood on labor market earnings in Panel B, and the effect of parenthood on labor market participation (defined as having non-zero labor market earnings) in Panel C. The estimates show that although women leave academia, they do not do so for higher-paid jobs: they experience a long-run child penalty in earnings of 12 percent, while men's earnings remain unaffected. The earnings child penalty for women with a PhD is half as large as that observed in the general labor market (Kleven et al., 2019). This likely reflects differences in labor market participation: in the general labor market, the child penalty in participation is 13 percent, whereas we find no participation penalty. These results rule out a shift from academia into better-paid occupations.

We then estimate child penalties on research careers more broadly. Specifically, we estimate child penalties for employment in the broader Danish research sector—such

[5] In Figure A3, we show the underlying estimates that generate the relative child penalties from Equation 3 shown in Figure 1, comparable to the results for economists reported by Lassen & Ivandić (2024). Panels A and B show the event-study estimates from Equation 1 for academic employment and tenure. Panels C and D present the counterfactual outcomes from Equation 2. Although the event-study estimates imply a long-run absolute child penalty ($Y_t^m - Y_t^w$) of 4 percentage points for academic employment and 3 percentage points for tenure, the larger relative penalty for tenure reflects the much lower counterfactual baseline probability, ($\widetilde{Y}^m$ and $\widetilde{Y}^f$) of being tenured compared with that of academic employment (15 vs. 30 percentage points).

[6] In Panel A of Figure A4, we also examine the intensive margin of research productivity — publishing in a given year. The child penalty on the intensive margin is roughly half the size of the penalty on the total number of annual publications and similar in size to the penalty on academic employment.

FIGURE 1: Impact of Children



Notes: The figures plots the gender-specific impacts of children P_t^m and P_t^w across event time. Outcomes shown at event time t are relative to the year before the first childbirth $t = -1$. The figure includes 95% confidence intervals around the coefficients. The estimations include fixed effects for age, year, and years since PhD start relative to event.

as research institutes and laboratories—and report the results in Panel D of Figure A4. The estimates show that women are not only leaving academia; they are leaving the research sector altogether. Women academics also don't make long-run adjustments on the intensive margin of their labor supply, as the likelihood of part-time work increases only in the first two years after motherhood, after which it fully recovers (panel E of Figure A4). In Panel F, we plot the effect of parenthood on the probability of moving abroad. We find that women become less likely to relocate internationally after motherhood. This implies that, once international mobility is taken into account, our

estimated child penalties in academia are likely a lower bound.

We complement our main event-study design with a set of robustness analyses. First, we use never-parents to account for non-child-related trends in academic employment and tenure rates and follow Melentyeva & Riedel (2023) to document heterogeneous treatment effects by age-at-first-birth. These exercises mitigate concerns related to strategic fertility in response to career prospects. Finally, we show the sensitivity of our estimates to differential dynamic treatment effects across cohorts. They are described in detail in Appendix Section A.2 and reported in Figure A5 and A6. Using never-parents as an alternative control group by assigning placebo birth years, we find that whether we compare mothers to fathers or to non-mothers, we can draw the same conclusions regarding the impact of parenthood for academic employment and tenure.[7] For age-at-first-birth, we observe no clear monotonic ranking. Motherhood is penalized primarily along the career margin that is most salient for each age-at-birth cohort, with employment penalties concentrated among younger women and tenure penalties concentrated among women giving birth at ages corresponding to the typical tenure decision.[8] Finally, using the Sun & Abraham (2021) interaction-weighted estimator with both not-yet-treated parent and never-parent control groups yields similar dynamic patterns of child penalties, with estimates based on not-yet-treated cohort parents nearly identical to the baseline and those based on never-parents modestly smaller in magnitude but qualitatively unchanged.

4.1 Impact of Children: Later Career Stage

It is not uncommon for women in academia to weigh whether children and an academic career are compatible and, if so, when is the optimal time to have a child. Recent testimonials in CSWEP (2025) highlight this concern, quoting now-senior academics: "*When I was a graduate student, I had an advisor who told everyone that grad school was the best time to become a parent*" and "*I often hear young women ask their senior colleagues for guidance on whether and when to start a family.*"

[7] For publication output, we also do not observe either a slowdown or an increase for mothers relative to non-mothers in the years before childbirth.

[8] A very small fraction of individuals appear to delay parenthood until tenure. While this is highly endogenous, we can exclude these individuals who appear to be the most strategic. This doesn't change the estimated child penalties in any meaningful way.

However, there is little empirical research to inform such decisions. To address this, we estimate child penalties on a sample of researchers who have secured academic employment after completing their PhDs. This allows us to assess whether child penalty estimates differ at a later career stage. This group represents 10% of men and 7% of women from our estimating sample of PhD entrants[9], and constitutes a selected group that may have postponed having children until after securing their first academic position. Yet, for most researchers, this is also a key time to demonstrate their research potential for tenure.

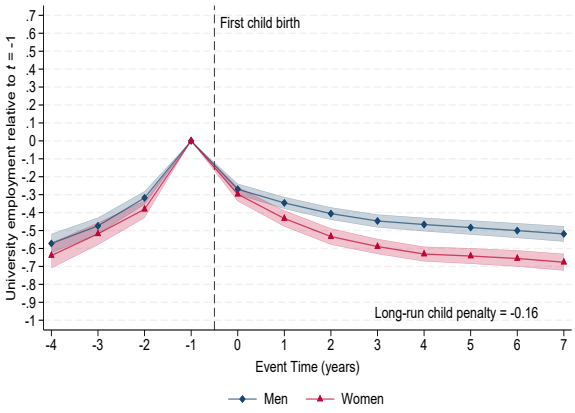
In Figure 2, estimates of men's and women's academic and research trajectories are reported for the same outcomes as before: university employment (panel A), tenure (panel B), the annual number of publications (panel C), and quality-adjusted publications (panel D), for the sample employed at a university in the year prior to becoming parents. Due to the smaller sample size, the confidence intervals are wider, but the overall pattern remains unchanged. Prior to parenthood, men's and women's academic careers evolve in parallel across all outcomes. Following parenthood, however, women's trajectories diverge adversely from those of men, with long-run child penalties of 16 percent in academic employment, 15 percent in tenure, and 21 percent in annual publications. The child penalties on having tenure and on research productivity are smaller in magnitude than the unconditional ones, but nevertheless indicate a substantial negative penalty for mothers who have postponed parenthood to after securing an academic job.

The comparison of child penalty estimates between the sample of all PhD entrants and the sample of employed academics allows us to show that parenthood leads to survivorship bias. Postponing parenthood until after securing an initial academic position may mitigate, but not eliminate, the costs of parenthood for academic mothers. Estimates obtained on a sample of employed academics underestimate the total effect of parenthood on tenure and research output.

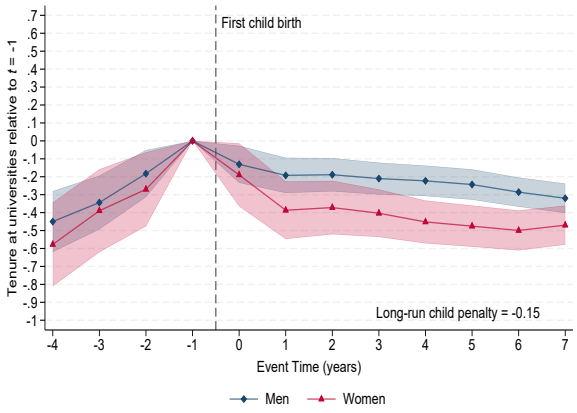
[9]This reflects both early fertility and the fact that many PhD students do not continue in academia regardless of parenthood.

FIGURE 2: Impact of Children: Later Career Stage

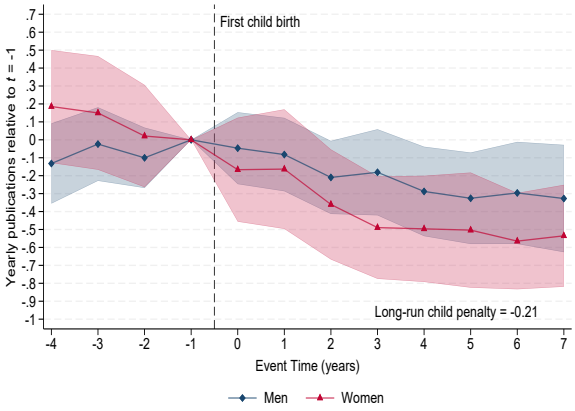
(a) University Employment



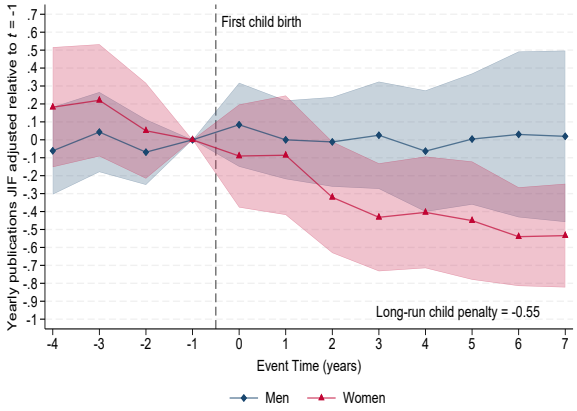
(b) Tenure



(c) Publications



(d) Quality Adjusted Publications



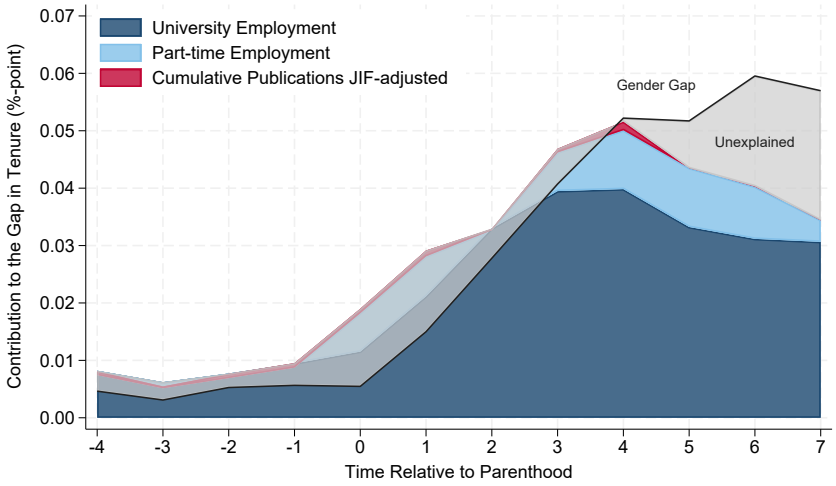
Notes: The figures plots the gender-specific impacts of children P_t^m and P_t^w across event time. Outcomes shown at event time t are relative to the year before the first childbirth $t = -1$. The figure includes 95% confidence intervals around the coefficients. The estimations include fixed effects for age, year, and years since PhD start relative to event.

5 Decomposing the Penalty on Tenure

Parenthood affects several dimensions of academic careers, including university employment, labor supply (full-time versus part-time work), and research output. Our goal is to quantify the extent to which these channels account for the parenthood penalty in promotions. We do so using the described adjusted Kitagawa–Oaxaca–Blinder

decomposition on the gender gap in tenure relative to time of parenthood[10]. We find that the effects on academic employment are the dominant mechanism in the early years after birth, while quality-adjusted publications contribute a small share to explaining the tenure gap. Reductions in labor supply, rare in this setting, also do not account for the observed penalties in tenure. Prior to and around parenthood, the difference in observable characteristics between women and men explain the gap in tenure rates. From the fourth year of parenthood, the differential returns to employment, and part-time work across men and women begin to explain a larger share of the gap in the penalty (visualized as the "unexplained" component).[11]

FIGURE 3: Decomposition of Child Penalties on Tenure



Notes: The solid black line in the figure depicts the residualised gap in tenure rates, adjusted for age, calendar-year, and phd-age fixed effects for year -4 to 7 around parenthood. The shaded areas depict the explained contributions from university employment (navy blue), part-time university employment (light blue), and publications, JIF adjusted (red). The unexplained component, shaded in gray, equals the vertical distance between the stacked areas and the solid black line. When the gray area is above the black line, the observables over-explain the gap (a negative unexplained contribution). The gray area below the line indicates a positive unexplained contribution.

