The Careers of Women Inventors*

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August 2025

[Preliminary. Please do not circulate.]

Abstract

We examine the careers of female inventors in Germany using unique data that link patent records to social security information. Our analysis reveals substantial gender gaps in patenting outcomes, wages, earnings, labor force participation, and the likelihood of holding managerial positions. Although male and female inventors follow similar early-career trajectories, women are more likely to stop patenting over time and tend to earn lower wages. Industry, occupation and patenting classes at the time of patenting do not account for these disparities. Exploiting within-firm comparisons of inventors listed on the same first patent, we show that female inventors experience systematically slower wage growth after their first patent application. The persistence of significant gaps among female inventors without children indicates that parenthood, while important, does not fully account for the observed disparities.

*We thank Eric Bettinger, David Card, Gaia Dossi, Lee Fleming, Stefano Gagliarducci, Pat Kline, Attila Lindner, Timea Molnar, Emily Nix, Carolyn Stein, Adam Szeidl, Emma Tominey, Fabian Waldinger, Andrea Weber, Bruce Weinberg and Alice Wu and seminar participants at UC Berkeley, Central European University, CEP-LSE Conference, COPE Zurich, EALE, EEA, the NOeG and SOLE Annual Conferences for helpful comments and discussions.

1 Introduction

Despite significant progress in reducing gender disparities across various professions over the past decades, substantial and persistent gaps remain (Olivetti et al., 2024). These disparities are especially pronounced in areas of innovation, research and development (Bell et al., 2019; Kim and Moser, 2021; Lubczyk and Moser, 2024). Data from OECD shows that the share of women inventors is low in high-innovation countries (Figure 1),[1] ranging between 5 to 14 percent, with a share of 6 percent in Germany. Pronounced gender imbalances in innovation reflect an inefficient allocation of talent (Hsieh et al., 2019; Brouillette, 2025) and are likely to have significant repercussions for economic growth and the direction of innovation (Einiö et al., 2019; Koning et al., 2021). In this paper, we examine the career trajectories of female inventors, show how their careers differ from those of male inventors, and investigate the underlying factors for the observed gaps.

Using administrative datasets that merge social security details with patent records, encompassing about 70 percent of all German DOCDB patent families, we uncover a number of findings.

A main contribution of our paper is to reveal significant gender gaps in patenting and labour market outcomes in the life cycles of inventor careers. Notably, the career trajectories of male and female inventors in terms of patenting likelihood follow a similar pattern until the age of 30, after which they diverge significantly. Male inventors reach the peak of their inventing productivity in their 40s, while for female inventors, the sharp drop-off at age 35 could prevent them from reaching their highest potential. Gaps are also apparent in wages, earnings, participation and in taking up managerial positions over the life cycle. Female inventors earn 16 to 32 percent less in daily gross wages compared to male inventors. Among female inventors, those without children have approximately 22 percent higher earnings. Although male and female inventors have similar patenting trajectories before the first patent application, women stop patenting more frequently than men. Compared to men, women inventors are significantly more likely to switch out of the occupation, the firm and the industry that they first patented in. While the gender gaps between male and female inventors largely expand during child-bearing years, we show that they are not driven by child penalties, nor by gender norms. Instead, child penalties are more relevant for explaining the differences between women inventors with children and those without children.

To understand whether men and women benefit similarly from patenting we leverage our comprehensive dataset to analyze the returns to the first patent application. We focus on inventors of both genders who were employed at the same firm and listed on the same initial patent. We estimate a difference-in-differences event study design, defining male inventors as the control group and female inventors as the treated group. This

[1] Defined as countries with 1 or more patents per 1 million inhabitants

approach compares out- comes around the first patent application while conditioning on inventors being at the same career stage (their first patent), employed by the same firm, and inventors on the same patent. While both male and female inventors experience wage gains following their first patent, the increase is significantly smaller for female inventors. This disparity is not fully accounted for by the arrival of children, as even female inventors without children exhibit lower wage growth than their male counterparts. The fact that gender gaps persist in such tightly controlled comparisons underscores the possibility of differential recognition or reward for women's innovative contributions

Although parenthood does not fully account for the gender gap relative to male inventors, it plays a significant role in worsening the career trajectories of female inventors with children. In the final part of the paper, we formally estimate the child penalty for female inventors with children. Following the birth of their first child, the likelihood of female inventors of filing for a patent drops by 28 percent. This decline is also mirrored in their log annual earnings, showing a decrease of 7.5 percent following the birth of a first child. Moreover, this reduction is stable within five years of childbirth. To investigate regional differences and potentially gender norms, we analyze the career trajectories of male and female inventors in East and West Germany. In the East, a former state socialist country with progressive gender norms, mothers were strongly encouraged to participate full-time in the labor market (Boelmann et al., 2021). Consistent with progressive gender norms, there is minimal child penalty between mothers and non-mothers inventors in East Germany. However, the gap with men in patenting and career advancement persists at a similar magnitude in both regions, suggesting that factors beyond gender norms contribute to these disparities.

This paper contributes to multiple strands of literature, particularly on gender gaps in the labor market. Economic research has long sought to uncover the underlying causes of these disparities (Olivetti et al., 2024). We extend this literature by focusing on an understudied group–female inventors–contributing to the growing body of research on gender gaps in science and innovation (Bell et al., 2019; Kline et al., 2019; Kim and Moser, 2021; Iaria et al., 2022; Akcigit and Goldschlag, 2023; Hochberg et al., 2023; Lubczyk and Moser, 2024). To study female inventors, we leverage unique data that, for the first time to our knowledge, not only include patent information but also provide a comprehensive view of inventors' careers from labor market entry onward. This dataset offers yearly information on wages, employment, industry, occupation, firm affiliation, and maternity leave status, allowing us to analyze gender disparities with unprecedented detail. Our life cycle analyses rule out industry and occupation at time of patenting (Blau and Kahn, 2017) as primary drivers of gender disparities in employment, wages, and innovation, contrasting with recent findings for U.S. female scientists (Lubczyk and Moser, 2024).