In Panel A of Figure A7, we add additional covariates for the PhD field and weeks of parental leave. The predominant explanation for the child penalty in tenure contin-

[10] As the event-study results show no fatherhood effect on tenure and no pre-existing gender gap before childbirth in Figure 3, the post-birth gender gap in residualised tenure among parents relative to time of parenthood is numerically very close to the previously reported event-study estimates of the child penalty on tenure.

[11] We also decompose the gender gap in academic employment on the same covariates. In this setting, publications explain up to 20 % of the gender gap, suggesting that remaining active in publication plays an important mitigating role on this margin.

ues to be the effect of parenthood on exiting academic employment altogether. Even when we examine the sources of the tenure penalty within the tenure-track sample (Panel B of Figure A7), differences in women's attrition from academia account for far more of the tenure gap than do research output or labor supply adjustments.[12] In Panel C, we restrict the decomposition to individuals in STEM, under the assumption that research output is measured more contemporaneously and with greater precision in the sciences. While the coefficient increases relative to all fields, quality-adjusted publications still explain little of the variation in the child penalty in tenure.

While academic employment, or differently put, leaving academia, is the first order explanation of the gender gap in tenure rates across different specifications and samples, there may be other factors that contribute to the gender gap in tenure that we are not able to capture in data. It is plausible that teaching quality, success in obtaining funding and service work matter for obtaining tenure, beyond the success in one's publishing record. Moreover, if a large network and attending conference exacerbates and promotes a more successful publishing record, and men find it easier to travel after parenthood than women, we could be underestimating the overall contribution of research output's impact on one's career.

Echoing the finding in Buckles (2019, p. 47) that "*Women matriculate from PhD programs at roughly the same rate at which they enter. The first significant leak in the academic pipeline occurs in the transition from graduate programs to assistant professorships.*", our results show that parenthood causally leads to this first leak in the academic pipeline. Indeed, as described earlier, following Kleven et al. (2024), we find that children explain roughly 70% of women's under-representation in academic employment. In sum, we find that the effect of parenthood on the first leak in the academic pipelines is the main culprit in explaining the gender gap in tenure.

[12] To understand the importance of publications more broadly, we run a cross-sectional regression analysis on a sample of men seven years after their PhD graduation. We find that measures of publications correlate positively, but with an economically very small effect on the probability of tenure - one standard deviation increase in the number of quality-adjusted publications correlates to a seven percent increase in the probability of tenure.

6 Sources of Child Penalties

Having documented sizable child penalties in academic retention and promotion to senior positions, we next examine potential mechanisms underlying these gaps. Using a newly collected cross-sectional survey on the academic and PhD student population, we can speak directly to working hours, childcare, and aspirations. The richness of the administrative data allows us to conduct a series of heterogeneity tests, investigating mitigating channels that could reduce the penalty's size, focusing on the workplace and family environment.

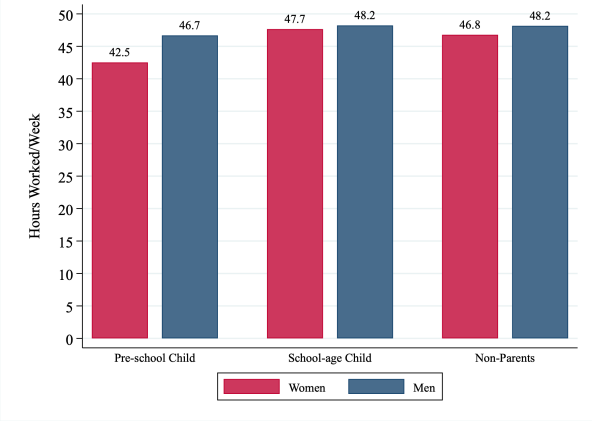
Aspirations One hypothesis is that women, ex-ante, have different career aspirations than men and, although they choose to pursue a PhD, do not intend to pursue a research career (McFall et al., 2024). To test this, we asked PhD students which career they would prefer the most, assuming they had the choice. As Figure A8 shows, 74% of all PhD students aspire to do research following their PhD, and men and women PhD students hold similar aspirations. Men and women have the same interest in staying in research and teaching, with women being slightly more interested in doing research outside of universities. Women and men also place the same importance on key job aspects such as the opportunity for career advancement, the desire for intellectual challenges, degree of independence, job benefits, and security, as shown in Figure A9. In sum, this shows that among PhD students gender differences in preferences for an academic job are not driving the leaky pipeline.

Childcare Constraints Another hypothesis is that parenthood constrains working hours differently for mothers and fathers, which may in turn affect their productivity and progression up the academic career ladder, given that academia is considered a "greedy" profession with convex returns to hours (Goldin, 2014). To test this hypothesis, we collected novel data asking researchers to self-report their working hours. Although full-time contracts typically specify 37.5 hours per week, actual hours worked may vary substantially across researchers. Although the average self-reported hours among the working population in Denmark are 38 hours for women and 42 hours for men (Eurofound, 2015), both men and women researchers report significantly longer hours of 47 per week (45.5 hours for women and 47.5 hours for men) with a standard deviation of 10 hours. To test whether the observed gap in working hours is due to the differential effect of parenthood, we test across differences in hours between parents

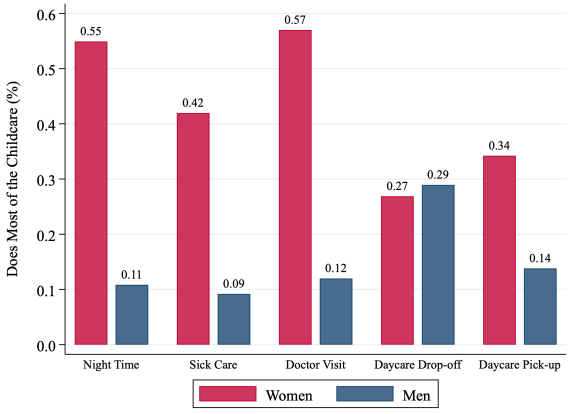
of pre-school and school-age children, and across differences in hours between parents and non-parents. As Panel a) of Figure 4 shows, women with preschool-aged children work four hours less per week than men with children of the same age, corresponding to a ten percent shorter work week. Yet, when children are school-aged, both men and women work slightly longer hours and the gender gap in working hours closes to 0.5 hours per week. Non-parents work similar hours as parents with school-aged children.

FIGURE 4: Survey Evidence: Working Hours and Childcare Split

(a) Weekly Hours Worked



(b) Who Does Most of the Childcare (%)



Notes: Panel A reports the answers to the question "How many hours do you work in a typical week?" split across individuals who reported having a pre-school child (aged 6 or younger) versus school-age child(ren) versus individuals without a child. It is based on 1500 responses of parents and 900 responses of non-parents. Panel B reports the share of individuals who replied "Always me" or "Mostly me" to the question "In your household, when your youngest child was not yet of school age, who performed the following tasks?" across the following categories: getting up at night to take care of the child, taking care of the child when they were sick, taking the child to the doctor, taking the child to paid care and picking up the child from paid care. It is based on 1100 responses.

Using uniquely detailed responses on the household split of childcare work among researchers and their partners, we investigate whether differential patterns in childcare can explain the observed motherhood penalties in academia. Researchers were asked whether they believe "Families usually function best if partners share childcare, household work, and paid work tasks equally". The overwhelming majority of researchers (75%) strongly agree or agree with this statement. As shown in Figure A10, women are slightly more likely to agree with the statement, but even among men, 72% agree that that childcare and household work should be shared equally. Yet, in practice, these attitudes do not translate into equality in actual childcare responsibilities,

as women continue to bear a disproportionate share of childcare responsibilities. In Panel b) of Figure 4 we show the share of researchers who reply they did most or all of the childcare when their child(ren) were not of school age across five types of childcare responsibilities: getting up at night to take care of the child, taking care of the child when they were sick, taking the child to the doctor, taking the child to paid care and picking up the child from paid care. Across the more time-constraining childcare tasks (night-time care, sick care, pick-up, and doctor visits), women academics do almost five times more childcare than their male academic counterparts. For example, 55% of female researchers get up at night to take care of the child most or all the time, in comparison to 11% of men. Men and women do similar levels of day-care drop-offs, yet this is the only childcare responsibility that has predictable timing and doesn't impose on working hours. [13] Even across the highest educated and parts of the population who state that childcare should be shared equally, a huge gender gap emerges in who bears the childcare load. This inequality in childcare is likely to disproportionately hamper women's ability to work at their full capacity. Night-time care reduces productivity the next day, while sick care, doctors' visits, and pick-ups affect working hours and require a certain "mental load", reducing the ability to solve complex problems even outside of working hours.

Mobility Constraints One potential constraint that may differentially affect women relative to men in academic careers is their willingness to move to secure an academic job following their PhD, a mechanism suggested by evidence of a distaste for commuting and relocation among women in the broader labor market (Petrongolo & Ronchi, 2020; Le Barbanchon et al., 2021). To examine this mechanism, Figure A12 presents descriptive evidence on post-PhD mobility patterns by parental status and gender. Using administrative data on individuals' residential location in the second year of the PhD and five years after completion, we define a move as a change in the region of residence. We show that non-parents exhibit higher average mobility than parents, with the lowest mobility observed for mothers. Specifically, mothers are 5 percentage points less likely to relocate than fathers in the five years following the PhD, corresponding to an approximately ten percent lower mobility rate, which constraints their academic job search. This pattern is also evident in Panel F of Figure A4, which shows

[13] In Figure A11 in the Appendix, the share of individuals who replied that their partner does most or all the care is plotted - with a similar pattern emerging - male academics' female partners do on average five times more childcare than the male partners of female academics.

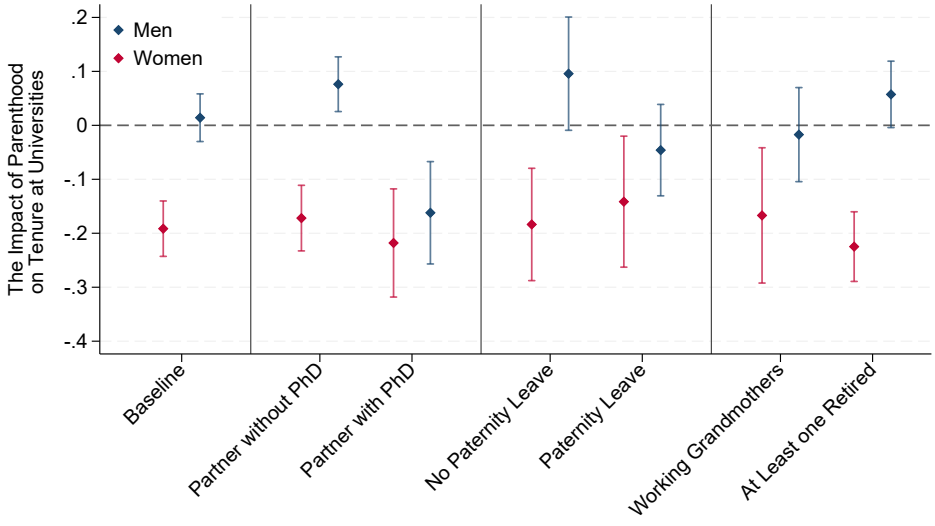
international mobility. After motherhood, women are less likely than men to move internationally, which constrains their pool of possible academic jobs.

Family Environment We also examine how researchers' choices in the family sphere shape their academic trajectories after parenthood. The richness of the administrative data allows us to study three sources of variation: (i) having a partner with a PhD, (ii) the partner's or the researcher's uptake of paternity leave, and (iii) the researcher's availability of grandmaternal care. In our sample, 11% of men and 9% of women cohabit with or are married to a partner with a PhD. A plausible hypothesis is that partners with PhDs may better understand the demands of academic careers and may have greater flexibility, potentially easing childcare constraints. In Figure 5, we find that women academics experience similar child penalties on tenure regardless of whether their partner has a PhD, whereas men academics with a partner holding a PhD experience substantially larger child penalties - of similar magnitude to the average penalty for women. We next compare women whose partner takes no paternity leave to those whose partner takes two or more months, placing them in the top of the distribution of paternity-leave uptake.[14] This may both allow women to return to work sooner and proxy for higher long-run paternal involvement in childcare. As shown in Figure 5, women academics face similar child penalties regardless of their partner's paternity-leave uptake. By contrast, men academics who take at least two months of paternity leave experience significantly worse career outcomes than men who take no leave, consistent with the idea that time away from research and greater childcare involvement carry substantial career costs, regardless of the caregiver's gender. It is worth keeping in mind that the source of variation - 2 months of paternity leave, taken by 20 % of fathers - is very far from parity. Even in these couples, the mother remains the primary caregiver and takes an average of 3-4 times longer leave. Finally, we compare academics whose child has at least one retired grandmother in the year before their birth, defined by no mandatory pension contributions for the researcher's or their partner's mother, to academics without any retired grandmother, proxying the availability of grandmaternal care. We test the size of child penalties across these two subsamples, as retired grandmothers could ex-ante alleviate some childcare constraints. However, Figure 5 shows that women face similar penalties re-

[14]The distribution of paternity leave shows that fathers are most likely to have either no weeks of leave registered or two weeks around the date of birth. If claiming additional paternity leave, the most common duration is 10-12 weeks. A cut-off at 2 months - 9 weeks - corresponds to the top quintile.

gardless of grandmothers' retirement status. However, Scandinavian parents usually rely less on extended-family–based childcare arrangements than their Southern and Central European counterparts. Appendix Figure A14 shows that these patterns are similar for the other outcomes: university employment and annual publications confirming the results on research output in Cairo & Tartari (2025). Overall, the results mirror the survey findings on the large gender differences in childcare responsibilities. These constraints are insufficiently lifted by supportive, involved partners or retired grandmothers.

FIGURE 5: Child Penalties: Family Environments

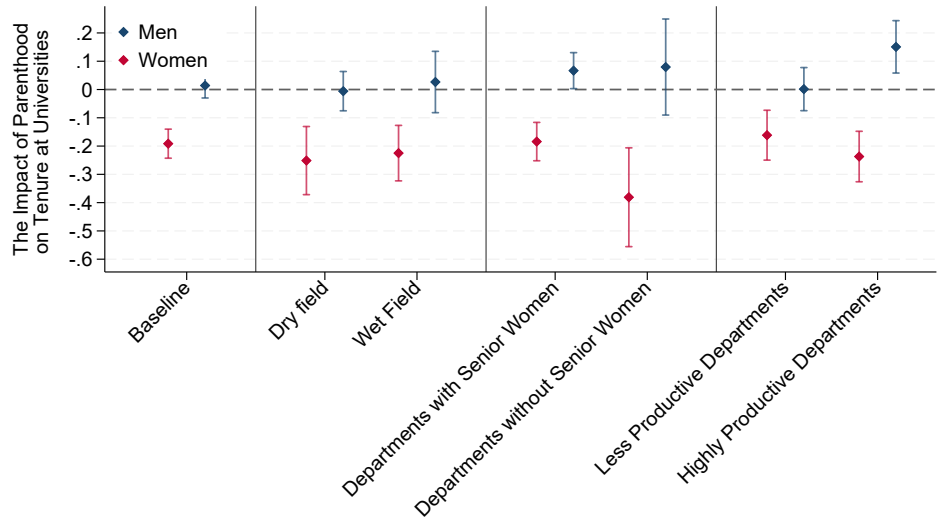


Notes: This graph reports the gender specific impact of children, estimated jointly for $t > 0$. Men and women are estimated separately, and the estimation includes fixed effects for age, year, and years since PhD start relative to parenthood. See the text for definitions of different family environments.

Workplace Environment A key policy concern is whether and how workplaces and their characteristics can mitigate the child penalties. We empirically test this in two ways. First, we investigate the role of scientific fields in the survival and promotion of women in academia after parenthood. To do so, we divide the natural science fields into *dry fields* and *wet fields* on the basis of the field of the academic's Master's degree. We define dry fields as STEM fields where research is done behind a desk and, therefore, offers more flexibility in the location and time when the research is being done, such as physics, math, statistics, and computer science. We define wet fields as STEM fields in which research is conducted in laboratories that rely heavily on access

to specialized research infrastructure and technical equipment and are constrained by working hours and laboratory location, such as biochemistry, chemistry, and biology. In Figure 6, we show the average child penalty in the periods from the first to the eighth year of parenthood for men and women across several dimensions of workplace characteristics. We observe that, regardless of whether individuals work in a dry, more flexible field or a wet, less flexible field, the child penalty on tenure is empirically the same. This shows that, while academics enjoy greater flexibility than other white-collar professions, the additional flexibility offered by dry fields doesn't translate into lower child penalties on tenure for women. In Figure A13, we find that, while child penalties in wet and dry fields on university employment are also the same, child penalties in publications significantly decrease relative to wet fields in line with the results reported by Cairo & Tartari (2025). While workplace flexibility affect the magnitude of the decline in research output, the finding that child penalties on employment and tenure are the same across all fields suggests that factors common across fields are the key drivers of survival and promotion in academia. This is consistent with earlier results indicating that the motherhood-related tenure penalty is not primarily mediated by a drop in research output.

FIGURE 6: Child Penalties: Work Environments



Notes: This graph reports the gender specific impact of children, estimated jointly for $t > 0$. Men and women are estimated separately, and the estimation includes fixed effects for age, year, and years since PhD start relative to parenthood. See the text for definitions of fields and departments.

Second, to test the role of workplaces in mitigating or exacerbating child penalties, we examine the characteristics of university "departments," which we define as field-specific researcher groups within each university. We focus on two potential mechanisms: (i) exposure to at least one senior female role model and (ii) the productivity of the research environment. We measure exposure to role models by comparing departments without any senior women to all other departments, measured in the second year of the individual's PhD.[15] To capture differences in research intensity, we compare departments below field-average ("Less Productive Departments") and above average ("Highly Productive Departments") of total faculty publications, measured in the department in which the individual completed the second year of their PhD.[16] Figure 6 presents the subsample analysis for the probability of having tenure, while the Appendix Figure A13 reports the corresponding results for university employment and annual publications. Women trained in departments with no senior women face penalties that are twice as large as those of women trained in departments with at least one senior woman. That the presence of senior women reduces gender gaps aligns with findings by Dupas et al. (2026) and Kjelsrud & Parsa (2024) on seminar experiences and academic career outcomes, respectively. We also find that individuals trained in high-productivity departments experience substantially larger child penalties in having tenure. This pattern is consistent with the idea that such departments operate under a "winner-takes-all" environment, in which taking time away from research - more common for women around childbirth - is particularly costly for subsequent career advancement.

[15] 9.6 % of candidates are trained in departments without any senior women. Alternatively, we compare the bottom and top quintiles and find that in the top quintile, the gender gap is completely mitigated. In the bottom quintile, the gender gap is slightly smaller than what we report here for departments without any senior women.

[16] In "Less Productive Departments", the mode of yearly publications per researcher is 0, and the average is 6, while in the "Highly Productive Departments", the mode of yearly publications per researcher is 8, and the average is 12.5.

7 Conclusion

Upon parenthood, women's and men's career trajectories diverge sharply. . Using data that span the academic pipeline from PhD enrollment onward, we show that women and men follow similar trajectories prior to having children, but diverge substantially thereafter. We show that these post-parenthood divergences arise primarily through differential transitions out of academia, rather than changes in labor supply within academic careers. We find that mothers are 15 percent less likely than fathers to be employed at universities. The child penalty is particularly stark when we examine the likelihood of tenured employment after childbirth - while men's employment in tenured positions is unaffected by the arrival of a child, women experience a persistent drop of 23 percent in their rate of tenured employment. We show that parenthood is an important contributor to the persistent lack of women among faculty members. This is largely driven by mothers' lower likelihood of remaining employed at universities rather than by career slowdowns alone. We find no evidence that this is driven by gender gaps in aspirations regarding a research career. Instead, we find large gender differences in the constraints from childcare, including doctors' visits, night-time childcare, and sick days. These types of childcare are likely to restrict working hours, but perhaps more importantly for the research occupation, cognitive ability.

We document that penalties on tenure rates are mitigated, but not absent, among researchers who postpone parenthood until having secured university employment. Put differently, efforts to reduce the leaky pipeline - i.e. improve female representation at the later career stages - should direct their attention to the early career stages. Increased paternal involvement over the last decades - while meaningful - has not managed to reduce the impact of parenthood on women's career progression. Rather, we find that fathers taking paternity leave also face a higher likelihood of leaving academia, compared to fathers who spend little time on childcare. Finally, we show that the interaction between parenthood and highly competitive work environments or environments without female role models also contributes to the under-representation of women in top positions.

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PARENTHOOD AND THE CAREER LADDER: EVIDENCE FROM ACADEMIA

Online Appendix

Sofie Cairo Ria Ivandić Anne Sophie Lassen Valentina Tartari

A Appendix

A.1 Collective bargaining

Annual earnings for all academics at Danish universities is set via centralized collective bargaining. We have collected data on annual collective bargaining agreements in the archives of the trade union for academics (*DanskMagisterForening*). Earnings consist of a base salary (*grundløn*) and an allowance (*tillæg*). The archives cover the years 1997-2014, 2021, and 2022, and also contain a wage floor index tracking cumulative changes over time in the period from 2011-2021, when detailed data isn't available. In essence, the collective agreements translate into wage floors for the yearly earnings associated with each academic position (PhD Fellow, Assistant Professor, Associate Professor, and Full Professor) for the period from 1997 to 2022.

The base salary varies by years of relevant experience. According to the union, PhD students are placed on the lowest level of experience, assistant professors on a salary level corresponding to four years of experience, and associate professors and professors on a salary level corresponding to seven or more years of experience. The allowance varies by position. The evolution of the base salary for the relevant levels as well as the allowances for each type of position are reported in Figure A1. An assistant professor can be defined as having a salary with four years of experience + the assistant professor allowance, but below the level of seven years of experience + the associate professor allowance for a given year, i.e. between the light grey and dashed blue line. Both an associate professor and a professor would earn at least the base salary corresponding to seven years of experience, but their allowances would differ. Heads of Department, and members of senior management are likely to earn a professor wage. In addition, bonuses may be given for e.g. teaching excellence, success in securing external funding, and publications.

As of 1997, a change to the collective agreement system was agreed upon and phased in. Until 1997, wages increased mechanically with years of employment and the position of the researcher. This was replaced with a system with fewer steps and more discretion to allocate bonuses, whether yearly (one-off) or permanent.

We validate our measure of academic rank obtained by combining earnings and in-

formation from collective bargaining against titles from pay slips. Pay slip data comes from the ISOLA dataset from the Agency for Digital Government, a public agency responsible for paying public sector employees, including university employees. The two data sources overlap from 2017 to 2021.