Our returns to the first patent analysis reveals slower wage growth after the first patenting application for female inventors, employed at the same firm and listed on the

same first patent as male inventors. The persistence of significant gaps among female inventors without children suggests mechanisms beyond parenthood, such as employer expectations regarding future fertility or gender-based discrimination.

We also formally investigate the role of children, a key factor in slowing women's career progression (Kleven et al., 2019a,b), in shaping gender gaps among inventors.[2] However, our findings suggest that the child penalty does not drive gender disparities among inventors, in contrast to recent evidence for US female scientists (Kim and Moser, 2021). By studying inventors in East Germany, our results indicate that gender norms are not a primary driver of the observed gender gaps among inventors, contrary to gaps in some contexts for non-inventors (Fernández, 2013; Boelmann et al., 2021). Finally, we contribute to the literature on talent allocation, showing that women remain severely underrepresented as inventors in Germany. This misallocation of talent is likely to have significant economic consequences in terms of equity, growth, and productivity (Hsieh et al., 2019; Brouillette, 2025; Lubczyk and Moser, 2024).

2 Data

We use the Linked Inventor Biography Data (INV-BIO ADIAB) that was created in a joint effort by the Institute for Employment Research (IAB), the Max Planck Institute, and the University of Mannheim (see Dorner et al. (2019) for more detailed information about the data construction). The data set combines information from patent filings of the PATSTAT data provided by the European Patent Office (EPO) with social security information from the Integrated Employment Biographies (IEB) provided by the German Federal Employment Agency (BA).

The PATSTAT data database provides comprehensive worldwide bibliographical and legal information on patent applications and granted publications. It covers more than 100 million patents and 200 million legal status records from over 90 patent offices. The dataset includes details such as the names and addresses of inventors and patent holders, application and publication dates, backward and forward citations, and the technological domains of the inventions.

The INV-BIO ADIAB organizes patent data at the level of DOCDB patent families, which group together applications and publications related to the same technological innovation across different jurisdictions and over time (see Martinez (2010) for more details about patent families). The PATSTAT dataset is merged to social security records from the IEB using inventors' names and addresses. The resulting INV-BIO ADIAB data identifies 152,350 unique inventors who filed at least one patent application between 1999 and 2011. In addition, this dataset tracks the employment and patenting histories of these

[2]Maternity leave can indeed lead to skill depreciation (Adda et al., 2017), and women often work fewer hours after returning to the workforce (e.g., Bertrand et al., 2010; Kleven et al., 2019b).

inventors over the period 1980-2014.[3]

The IEB social security records cover the entire population of individuals registered in the German social security system from 1980 to 2014. These includes all employees subject to social security contributions as well as recipients of unemployment benefits, but exclude students, military personnel, civil servants, and the self-employed.[4] Individuals exit the dataset if they emigrate or die. The data provides detailed information on earnings, wages, unemployment benefits, occupations, and a wide range of individual labor market characteristics. Unique personal and establishment identifiers enable the longitudinal tracking of both workers and firms. We link these data to the Establishment History Panel (BHP), which reports firm-level information–such as firm size, median wage and industry–for all German establishments employing at least one worker subject to social security contributions as of June 30^{th} of each year.

Because civil servants and self-employed workers are not subject to social security contributions in Germany, our dataset does not capture the entire population of German inventors. For instance, publicly employed professors and private firm owners who are listed as inventors on patents remain unobserved. Nevertheless, between 1999 and 2011 our data cover approximately 70 percent of all German DOCDB patent families.[5] recorded in PATSTAT. In total, our dataset comprises 2,918,593 observations of 152,320 unique inventors, of whom 140,688 are men and 11,632 (7.6%) are women.

Finally, we draw on the German Sample of Integrated Labour Market Biographies (SIAB)–a two percent sample of the IEB provided by the Institute for Employment Research–to create a comparison group of non-inventors employed in comparable sectors and occupations (see Antoni et al. (2016) for more details about the data).

2.1 Patenting Information

The patent data provide extensive information on patent applications and granted publications. Following the common approach in the literature, we backdate all patent information to the earliest application date within a patent family—including the information of granted patents. The earliest application date is closest to the actual invention process and thus offers the most accurate reference point for assessing how workers and firms contribute to innovation.

Based on these data, we construct five sets of variables to measure the quantity and quality of patents.

[3]Although the dataset includes only inventors who applied for at least one patent between 1999 and 2011, it also allows us to trace their employment histories and patenting applications before 1999 and after 2011.

[4]Self-employed individuals are observed if they pay themselves a wage. Since this practice offers tax advantages for many small businesses, the data likely captures a substantial share of the self-employed.

[5]German patent families are defined as those including at least one inventor whose workplace is located in Germany.

Patent quantity. We create a variable that counts the number of weighted inventor patent applications per year. Specifically, the variable only counts the earliest application for each patent family according to the DOCDB classification, and weights this count by the inverse of the number of inventors within the patent family. We use 10-year forward citations of patent families to assess the patent quality. We distinguish between citations received from patents filed at the German patent office, the European patent office, the US patent office, and all other patent offices. To mitigate the influence of extreme values,, all citation variables are capped at the 99th-percentile of citations.

Patent generality and originality. We create a variable measuring the generality and originality of patents. Our generality index reflects the number and distribution of forward citations across 34 IPC classes, following Trajtenberg et al. (1997). Formally, generality is defined as $1 - \sum_j S_{pf}^2$, where S_{pj} is the share of forward citations to patent p from IPC technology class j. The originality index is constructed analogously, but based on backward rather than forward citations. Higher values of either index indicate more radical innovations.

Technology classes. We classify patents into broad technology classes. The INV-BIO dataset uses a slightly modified version of the WIPO classification (Schmoch and Schubert, 2008), which originally includes 35 technology areas, though classes 21 (surface technology) and 22 (nanotechnology) are merged. For the purpose of our study, we focus on five broader categories that are most relevant to German inventors: electrical engineering, instruments, chemistry, mechanical engineering, and other.

Inventor team characteristics. Finally, we construct variables capturing inventor teams. These include the number of inventors in the team, the share of women inventors and share of foreign applicants.

2.2 Labor Market Characteristics

Our main labor market outcomes are monetary measures—i.e., daily wages and annual earnings—and non-monetary outcomes—annual days receiving unemployment benefits, annual employment days, and full-time work. All monetary outcomes are expressed in 2010 Euros. We exclude a small number of observations with earnings below the social security thresholds, as these likely reflect erroneous data entries. Daily wages are measured on June 30^{th} of each year to align individual level data from the IEB with firm level data from the BHP. Annual earnings measure the sum of wages from all employment spells in a given year and are set to 0 if a worker is not observed in the data anymore.[6] In addition to our primary outcome variables, the dataset includes information on workers'

[6]Some monetary outcomes contain missing values, as workers exit the social security system when they fully leave the labor market, engage in studies, perform compulsory military service, or become civil servants. Following standard practice in the literature, we treat these missing values as non-employment and assign them a value of zero.

occupation, education, age, gender, experience, tenure, and other relevant labor market characteristics.

Although the employment and earnings data are highly reliable, as they are collected for social security purposes, the data has three minor limitations. First, the education variable is sometimes inconsistent or missing.[7] We address this by applying the imputation procedure of Fitzenberger et al. (2006), following standard practice (e.g., Dustmann et al., 2009).[8]

Second, earnings are top-coded at the annual German social security contribution ceiling, affecting approximately 10 percent of workers. To impute the missing upper tail of the wage distribution, we follow the standard approach in the literature (e.g., Card et al., 2013) and apply a two-stage stochastic imputation procedure.[9]

Third, the data lack household information for employed workers, including direct information on childbirth.[10] Because fertility likely affects women's labour market and patenting decisions, we overcome this limitation by applying the approach by Müller et al. (2022) and use maternity leave information to approximate women's fertility. In Germany, maternity leave is mandatory and generally leads to a social security entry, allowing accurate identification of births (Schönberg (2009)). Women are classified as having given birth if they take maternity leave and do not return to work before the 97-day mandatory period ends. The expected delivery date is calculated by adding 42 days to the last employment date before maternity leave, reflecting the six-week pre-birth period. Since paternity leave is neither mandatory for men nor typically long in duration, accurately identifying the timing of fatherhood is difficult; consequently, we cannot determine the birth dates of children for men.

2.3 Descriptive Evidence

This section provides a descriptive overview of the characteristics of female inventors, with a focus on patenting activity, labor market outcomes, and initial firm and team characteristics. An inventor is defined as an individual with at least one patent granted between 1999 and 2011. We compare female inventors to male inventors and, to explore

[7]Because the BA does not require this information for administrative purposes, it is recorded with lower quality than employment and earnings data.

[8]Specifically, we perform the imputation in the style of the IP1 procedure described in Fitzenberger et al. (2006). For individuals observed in multiple spells, we assign all observations to the highest education category and forward-extrapolate it over time. Missing values are backdated to the typical age at which the degree is obtained.

[9]In the first stage, Tobit models are estimated for each year and education group. In the second stage, censored observations are imputed using the first-stage estimates plus a random draw from the associated left-censored distribution. Control variables include gender, age, age^2, a dummy for older individuals, tenure, and tenure squared. A second round of imputation incorporates each worker's average log wage in other periods and the average annual wage of co-workers (leave-out means). If a worker is observed only once, the sample mean is used with an indicator variable; similarly, if a worker is the sole employee in a firm, the co-worker wage is set to the sample mean with an indicator.

[10]Household data exist for unemployed workers due to unemployment benefit calculations.

the role of motherhood, distinguish between female inventors with children and those without.[11]

Table 1 presents descriptive statistics on patenting outcomes. Female inventors, whether mothers or not, file on average between 2 and 3 patent applications over their lifetime, with roughly 1 patent granted.[12] By comparison, male inventors submit 3 to 4 applications on average, of which 1 to 2 are granted. In a given year, the probability of submitting a patent application is 0.15 for female inventors and 0.19 for male inventors, while the probability of obtaining a granted patent is 0.07 for female inventors and 0.09 for male inventors. Patents from male and female inventors have nearly identical originality (0.06 vs. 0.05) and identical generality scores (0.04). However, male inventors' patents tend to receive more citations (2.97 on average, compared to 2.6 for female inventors). For a subset of inventors, we also observe the composition of their first patent teams. Female inventors are more likely to work in larger teams and in more internationally diverse groups than male inventors. The timing of entry into patenting differs slightly between female inventors with and without children: those with children file their first application at around age 34, compared with age 35 for female inventors without children and men. Beyond this small timing difference, female inventors with and without children display broadly similar outcomes in terms of patenting activity and patent success.