Validation: When using the measure obtained from collective bargaining, we slightly over-estimate tenure rates. Assuming pay slip data has the correct title of the researcher, we misclassify 8.7 % of individuals. This is largely due to misclassifying 6.7 % junior researchers as senior researchers (due to relatively high earnings, likely reflecting the payment of bonuses). The gender difference in measurement error is tiny (i.e., leading to a 0.3 percentage-point difference in the estimated share of women among tenured faculty in a given year). The remaining 2% are senior researchers (according to their pay slips), but with earnings below the earnings floor. This is more likely to occur for women. In Figure A2, we plot the error rates relative to parenthood and time to promotion. Since the gender difference in the measurement error appears to be uncorrelated with both the timing of parenthood and time to promotion, it does not introduce a bias in the estimates of the child penalty in tenure rates.

A.2 Empirical Analysis: Robustness

In our main research design, we use an event study specification to estimate the dynamic effects of having a first child on academic outcomes. In this section, we describe the robustness analyses we additionally conduct. First, we follow Kleven et al. (2019) and assess the validity of our research design by using an event-study design and including never-parents as a control group. We assign placebo years of treatment to individuals who we observe at age 39 without children. This minimizes reliance on individuals who have not *yet* reached parenthood. The placebo year of first birth for the never-parents is assigned using the distribution of age at first birth separately by their birth-year cohort. On average, the never-parent control group accounts for 20% of our estimating sample. As relative child penalties are a function of event study child penalties from Equation 1 and the counterfactual outcomes estimated in Equation 2, but the counterfactual outcome do not vary across these specifications, in our robustness analysis we only report the event study estimates that can be compared to those in Figure A3 panels A and B. The results of the specifications, using never-parents as a control group, are reported in Figure A5: in panel A for academic employment and panel B for tenure, where we additionally plot the estimates for never-mothers and never-fathers. These event study estimates of the impact of children are very similar to the baseline results. Pre-trends across all four groups are extremely similar. However, at parenthood, mothers sharply diverge from all other groups, and never-mothers and never-fathers follow the same trend as fathers. This exercise shows that regardless of whether we compare mothers to fathers or to women who never become mothers, we can draw the same conclusions on the magnitude of the child penalties.

Second, recent literature has shown that event study estimates can be biased when treatment effects vary dynamically, when multiple cohorts that have heterogeneous cohort dynamic effects, and when already-treated parents are used as controls. Specifically, regarding child penalties, Adams et al. (2024) and Melentyeva & Riedel (2023) have noted that dynamic effects across educational groups and maternal age might differ. While our estimation sample is homogeneous with respect to education and has less age variance, there may be a concern that early and late-parents still differ in their career stage and in their selection into parenthood. To address these concerns, we use the interaction-weighted (IW) estimator proposed by Sun & Abraham (2021) to estimate the dynamic treatment effects. We use two control groups as proposed by Sun &

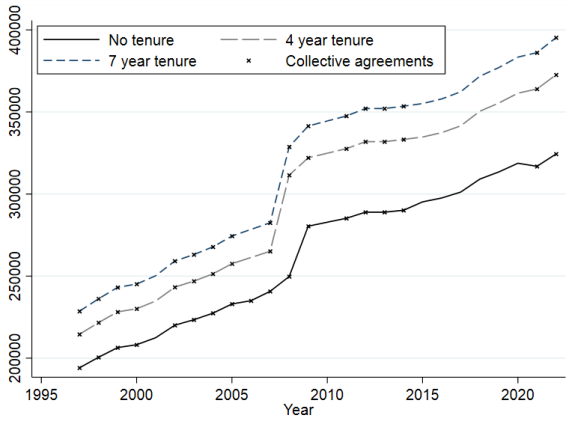
Abraham (2021): never-parents and not-yet-treated parents. The never-parent control group is defined as earlier described without assigning the placebo years of first birth. We define the not-yet-treated parent control group as individuals who have their first child in the period from 2020 to 2024, whom we originally did not include in our estimating sample. The not-yet-treated parent control group, on average, becomes 10% of our estimating sample. We show the dynamic event study child penalties estimated by the Sun & Abraham (2021) interaction-weighted (IW) estimator in Figure A5 on the outcomes of academic employment using the never-parent control group in panel C, academic employment using the not-yet-treated parent control group in panel E, tenure using the never-parent control group in panel D, and tenure employment using the not-yet-treated parent control group in panel F. The alternative estimators of the child penalties show the same patterns and similar magnitudes of dynamic effects of parenthood on academic employment and tenure for men and women. In fact, using the not-yet-treated parents as the control group leads to almost indistinguishable event study child penalties from those in our main empirical specification. Using the never-parents as the control group leads to, in absolute terms, smaller dynamic penalties for men and women following parenthood, but the dynamic patterns and the sizeable child penalties remain. Using the never-parents as the control group, albeit allowing us to remove the forbidden control and contamination effects in the standard event study specifications, anchors the counterfactual in a group that may evolve differently in outcomes even in the absence of treatment, which marginally attenuates the estimated effects. Finally, to allow for heterogeneous treatment effects by age at first birth (Melentyeva & Riedel, 2023), we estimate the Sun & Abraham (2021) model separately by four age-at-first-birth cohorts, while defining treatment timing by the calendar year of first childbirth using not-yet-treated individuals as the control group, and we report the weighted average of the age-at-birth-specific estimates. In Figure A6, we replicate Figures 3A and 3B from Melentyeva & Riedel (2023) on our estimating sample, focusing on the motherhood penalty. We observe no clear monotonic ranking across age-at-first-birth cohorts; if anything, employment penalties are larger for younger cohorts, while tenure penalties are more pronounced for women who give birth later. The age-at-birth estimates show that motherhood has larger career costs around any important academic step - the child penalty on employment is the most costly for women in the cohort just out of the PhD, while the child penalty on tenure is the most costly for women in the older cohort, which is the age group when, on average, academics obtain tenure. The child penalty in tenure materializes immediately for older cohorts, but

only with a delay for younger cohorts. Aggregating across cohorts, the average treatment effect is slightly larger than our baseline estimate but exhibits the same dynamic pattern, suggesting that age-at-first-birth heterogeneity, if anything, amplifies, rather than overturns, our main results.

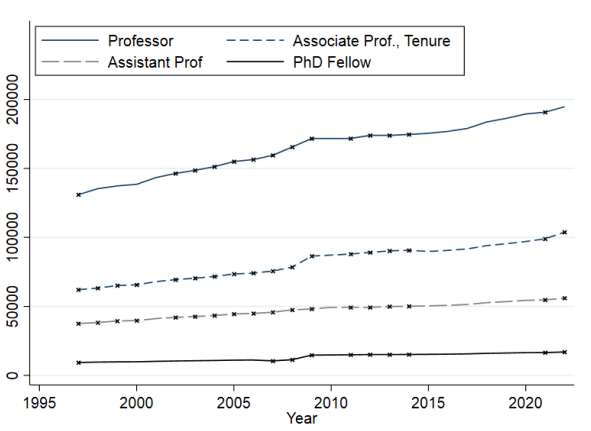
A.3 Figures

FIGURE A1: Earnings from Centralized Bargaining

(a) Baseline Earnings



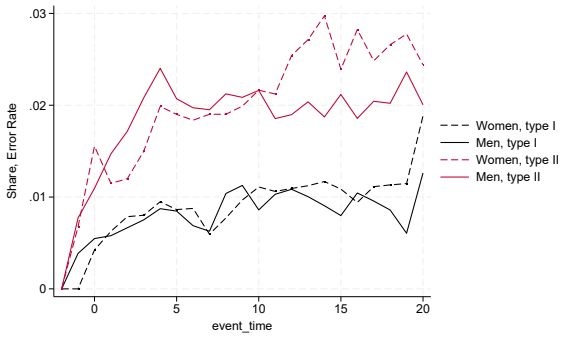
(b) Allowance



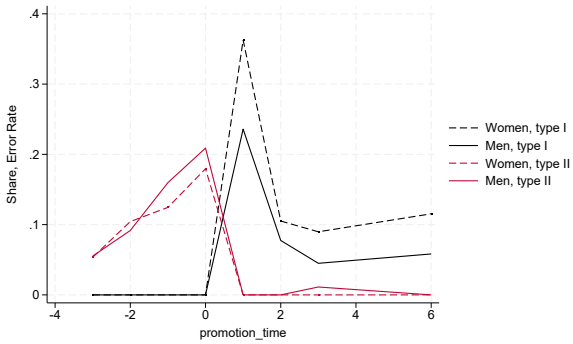
Notes: For each year since 1997, we have collected information on the base salary of researchers with different tenure durations (i.e. years of work experience) (panel a). On top of this base wage, researchers receive an allowance, corresponding to their position (panel b). In 1997, a change to the collective agreement system was put in place and gradually phased in. Until 1997, wages increased mechanically with years of employment and the rank of the researcher. This was abolished and replaced with a system with fewer steps and more discretion to allocate bonuses, whether yearly or permanent. From 1997 to 2008, new hires could choose between the two schemes. As of 2008, the new scheme was fully in place.

FIGURE A2: Validation of Position Measure

(a) Error Shares by Time to Parenthood



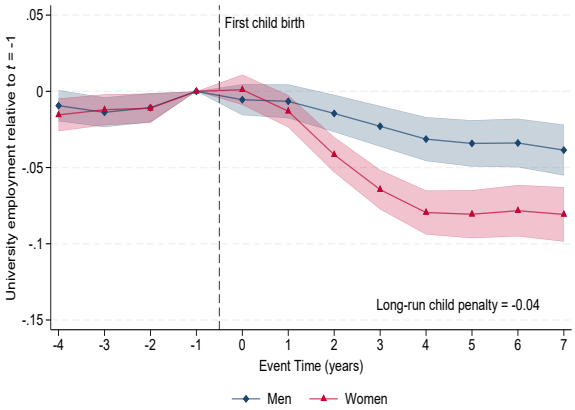
(b) Error Rates by Time to Promotion



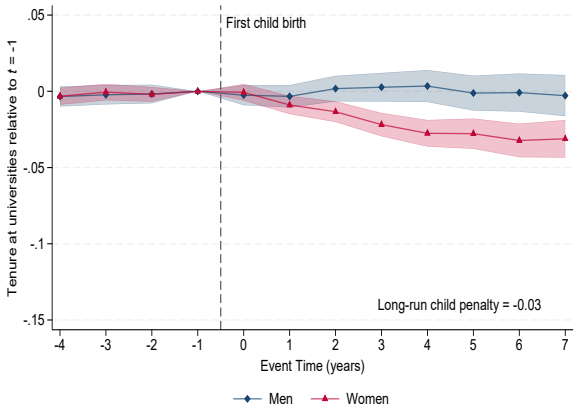
Notes: Panel A plots error rates relative to time to parenthood. Plot B plots error rates relative to promotion time. Type I errors (or false negatives, depicted in black) occur when we classify researchers as junior – due to earnings below the floor of associate professors – but according to Isola data, they are employed as associate (or full) professors. A type II error (or a false positive, depicted in red) occurs if individuals are classified as senior, due to earnings/wages above the floor of associate professors, but according to Isola data, are employed as juniors (or as technical support staff).

FIGURE A3: Impact of Children: Estimates Decomposition

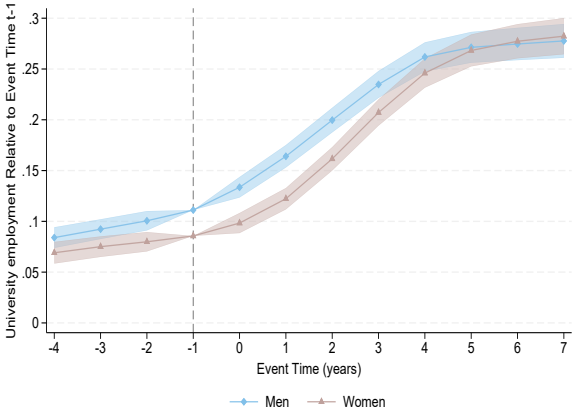
(a) Event Studies (University Employment)



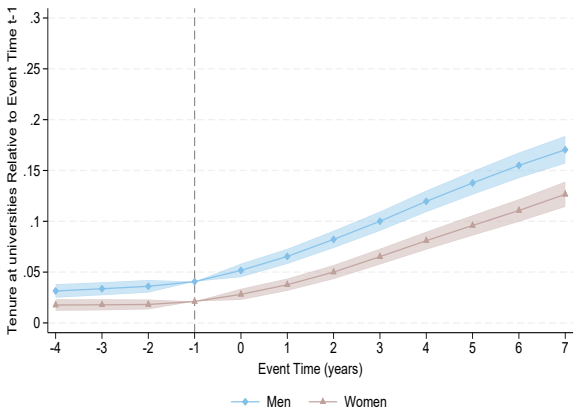
(b) Event Studies (Tenure Rates)



(c) Counterfactual (University Employment)



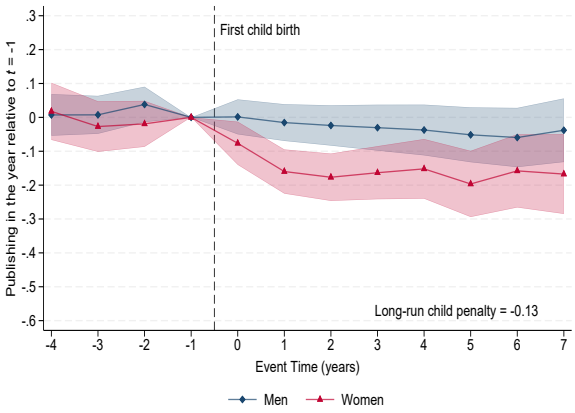
(d) Counterfactual (Tenure Rates)



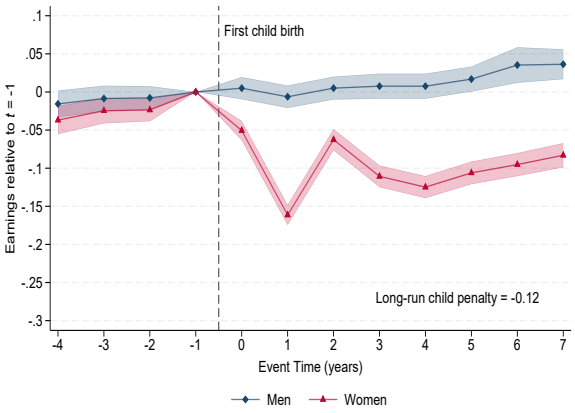
Notes: The top panel of the figures plots the gender-specific impacts of children, Y_t^m and Y_t^w, absence of the counterfactual, across event time. Outcomes shown at event time t are relative to the year before the first childbirth $t = -1$. The bottom panel plots the predicted counterfactual levels, $\widetilde{Y}^m$ and $\widetilde{Y}^f$. The figure includes 95% confidence intervals around the coefficients. The estimations include fixed effects for age, year, and years since PhD start relative to event.

FIGURE A4: Impact of Children on Additional Outcomes

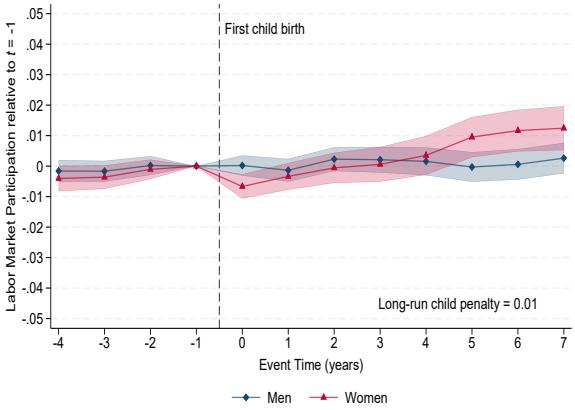
(a) Any Publication



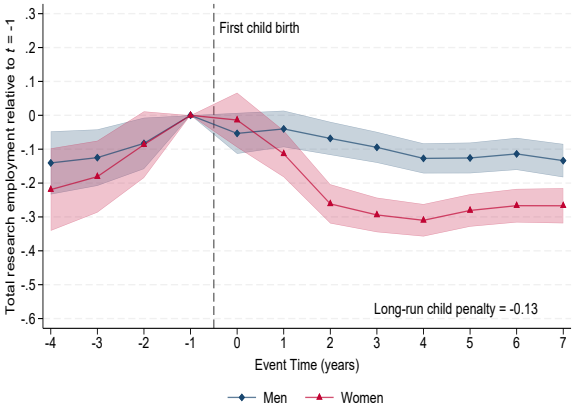
(b) Labor Market Earnings



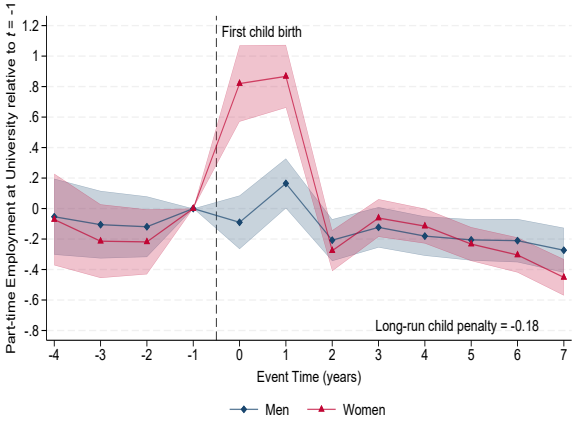
(c) Labor Market Participation



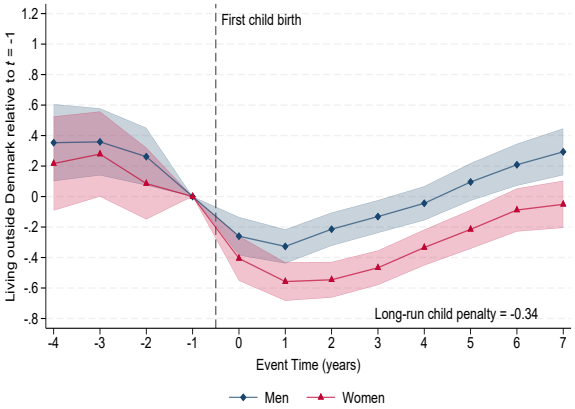
(d) All Research



(e) University Employment Part-Time



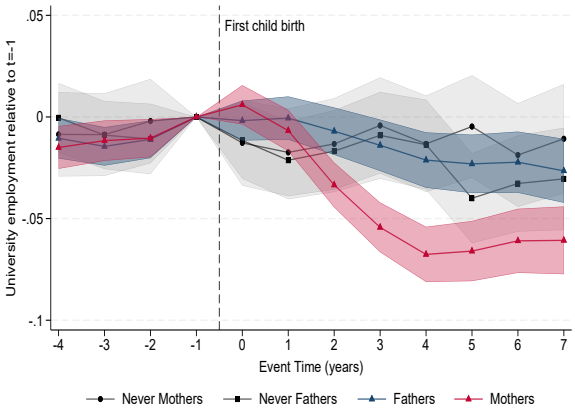
(f) Going Abroad



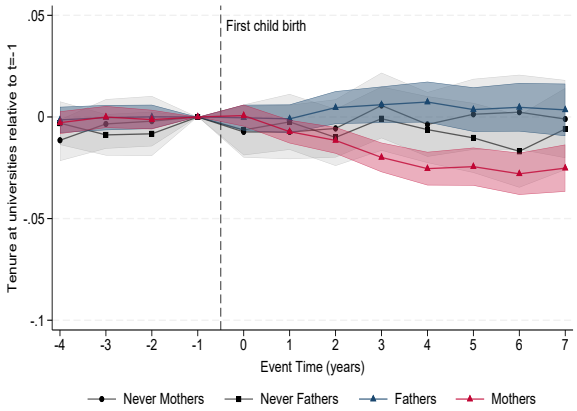
Notes: The figures plot the gender-specific impacts of children P_t^m and P_t^w across event time. Outcomes shown at event time t are relative to the year before the first childbirth $t = -1$. The estimations include fixed effects for age, year, and years since PhD start relative to the event year. Panel A plots the effect on the extensive margin of publication, Panel B plots the effect on labor market earnings, and Panel C shows the effect on participation rates. Panel D shows the impact of having any research job - university or the broader research sector. Panel E plots the effect of labor supply at universities, at part-time work defined from mandatory pension contributions. Panel F shows the impact on residing in Denmark.

FIGURE A5: Impact of Children: Robustness Empirical Analysis

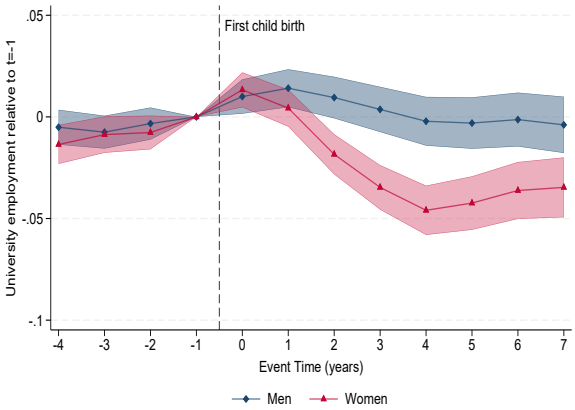
(a) Uni. Employment (Inc. Never Parents)



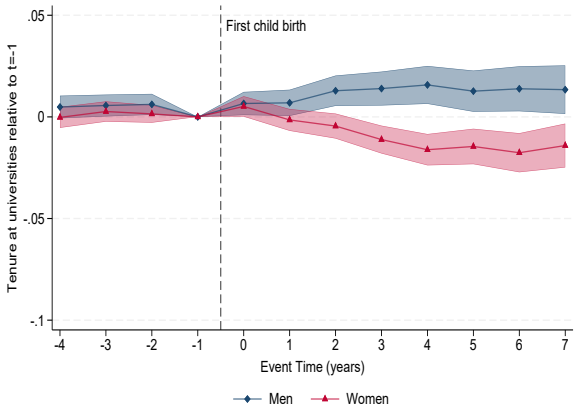
(b) Tenure (Inc. Never Parents)



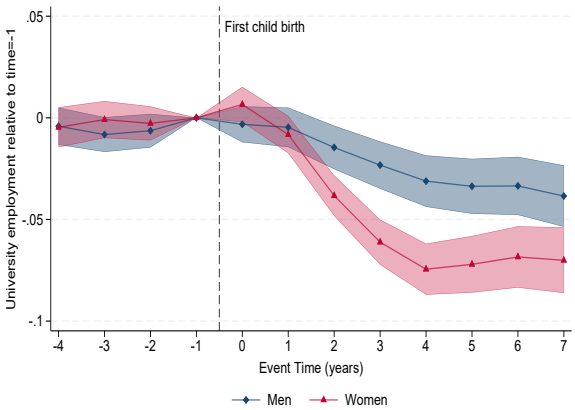
(c) Uni. Employment (S&A Never Parents)



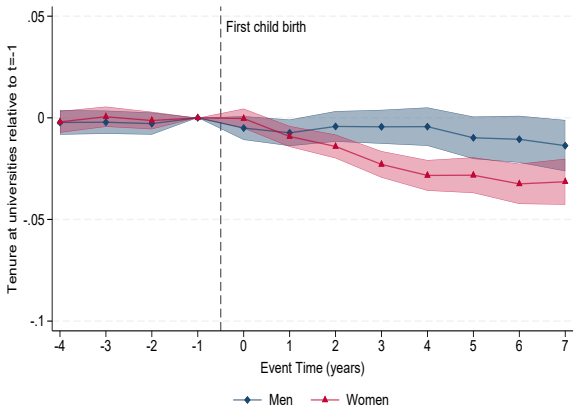
(d) Tenure (S&A Never Parents)