Figure 2 shows the distribution of male and female inventors by broad patent classes for their first patent. The figure reveals pronounced gender differences across patent classes. Female inventors are highly concentrated in Chemistry, where they represent more than half of inventors. Male inventors are more evenly distributed, with their largest representation in mechanical engineering and electrical engineering. In contrast, female inventors account for a substantially lower share in electrical engineering and mechanical engineering. The gender gap is less pronounced in instruments and other fields, where female inventors shares are closer to those of male inventors. These patterns highlight the persistence of field-specific gender disparities in inventive activity, further confirmed in Figure 3 which reports the share of female and male inventors by detailed patent classes.

Table 2 reports labor market statistics for male inventors and female inventors, distinguishing between female inventors with and without children. Male inventors have substantially higher average daily wages and annual earnings compared to both groups of female inventors. Among female inventors, those without children earn more (164 euro) than those with children (135 euro), though their earnings remain below those of men. The share of censored wages is higher among male inventors (57 percent) and to a lesser extend among female inventors without children (35 percent) compared to female inventors without children. While labor market participation is nearly universal across

[11]Female inventors with children are defined as those who have at least one child, while those without are women who remain childless throughout the period.

[12]Patent data are observed for the period 1980–2014; additional grants may occur outside this observation window.

all groups, full-time employment rates differ markedly: almost all male inventors work full-time, compared to 64 percent of female inventors without children and 86 percent of female inventors with children. A larger proportion of female inventors (12 percent) are located in East Germany relative to male inventors (only 7 percent). In terms of education, the majority of inventors across all groups hold a university degree, though female inventors more likely to have completed vocational training. Overall, these descriptive statistics highlight notable gender differences in wages, employment patterns, and educational attainment, as well as heterogeneity among female inventors depending on parental status.

As for firm characteristics, female inventors with children work in smaller firms than male inventors (about 190 fewer employees on average) and in firms with lower firm fixed effect, as shown in Table 3. Female inventors are slightly more likely than male inventors to switch their first patent occupation, firm, and sector than male inventors, and this pattern is even stronger for those with children.

3 Career Life Cycles

This section investigates the career trajectories of female and male inventors over their prime labor market life cycles, differentiating female inventors with and without children. Outcomes are plotted for cross-sections and focus on inventors aged 25 to 55.

3.1 Methodology

To analyze gender differences in inventors' career trajectories over the life cycle, we estimate the following regression:

$$Y_{it\tau} = \sum_k \beta_k I[k = age_{it}] + Female_i + \eta_\tau + \eta_\tau \times Female_i + X_i + \nu_{it}, \tag{1}$$

where i refers to inventor, t year, and τ birth cohort. The dependent variable $Y_{it\tau}$ represents the outcome of interest, either a patenting measure—such as the number of patent applications, patent granted, forward citations and the probability of remaining active in patenting—or a labor market outcome–such as the (log) wage or labor market participation.

The term $\sum_k \beta_k I[k = age_{it}]$ captures age-specific effects. The coefficient on $Female_i$ measures the average gender difference in outcomes, while the inclusion of η_τ accounts for cohort fixed effects, such as common shocks or technological environments faced by inventors of the same cohort. To allow for gender-specific cohort dynamics, we include the interaction term $(\eta_\tau \times Female_i)$. Finally, the vector X_i controls for inventor characteristics at the time of first patent application: education, one-digit occupation, two-digit

industry and broad patent classes. Controlling for these variables is essential, as education, occupation and industry have strong effects on wages and because male and female inventors are distributed very differently across the five broad patent classes (see Section 2.3). This specification identifies gender differences by comparing inventors of the same age and cohort, holding constant their initial characteristics at first patenting.

After estimation, we construct adjusted outcomes by removing the effect of X_i and cohort effects. This procedure isolates the unexplained gender component of each outcome. We then compute average residuals by age, gender and family status (for female inventors) and smooth the resulting profiles using locally weighted scatterplot smoothing. The resulting figures show the evolution of career trajectories for male inventors, female inventors with children, and female inventors without children, focusing on ages 25 to 55.

3.2 Results

The career trajectories of inventors over the life cycle reveal significant gender gaps in patenting outcomes. Gaps are also apparent in wages, earnings, participation and in taking up managerial positions—role that is typically highly paid). These gender gaps in outcomes are associated with less frequent patenting by female inventors. Compared to men, female inventors are more likely to exit the occupation, firm and industry in which they first patented. Importantly, these gender gaps do not seem to be fully explained by child-related penalties. Rather, child penalties help account for the differences between female inventors with children and those without. We therefore rule out sorting by industry, occupation and patent class at the time of first patent application as drivers of the gender gaps between male and female inventors. We therefore rule out sorting by industry, occupation, or patent class at the time of the first patent application as an explanation for the gender gaps between male and female inventors.

Likelihood of patenting. Female inventors with and without children patent at similar rates to male inventors up to age 30, as shown in Panel (a) of Figure 4. Patent activity among female inventors (with and without children) peaks around age 35, while male inventors continue to increase their patenting and reach their peak around age 40. After age 35, female inventors' patenting declines, with the sharpest drop observed for female inventors with children. For male inventors the decline begins later, after age 40. Notably, however, for female inventors with children, the likelihood of patenting rises again after age 40, eventually converging with that of female inventors without children.

Similar patterns emerge for the likelihood of patents being granted, as shown in Panel (b) of Figure 4. Strikingly, for women with children, the peak occurs around age 30, and its magnitude is higher than for female inventors without children (and the same as for male inventors). After the peak—around age 35 for female inventors without children and around age 40 for male inventors—the likelihood of obtaining a granted patent declines

for both genders, but the decline is steeper for female inventors than for men. During the childbearing years, female inventors with children have a lower probability of securing patent granted compared to female inventors without children.

As shown in Panel (c) of Figure 4, both male and female inventors have filed approximately two patent applications by age 35. Beyond this age, the cumulative number of applications filed by male inventors rises steeply, reaching about 9 by age 55. In contrast, over the course of their careers, female inventors without children file a total of 7 applications, while those with children file 6.

Finally, Panel (d) of Figure 4 reports citation intensity–the average number of citations within 10 years, weighted by the number of patents. At age 32, female inventors with children exhibit the highest citation intensity relative to both male inventors and female inventors without children. Subsequently, their citation intensity declines sharply, converging to the trajectory of female inventors without children by approximately age 45. Together with the total number of lifetime patent applications, these patterns suggest that observed gender gaps in overall citations are primarily attributable to women producing fewer patents, rather than to systematic differences in the quality or impact of individual patents.

Log wages and log earnings Gender gaps in wages and earnings begin to emerge after age 25 and remain substantial thereafter, as shown in Panels (a) and (b) of Figure 5. For male inventors (and to a lesser extent for female inventors without children), both wages and annual earnings continue to grow steadily through their mid-career years. In contrast, female inventors with children face a sharp decline following the birth of their first child in their mid 30s. After age 45, the child-related gap begins to narrow, and by age 55 female inventors with and without children exhibit similar wage and earnings levels. However, among female inventors without children, earnings start to decline after age 45, a pattern that may reflect declining labor force participation.

Labor market participation and becoming a manager. Despite consistently high labor market participation (falling to only about 93% at its lowest point), child-related penalties in participation rates are evident for women with children (Panel (c) of Figure 5). Participation among this group improves markedly around age 45 and increases for the following 15 years. By contrast, women without children experience a mid-career decline in participation that is likely driven by factors unrelated to childbirth. Overall, inventors maintain exceptionally high attachment to the labor market throughout their careers—around 96% for female inventors and 98% for male inventors at age 55, substantially higher than participation rates observed in the broader labor force.

Despite relatively high rates of managerial roles—around 50% for female inventors and 60% for male inventors—the gender gap widens around age 30 (Panel (d) of Figure 5). For male inventors, the probability of becoming a manager rises quickly in the late 20s, peaking at around 65% by age 30. Afterward, it gradually declines through mid-career,

stabilizing around 60%, before increasing again after age 50. For female inventors (with and without children), the likelihood of being in a managerial role is lower throughout the life cycle. It reaches a peak just before age 30, at about 55%, and then declines through the 30s and 40s, dropping to about 50%. Overall, male inventors are more likely than female inventors to hold managerial positions at every age.

Switching outcomes. Gender gaps are also apparent in mobility patterns and sectoral choices. In Figure 6, we plot the likelihood of switching occupation, firm and industry relative to the time of first patent application. Female inventors with children are consistently more likely than male inventors to switch across all three dimensions. Since these moves are not associated with higher wages (Panel (a) of Figure 5), they may reflect transitions into occupations, firms, or industries that offer greater flexibility to accommodate family responsibilities. Notably, however, even among female inventors without children, the probability of switching industry remains higher than that of men. In addition, female inventors are more likely than male inventors to exit patenting.

Regional differences. Our life cycle analysis reveals that the career trajectories of male and female inventors—measured by patent applications, wages, and labor force participation—begin to diverge in the early 30s. This divergence cannot be attributed to differences in industry,occupation and patent class at the time of the first patent application. Despite career trajectories differing between female inventors with and without children, the persistent gender gap relative to male inventors suggests that while children amplify but do not fully account for the disparity. To investigate the role of gender norms in shaping this divergence, we examine inventors in East Germany, where gender norms have historically been more progressive than in West Germany.[13] The four decades of division produced substantial divergence in gender norms and female labor supply between East and West Germany (Campa and Serafinelli, 2019). Even 20 years after reunification, child penalties and return-to-work behavior still differ substantially between the two regions (Boelmann et al., 2021). Figure 7 compares the life cycle profiles of inventors in West and East Germany. The gaps in the likelihood of patenting (Panel (a)), wages (Panel (c)) and even labor force participation (Panel (d)) between female inventors with and without children narrows considerably in East Germany. However, the corresponding gender gaps between male and female inventors remain large and persistent over the life cycle. This suggests that gender norms, while relevant for within-gender disparities, are unlikely to constitute the primary driver of the gender gaps in inventors' career trajectories.

[13]Between 1945 and 1990, Germany was divided into two parts. Socialist East Germany (German Democratic Republic) actively promoted the participation of women in the labor force through a 'dual earner / state career model', which included extensive policy support for working mothers. In contrast, capitalist West Germany (Federal Republic of Germany) adhered to a more traditional male breadwinner model (Boelmann et al., 2021)

4 Returns from first patent

Previous research has shown that inventors' wages increase following a patent application (Aghion et al. (2018), Harhoff et al. (2024)). We extend this literature by asking whether the wage returns to patenting differ by gender. To answer this question, we exploit the richness of our data and focus on the sample of male and female inventors who were employed at the same establishment at the time of their first patent application and were jointly listed on the same first patent. This sampling choice ensures comparability across inventors by holding constant both employer characteristics and the quality of the patent.