(e) Uni. Employment (S&A Not-Yet Parents)



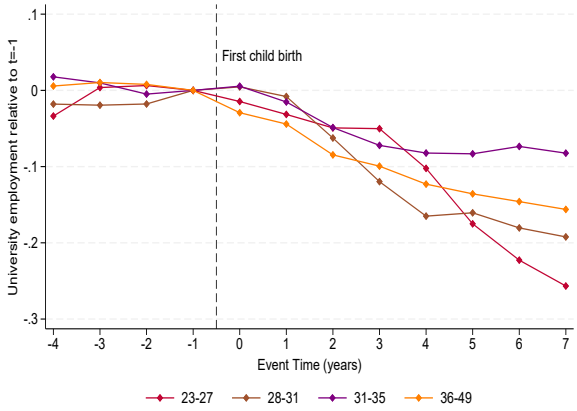
(f) Tenure (S&A Not-Yet Parents)



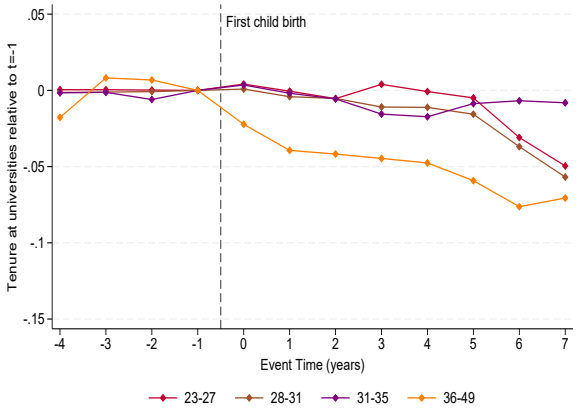
Notes: The figures plot the gender specific event study estimates of having a first child across event time. Panel A and Panel B use the specification in Equation 1, but include the never-parents as described in Section A.2. Panels C, D, E and F plot the estimates from the Sun & Abraham (2021) IW estimator with two different control groups: never-parents (Panels C and D) and not-yet-treated parents (Panels E and F) described in Section A.2. Outcomes shown at event time t are relative to the year before the first childbirth $t = -1$. The figure includes 95% confidence intervals around the coefficients. The estimations include fixed effects for age, year, and years since PhD start relative to event.

FIGURE A6: Impact of Children: Robustness Empirical Analysis (II)

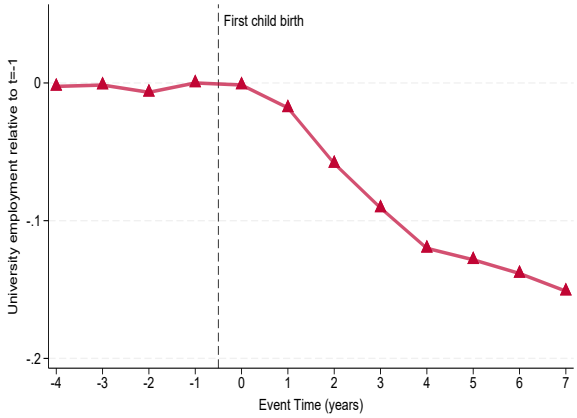
(a) Uni. Employment: Age Cohorts



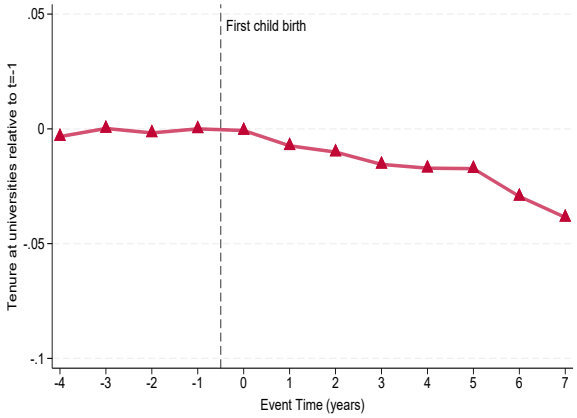
(b) Tenure: Age Cohorts



(c) Uni. Employment (Age-Weighted ATT)



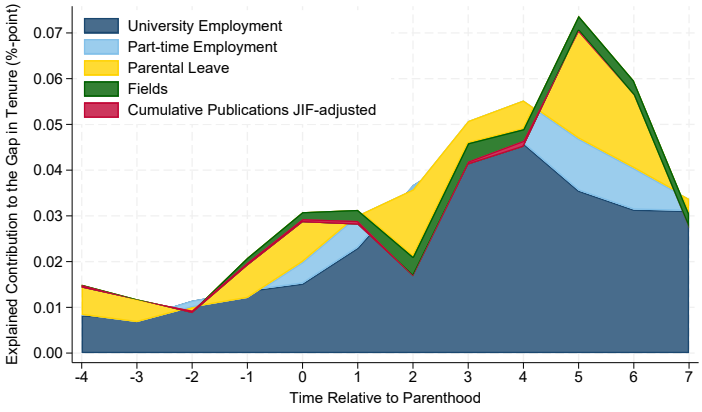
(d) Tenure (Age-Weighted ATT)



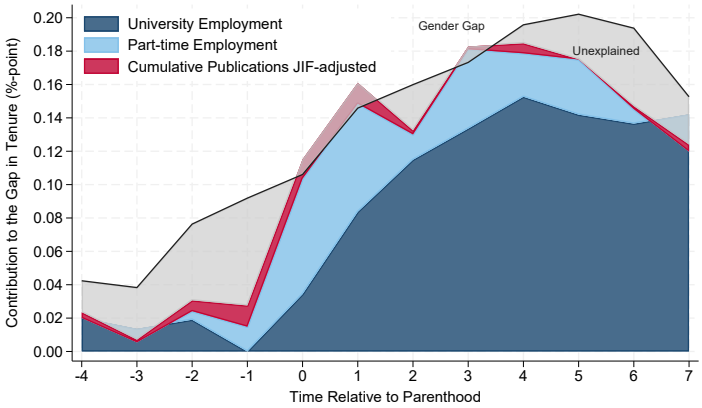
Notes: The figures plot the event study estimates of having a first child across event time for mothers. Panels A and B plot the estimates from the Sun & Abraham (2021) IW estimator with the not-yet-treated control group across four age cohorts, described in A.2. Panels C and D plot the weighted average of the age-at-birth-specific estimates. Outcomes shown at event time t are relative to the year before the first childbirth $t = -1$. The estimations include fixed effects for age, year, and years since PhD start relative to event.