4.1 Estimation Approach

We estimate a difference-in-differences event study design, defining male inventors as the control group and female inventors as the treated group. This approach compares outcomes, such as wages and the likelihood of patenting, around the first patent application while conditioning on inventors being at the same career stage (their first patent), employed by the same firm, and inventors on the same patent. By doing so, we isolate gender-specific differences in the returns to the first patent application from confounding factors related to firm-level heterogeneity, inventor experience, or patent quality. Formally, we estimate the following regression:

$$y_{ijt\tau} = \sum_{\tau=-5}^{-2} \gamma_\tau Event_{ijt}^{\tau} + \sum_{\tau=0}^{5} \gamma_\tau Event_{ijt}^{\tau} + \rho_t + \theta_\tau + \phi_j + e_{ijt\tau} \tag{2}$$

where the subscript τ denotes the time period relative to the first patent application, so that $\tau = 0$ is the year of the first patent application. y_τ denotes the outcome variable (e.g., daily wages, earnings, patent application) for inventor i in firm j in calendar year t, τ periods before or after the patent application (we let $\tau \in [-5, 5]$). $Event_{ij}^{\tau}$ are indicator variables equal to 1 for female inventors in period τ and zero otherwise. Equation 2 controls for firm fixed effects ϕ_j, aggregate shocks through year fixed effects ρ_t, and for event period fixed effects θ_τ, where we omit the period before the patent application $\tau = -1$. Therefore, the post-event coefficients γ_τ capture the dynamic changes in the outcome between female and male inventors, relative to the same difference at $\tau = -1$, which is normalized to zero.

To further investigate the role of children, we separately estimate the event-study for female inventors with children (with male inventors as control) and female inventors without children (with male inventors as control).[14]

[14]We do not use non-inventors as a control group (i.e., in a triple-differences framework) because inventors differ systematically from non-inventors, even after matching on a rich set of observable characteristics such as past wages, age, occupation, and industry. This pattern suggests that inventors possess unobservable characteristics–such as ability, motivation, or access to networks—that distinguish them

4.2 Results

Figure 8 presents the estimated effects of the first patent application on log daily wages (Panel a), the likelihood of subsequent patenting (Panel b), and the probability of attaining managerial (Panel c) or departmental leadership positions (Panel d). Prior to the first application, male and female inventors exhibit parallel wage trajectories. Following the application, however, wage growth diverges: in the five years after the first patent, female inventors' wages increase at a rate approximately 1% lower than that of male inventors. In addition, female inventors are 0.5% less likely to file another patent and less likely to become department leader (albeit insignificant). By contrast, we find no significant gender differences in the probability of becoming a manager.

Figure 9 reports the effects of the first patent on employment duration (Panel a) and on major career transitions, including the likelihood of working in STEM (Panel b), leaving the patenting occupation (Panel c), leaving the patenting firm (Panel d), and leaving the patenting industry (Panel e). Relative to men, female inventors spend approximately 10% fewer days in employment but are 3% more likely to remain in STEM. We find a no statistically significant evidence of female inventors leaving the patenting occupation, but no evidence of gender differences in the probability of leaving the patenting firm and industry.

Finally, to assess the extent to which motherhood contributes to the wage and patenting gaps, we re-estimate the event-study model separately for female inventors with and without children. Figure 10 shows that, relative to female inventors without children, female inventors with children experience lower post-patent wage growth, are less likely to advance into managerial positions, and file fewer subsequent patents. However, even among female inventors without children, substantial gaps remain: they earn approximately 0.5% lower wages and are 0.8% less likely to patent again compared to male inventors. These results suggest that while motherhood amplifies gender disparities, it cannot fully explain them. The persistence of significant gaps for female inventors without children points to additional mechanisms, potentially including employer expectations regarding future fertility or broader gender-based discrimination.

5 Child Penalties

In the preceding sections, we have shown that female inventors with children experience substantially lower wages and earnings and are less likely to patent again. Although parenthood does not fully account for the gender gap relative to male inventors, it plays a significant role in worsening the career trajectories of female inventors with children and widening the gap between female inventors with and without children. In this section,

from other workers in the labor market, making non-inventors an unsuitable counterfactual.

we therefore turn our attention to the arrival of children and analyze the child penalty, following the framework of Kleven et al. (2019b).

5.1 Estimation Approach

We restrict the sample to female inventors who submitted their first patent application prior to the birth of their first child. Kleven et al. (2019b) acknowledges that the timing of childbirth is not fully exogenous; however, they argue that the unobserved factors influencing labor market outcomes are unlikely to be systematically affected by fertility decisions. In the case of inventors, who represent a highly educated and positively selected group, it is more difficult to rule out endogenous timing. In particular, inventors may coordinate the timing of their first childbirth with their early career milestones, such as the submission of their first patent application. If this is the case, both their labor market trajectories and patenting outcomes may be influenced by this decision. Given this potential endogeneity, we present estimates of child penalties in innovation as a descriptive analysis rather than a causal effect.

The methodology of Kleven et al. (2019b) follows three steps. First, for the treated group, female inventors with kids (Ik) we use the following event study:

$$Y_{\text{ist}}^{Ik} = \sum_{j \neq -1} \alpha_j^{Ik} \cdot I[j = t] + \sum_k \beta_k^{Ik} \cdot I[k = age_{\text{is}}] + \sum_y \gamma_y^{Ik} \cdot I[y = s] + \nu_{ist}^{Ik} \tag{3}$$

where i refers to individual, s to year, t time from the event of child-birth, and k to inventor with kids. Y_{ist}^{Ik} refers to the patent outcomes measured by the likelihood of patent application, patent granted, number of lifetime patent applications and citations. Labor market outcomes include log wage, log annual earnings, labor market participation and working full-time. Mobility outcomes include the likelihood of switching first patent occupation, firm, industry and switching out of patenting. We include age dummies to control for life cycle trends and year dummies to control for time trends. The event time dummy $t = -1$ is omitted, implying that the event time coefficients measure the impact of children relative to the one year before the first childbirth.
We run the same event study without including event time dummies and predict the counterfactual outcomes:

$$\widetilde{Y}_{\text{ist}}^{Ik} = \sum_k \hat{\beta}_k^{Ik} \cdot I[k = \text{age}_{\text{is}}] + \sum_y \hat{\gamma}_y^{Ik} \cdot I[y = s] \tag{4}$$

Then we calculate child penalty effect in percentages as follows:

$$P_t^{Ik} = \hat{\alpha}_t^{\text{Ik}} / E[\widetilde{Y}_{\text{ist}}^{\text{Ik}} | t] \tag{5}$$

Therefore P_t^{Ik} is the percentage effect of having children in year t relative to the counterfactual outcome in the case of not having children.

In the second step, we calculate the percentage effects for the control group. In our data, we do not know the birth of the first child for fathers as most of them do not take parental leave. That is why we use female inventors without children as control group.[15]

Third, for women inventors without children (Ink), we calculate the percentage effects as explained above and calculate penalties as follow where (Ik) refers to female inventors with kids:

$$P_t^a = \frac{\hat{\alpha_t^{Ink}} - \hat{\alpha_t^{Ik}}}{E[\widetilde{Y}_{ist}^{Ik}|t]} \tag{6}$$

P_t^a is the child penalty that estimates the percentage by which female inventors with children are falling behind female inventors without due to giving birth in event time t. In addition, we use the same methodology for women with kids working in STEM fields, women who will be managers and the average worker in our sample, to understand whether there is any additional penalty of being an inventor. The short-run penalties observed in the years immediately following childbirth can be attributed primarily to the arrival of the first child, whereas the longer-run effects may also capture the cumulative impact of subsequent births (e.g., the second or third child).

5.2 Results

In this section, we investigate the effects of having a first child on patenting outcomes and on the labor market trajectories for female inventors with children from 2002 to 2009 in comparison with female inventors that never have children.

Patent outcomes. Figure 11 displays small child penalty in the patent outcomes of inventors after giving birth. We look at the likelihood of submitting a patent application (Panel (a)), the likelihood of granting a patent (Panel (b)), the total number of patent applications (Panel (c)) and total citations (Panel (d)) relative to t=-1. The penalties are estimated as percentages as explained above. We observe a sharp decline in the likelihood of applying for a patent after the 4 years that the first child is born in of around 28 percent. The penalty for the other outcomes is small and not statistically significant.

Wages, earnings, participation and full-time status. Figure 12 shows the child penalty for daily gross wages, annual earnings, participation rate and full-time status. The child penalty in wages is around 8% five years after giving birth (Panel (a)), of similar magnitude to the child penalty in earnings (Panel (b)). The child penalty in labor market

[15] Additionally, in order for our control group to be as clean as possible we keep only those who based on observed characteristics are more likely to not be mothers as control. We run a linear probability regression on the probability to have kids, controlling for region, age, and education and assign women inventors without kids a probability score. Then we keep women with the highest score, where the share of the individuals that will never have kids is the same as in the previous cohort. We assign inventors without children placebo births based on the generation cohort and education.

participation is small, around 4% in the long run (Panel (c)), while the child penalty in full-time status is large at 40% in the long run.

Switching outcomes. Figure 13 displays a child penalty on different mobility outcomes of female inventors after giving birth. We look at the likelihood of switching the first patent occupation, firm, industry and switching out of patenting. Interestingly, we do not find any significant difference between female inventors with and without children in the long-run.

In comparison to other categories of workers. To understand how the child penalties of female inventors compare to other occupations, we investigate child penalties for female workers in STEM, managers and the average women in our sample as shown in Figure 14. We chose STEM workers and managers as these are high-skilled, high-wage occupations comparable to inventors. Even though penalties for female inventors are long lasting, they are smaller compared to the other three categories. Five years after giving birth, managers—those with the smallest penalties after inventors—have a 12% penalty on wages (Panel (a)), 13% penalty on earnings (Panel (b)) and 7% penalty on participation rates (Panel (c)). Surprisingly, female inventors with children have the largest drop in full-time status, comparable to that of the average female worker, at around 45% in the long-run (Panel (d)).

Recent critics of the child penalties, Melentyeva and Riedel (2023) argue that the methodology suffers from "forbidden comparisons" and "contamination bias". Forbidden comparisons happen in the case when the outcomes of mothers who gave birth act as the counterfactual part in the case of no birth. While the contamination bias happens when the estimate for each relative time period around the event can be "contaminated" by the treatment effects from all other periods. Accounting for these biases, they find even bigger earnings penalty for Germany. In the future, we aim to use their methodology to check the robustness of our results.

6 Conclusions

This paper provides novel evidence on the careers of women inventors in Germany. Using unique administrative data linking social security records with patenting information, we document substantial and persistent gender gaps in wages, patenting activity, labor force participation, and advancement into managerial positions.

Our life cycle analysis reveals that male and female inventors follow broadly similar trajectories until their early thirties, after which their career paths diverge sharply. While the arrival of children accounts for much of the difference between female inventors with and without children, it does not explain the persistent gender gap relative to male inventors. Even female inventors without children experience significant gaps in wages and patenting activity, suggesting that motherhood, while important, is not the sole driver

of gender disparities among inventors. Our analysis of East and West Germany further suggests that cultural norms mitigate some within-gender gaps (between female inventors with and without children), but do not eliminate the disparities between female and male inventors.

Turning to the returns to innovation, we show that both female and male inventors experience wage gains following their first patent application. However, these gains are systematically smaller for female inventors, even when comparing inventors employed at the same firm and listed on the same first patent. The fact that gender gaps persist in such tightly controlled comparisons underscores the possibility of differential recognition or reward for women's innovative contributions.