FIGURE A7: Decomposition: Additional Results

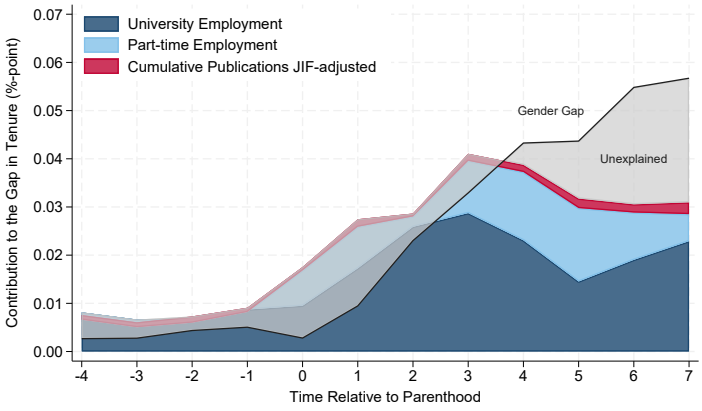
(a) Additional Covariates



(b) Tenure, Conditional on Employment

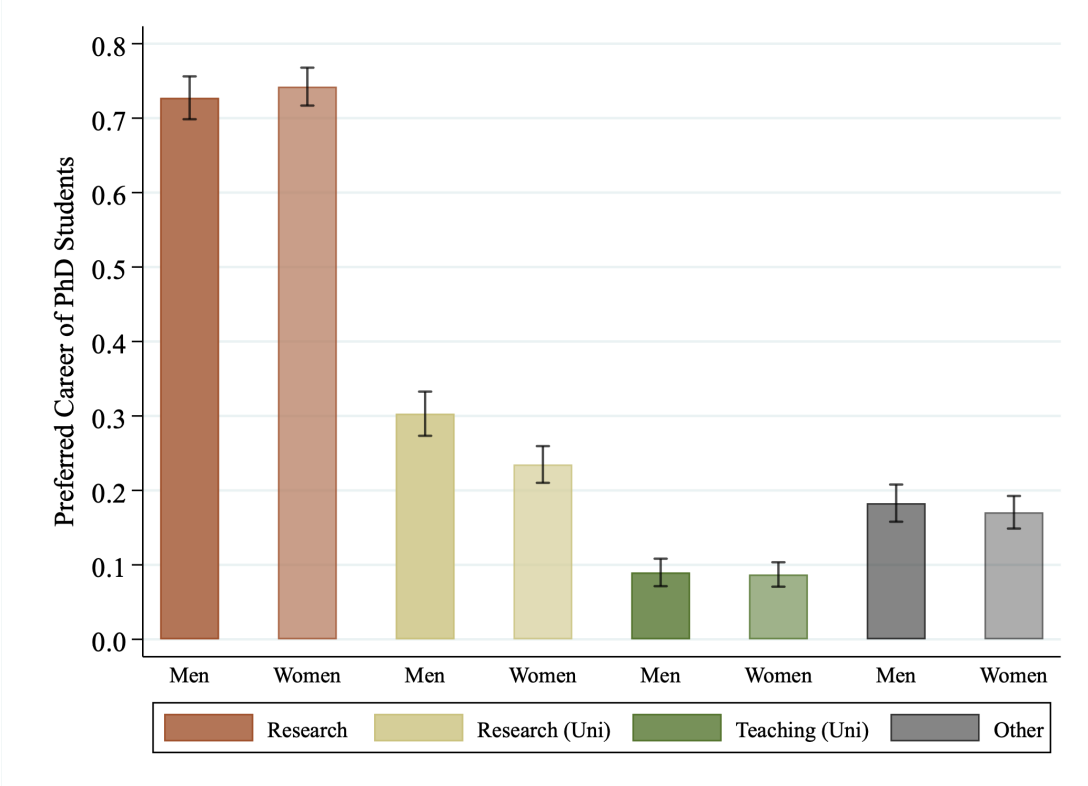


(c) Science Fields



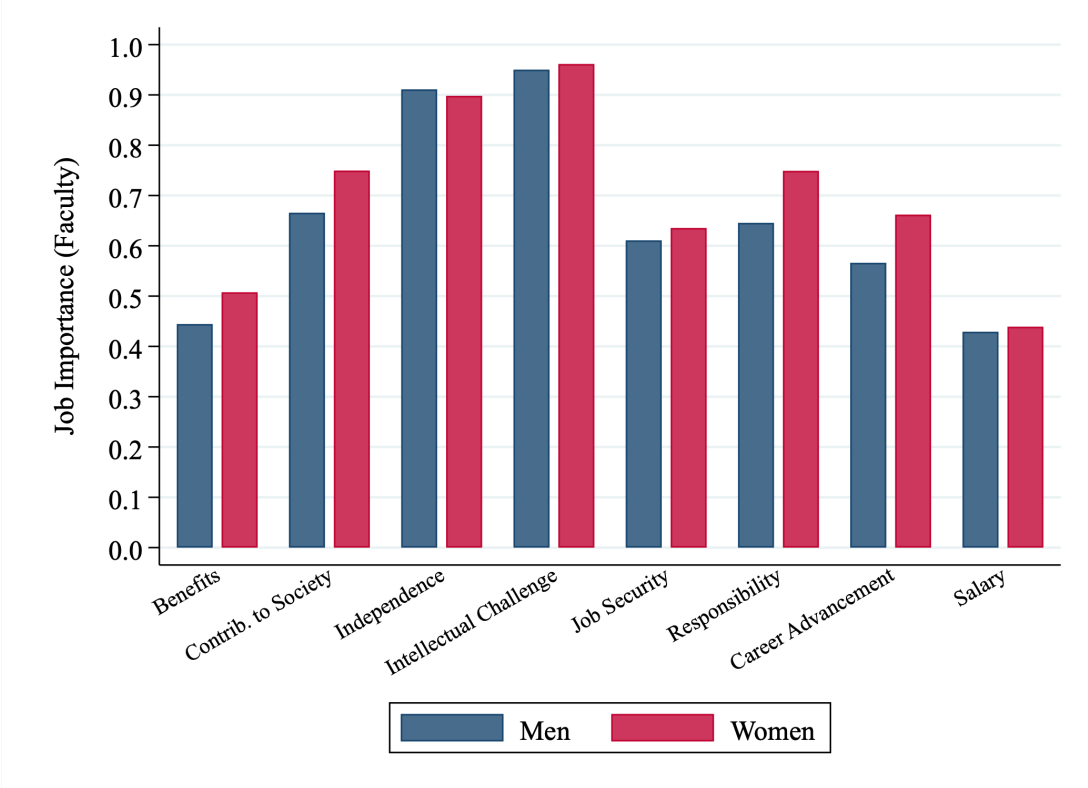
Notes: The solid black line in the figures depicts the residualised gap in tenure rates, adjusted for age, calendar year, and PhD-age fixed effects, for years 4 to 7 around parenthood. The shaded areas depict the explained contributions from university employment (navy blue), part-time university employment (light blue), and publications, JIF adjusted (red). In Panel (a), we add fields (green) and parental leave duration (yellow). The unexplained component, shaded in gray, equals the vertical distance between the stacked areas and the solid black line. When the gray area is above the black line, the observables overexplain the gap (a negative unexplained contribution). The gray area below the line indicates positive unexplained contribution.

FIGURE A8: Survey Evidence: Preferred Career of PhD Students



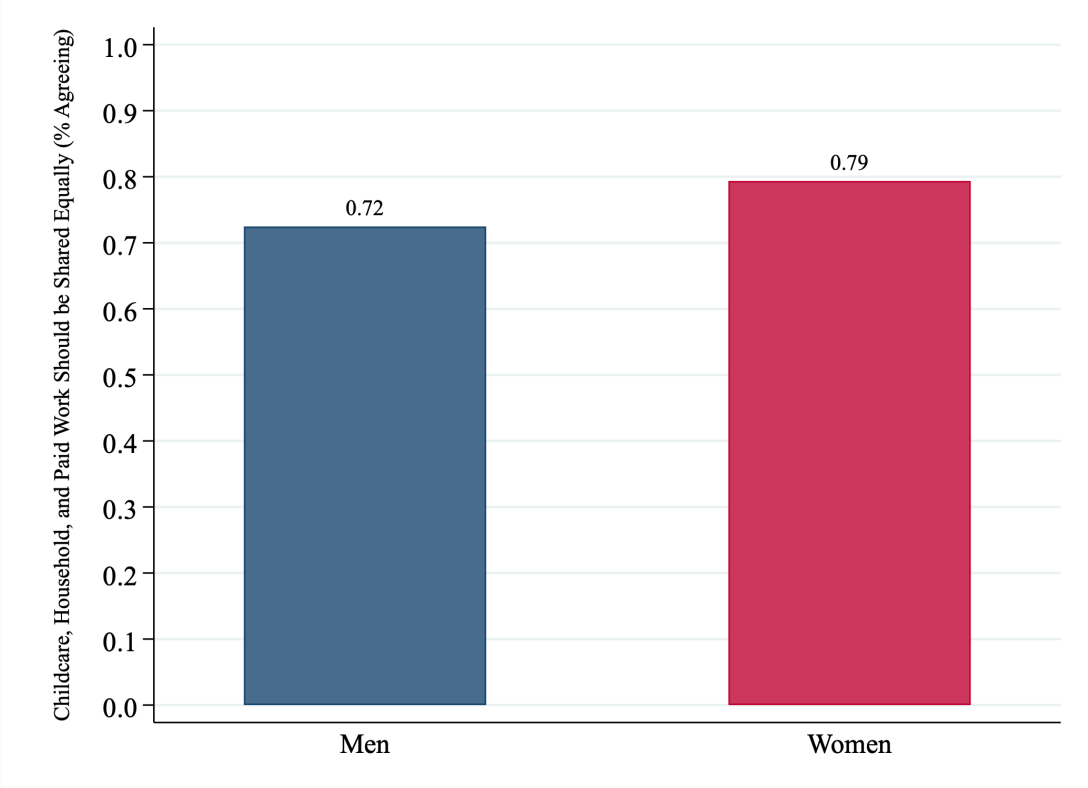
Notes: The figure plots the answers to the question "Assuming that you had the choice, which of the following careers would you prefer most?". It is based on 2000 responses of 2500 surveyed PhD students. The answer "Research" aggregates four responses that include working in research at universities, established companies, start-up companies, and the public sector. The answer "Research (Uni)" displays the share of individuals who answered they would prefer to do research exclusively at universities, while "Teaching (Uni)" displays the share of individuals who answered they would prefer to hold a teaching-focused job at universities.

FIGURE A9: Survey Evidence: Job Importance



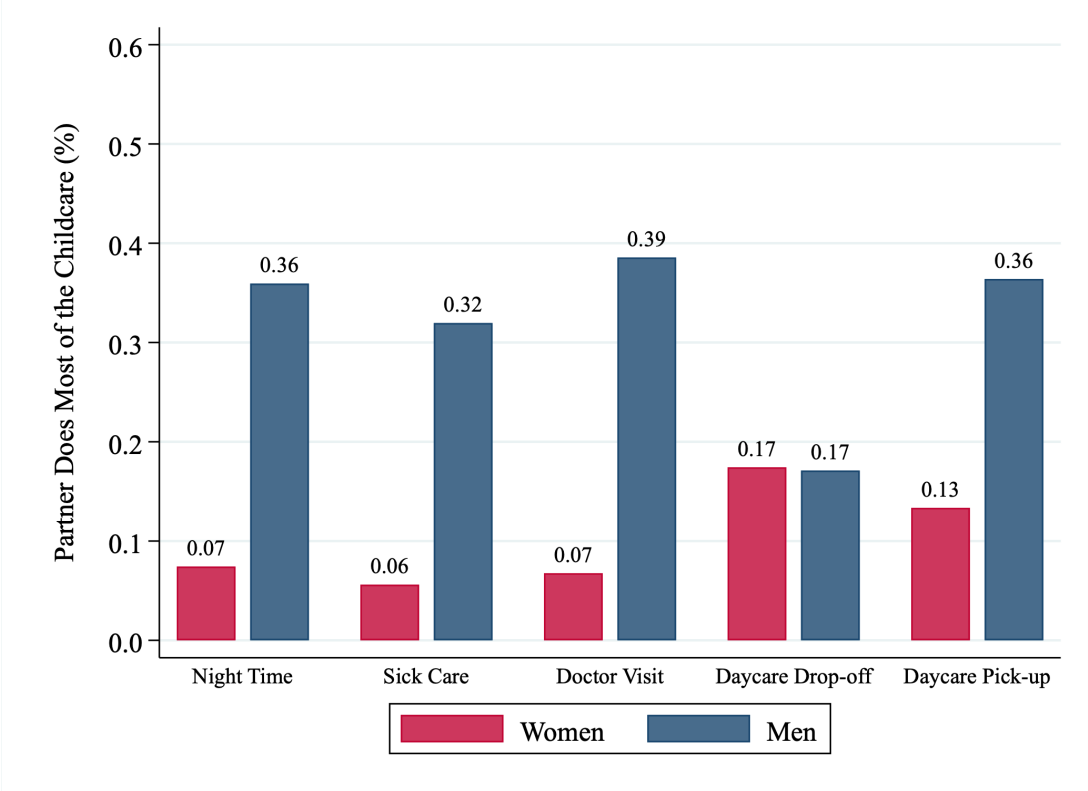
Notes: The figure plots the answers to the question "When thinking about your job as an academic, how important is each of the following factors to you?". It is based on 3300 responses from academic faculty. Answers that include "Crucial", "Important", "Somewhat important" are classified as important.

FIGURE A10: Survey Evidence: Beliefs on Shared Childcare, Household and Paid Work



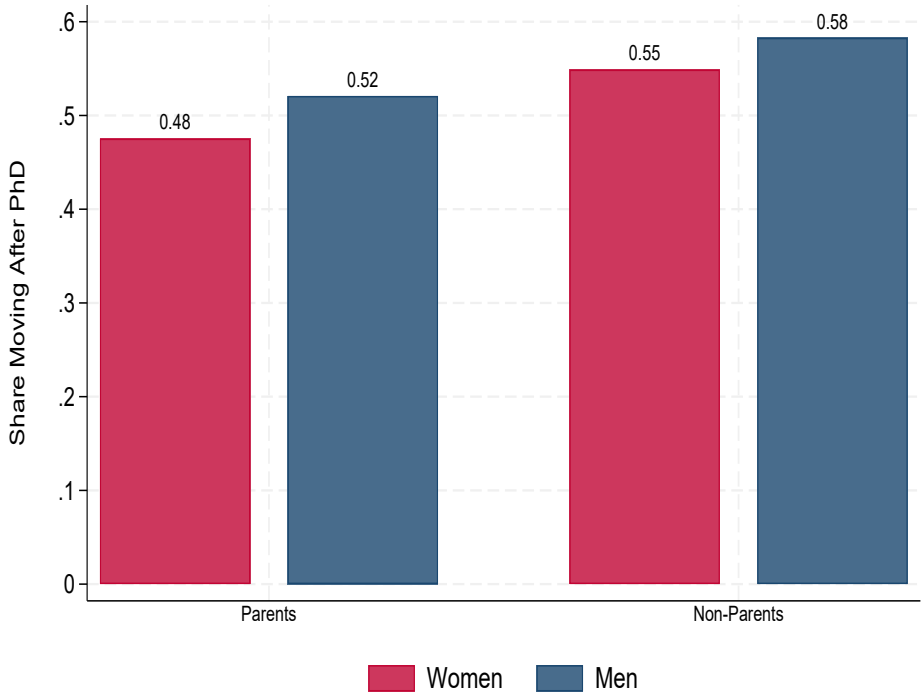
Notes: The figure plots the answers "Strongly Agree" and "Agree" with the statement "Families usually function best if partners share childcare, household work and paid work tasks equally". It is based on 3400 answers.

FIGURE A11: Survey Evidence: Childcare Split (Partner)



Notes: The figure plots the share of individuals who replied "Always my partner" or "Mostly my partner" to the question "In your household, when your youngest child was not yet of school age, who performed the following tasks?" across the following categories: getting up at night to take care of the child, taking care of the child when they were sick, taking the child to the doctor, taking the child to paid care and picking up the child from paid care. It is based on 1100 responses.

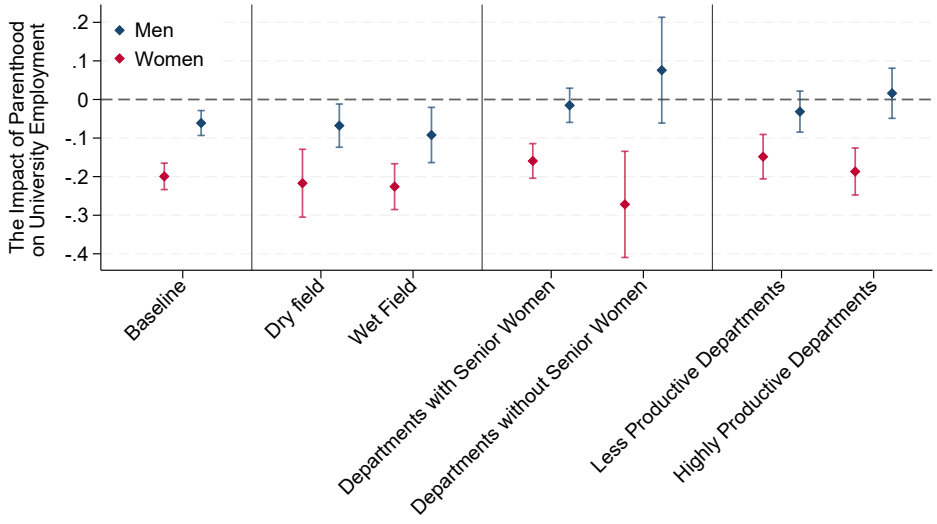
FIGURE A12: Mobility Patterns Among Parents and Non-Parents



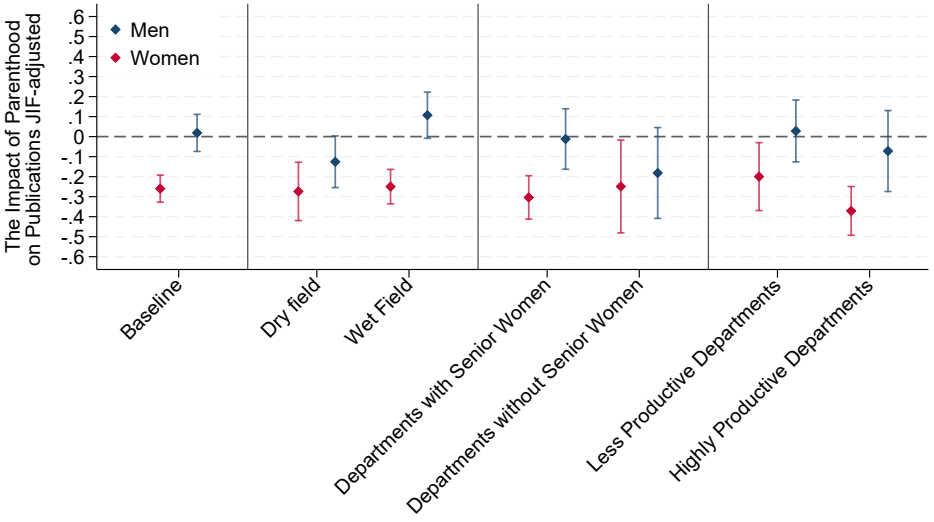
Notes: This graph shows the share of individuals whose residential region in the second year of the PhD and five years after completion are different. There are 8 regions in Denmark. Individuals who move abroad are also included and considered movers.

FIGURE A13: Child Penalties on Employment and Productivity: Work Environment

(a) University Employment



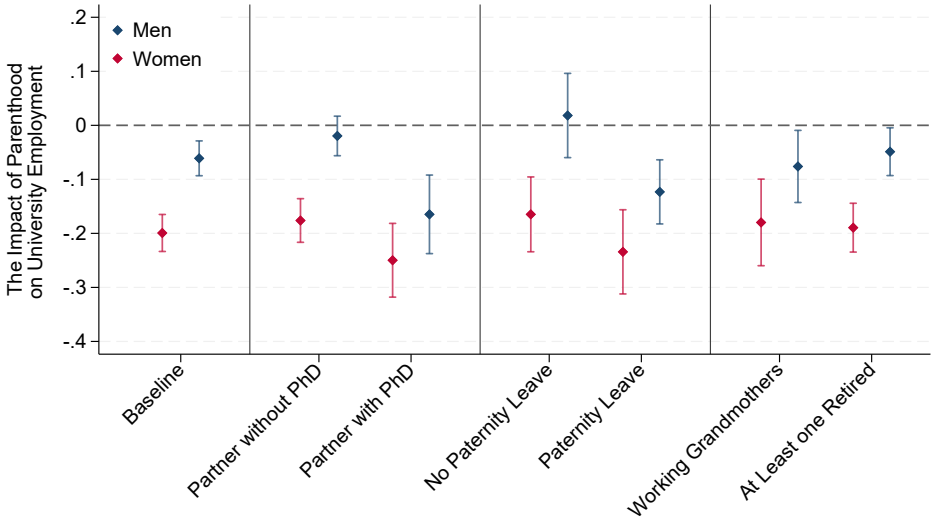
(b) Annual Publications



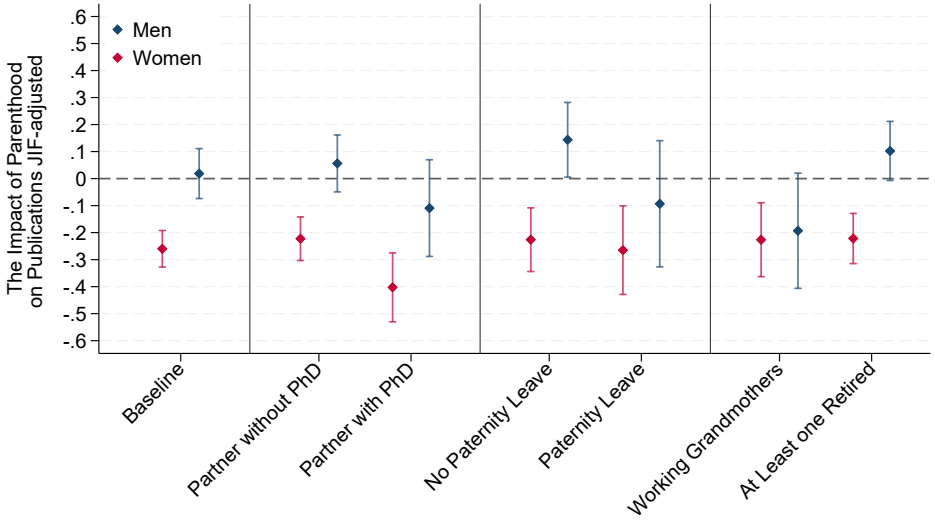
Notes: This graph reports the gender specific impact of children, estimated jointly for $t > 0$. Men and women are estimated separately, and the estimation includes fixed effects for age, year, and years since PhD start relative to parenthood. See the main text for definitions of fields and departments.

FIGURE A14: Child Penalties on Employment and Productivity: Family Environment

(a) University Employment



(b) Annual Publications



Notes: This graph reports the gender specific impact of children, estimated jointly for $t > 0$. Men and women are estimated separately, and the estimation includes fixed effects for age, year, and years since PhD start relative to parenthood. See the main text for definitions of different family environments.

A.4 Tables

TABLE A1: Summary Statistics

	All	Women	Men	Estimating Sample	Mothers	Fathers
Female	0.47	1.00	0.00	0.46	1.00	0.00
	(0.50)	(0.00)	(0.00)	(0.50)	(0.00)	(0.00)
Age at Enrollment	29.80	30.63	29.03	27.35	27.56	27.17
	(5.77)	(6.07)	(5.36)	(2.77)	(2.68)	(2.84)
Year of PhD Start	2008.51	2008.93	2008.15	2007.03	2007.72	2006.45
	(5.98)	(5.82)	(6.10)	(5.72)	(5.59)	(5.76)
Fertility						
Age at First Child	31.17	30.77	31.55	32.58	32.30	32.83
	(4.15)	(4.01)	(4.25)	(3.72)	(3.48)	(3.89)
First Child During PhD	0.19	0.21	0.17	0.49	0.57	0.43
	(0.39)	(0.41)	(0.37)	(0.50)	(0.50)	(0.50)
First Child After PhD	0.51	0.44	0.57	0.51	0.43	0.57
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Parental Leave (weeks)	17.26	28.76	6.14	19.86	34.44	7.69
	(17.21)	(17.01)	(7.13)	(16.65)	(12.55)	(7.19)
Education Fields						
Medical Master's	0.19	0.24	0.14	0.15	0.20	0.11
	(0.39)	(0.43)	(0.34)	(0.36)	(0.40)	(0.32)
Social Science Master's	0.10	0.11	0.09	0.10	0.11	0.10
	(0.30)	(0.31)	(0.29)	(0.30)	(0.31)	(0.30)
Humanities Master's	0.10	0.11	0.08	0.07	0.08	0.07
	(0.30)	(0.32)	(0.28)	(0.26)	(0.28)	(0.25)
Unknown Master's	0.22	0.19	0.24	0.14	0.14	0.14
	(0.41)	(0.40)	(0.43)	(0.35)	(0.34)	(0.35)
STEM Master's	0.40	0.34	0.45	0.53	0.47	0.58
	(0.49)	(0.47)	(0.50)	(0.50)	(0.50)	(0.49)
Within STEM: Wet Master's	0.19	0.23	0.15	0.25	0.33	0.19
	(0.39)	(0.42)	(0.36)	(0.43)	(0.47)	(0.39)
Within STEM: Dry Master's	0.21	0.11	0.29	0.28	0.15	0.39
	(0.40)	(0.31)	(0.46)	(0.45)	(0.36)	(0.49)
Ever Employed at Uni	0.38	0.37	0.38	0.40	0.38	0.42
	(0.48)	(0.48)	(0.49)	(0.49)	(0.49)	(0.49)
Ever Tenured at Uni	0.18	0.16	0.20	0.23	0.19	0.26
	(0.39)	(0.37)	(0.40)	(0.42)	(0.39)	(0.44)
Publications						
Share Publishing	0.45	0.44	0.47	0.52	0.49	0.54
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Number of Publications	15.24	11.11	18.65	16.14	11.28	19.91
	(28.83)	(18.85)	(34.63)	(32.57)	(21.63)	(38.57)
N	35902	16766	19136	13347	6111	7236

TABLE A2: Fertility Rates of Men and Women within and outside Academia

	Age at parenthood	At least one child			Number of children		
		5 years	10 years	15 years	5 years	10 years	15 years
Panel A: Women							
University	29.79	0.66	0.83	0.87	0.92	1.44	1.55
	(4.25)	(0.47)	(0.38)	(0.33)	(0.80)	(0.87)	(0.92)
N		1578	1193	811	1578	917	465
Broader Research	30.45	0.67	0.83	0.87	0.93	1.51	1.70
	(3.99)	(0.47)	(0.38)	(0.34)	(0.79)	(0.92)	(0.95)
N		449	407	299	449	324	213
Other Sectors	29.88	0.65	0.78	0.83	0.89	1.38	1.55
	(4.05)	(0.48)	(0.41)	(0.38)	(0.79)	(0.96)	(1.00)
N		14739	9607	4823	14739	5591	2651
Panel B: Men							
University	30.87	0.57	0.78	0.85	0.80	1.41	1.74
	(4.71)	(0.50)	(0.41)	(0.36)	(0.82)	(0.97)	(1.02)
N		2028	1700	1205	2028	1323	745
Broader Research	30.91	0.58	0.78	0.86	0.84	1.43	1.72
	(4.74)	(0.49)	(0.42)	(0.35)	(0.83)	(0.99)	(0.99)
N		582	551	408	582	434	312
Other Sectors	30.69	0.53	0.70	0.77	0.76	1.30	1.54
	(4.31)	(0.50)	(0.46)	(0.42)	(0.84)	(1.03)	(1.11)
N		16526	11224	6215	16526	7091	3778

Notes: This table reports the share of individuals who are parents and the mean number of children (reported below are the standard deviations in parentheses and number of observations for each cell), measured relative to PhD enrollment (in Denmark) among those who enrolled in 1996 or later. We report fertility at five, ten, and fifteen years after PhD enrollment, split by employment in universities, the broader research sector, or outside research. As our sample covers individuals enrolled up until 2019, the longer time horizon implies fewer observations.