Finally, our estimates of child penalties indicate that female inventors with children face lasting disadvantages in wages, earnings, and full-time participation, though the penalties are somewhat smaller than those experienced by women in other high-skilled occupations such as STEM workers or managers. This suggests that inventors, while highly selected, are not immune to the career costs of motherhood.

By showing that gender disparities among inventors cannot be explained solely by family formation or cultural norms, we underscore the need for further research into the institutional and organizational factors that shape career progression in innovative sectors. Future work should examine the role of firm-level promotion practices, inventor team dynamics, and potential biases in patenting recognition and evaluation.

From a policy perspective, our results highlight the continued underrepresentation and underutilization of women in inventive activity. Given the central role of innovation for economic growth, these disparities are not only a matter of equity but also of efficiency and aggregate productivity. Policies that combine family support with organizational reforms—such as transparent evaluation criteria for patent credit, flexible career trajectories, and targeted mentorship for female inventors—may help reduce the observed gaps and foster a more efficient allocation of innovative talent.

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Tables and Figures

Table 1: Patent outcomes

	Male inventor	Female inventor	
		with kids	without kids
Number of lifetime patents:			
Applications	3.85	2.55	2.82
	(9.15)	(6.36)	(7.30)
Granted	1.55	0.89	0.99
	(3.66)	(2.05)	(2.54)
Likelihood of patenting in a year:			
Applications	0.19	0.15	0.15
	(0.39)	(0.36)	(0.36)
Granted	0.09	0.07	0.07
	(0.29)	(0.25)	(0.25)
Age at first patenting:			
Applications	35.35	33.72	35.05
	(6.17)	(6.28)	(5.96)
Granted	40.04	38.63	40.00
	(6.25)	(6.36)	(6.11)
Citations:			
Patent citations within 10 years	2.97	2.53	2.67
	(15.59)	(15.74)	(14.93)
Originality score per year	0.06	0.05	0.05
	(0.16)	(0.16)	(0.16)
Generality score per year	0.04	0.04	0.04
	(0.13)	(0.13)	(0.13)
First patent, team characteristics:			
Team size	3.52	4.57	4.48
	(2.54)	(3.22)	(3.26)
Share of women inventors	0.04	0.16	0.14
	(0.15)	(0.29)	(0.28)
Share of foreign inventors	0.07	0.11	0.11
	(0.26)	(0.32)	(0.32)
Observations	1,950,735	68,996	84,843

Table 2: Individual characteristics

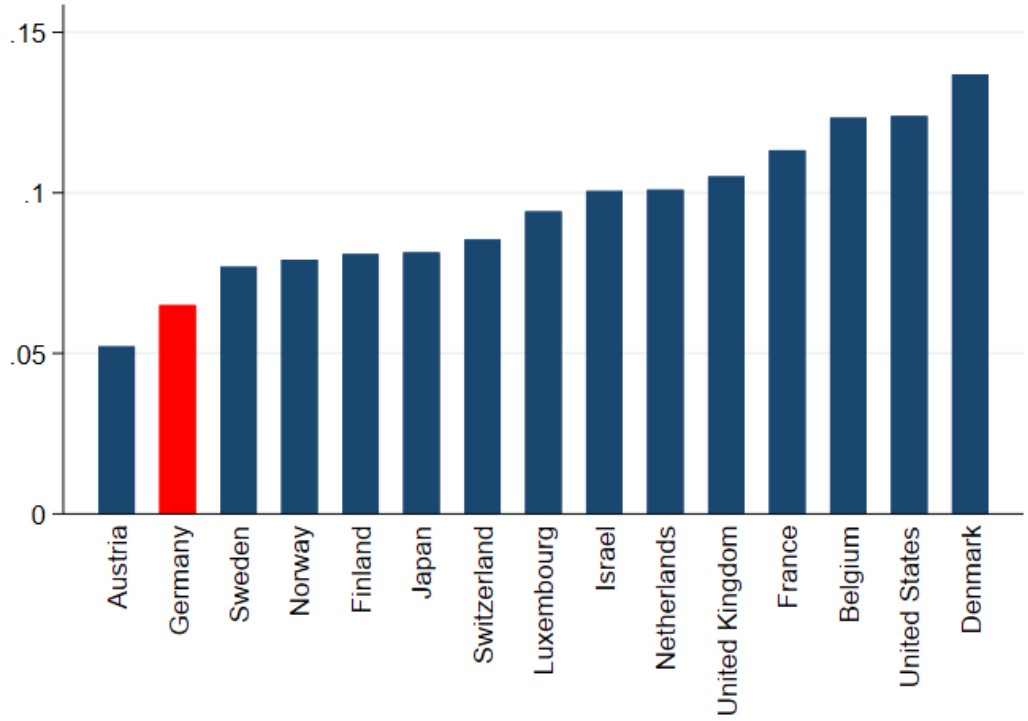
	Male inventor	Female inventor	
		with kids	without kids
Daily wage	195.38	134.61	164.15
	(70.77)	(68.00)	(74.44)
Annual earnings	70472.89	45547.70	58333.61
	(26633.09)	(25898.51)	(28043.35)
Share of censored wages	0.57	0.20	0.34
	(0.50)	(0.40)	(0.48)
Labor market participation	0.99	0.96	0.99
	(0.07)	(0.19)	(0.12)
Full-time	0.96	0.64	0.86
	(0.20)	(0.48)	(0.34)
Age	37.65	35.41	36.50
	(7.35)	(7.07)	(7.15)
East Germany	0.07	0.12	0.11
	(0.25)	(0.33)	(0.31)
Education:			
Low education	0.02	0.02	0.02
	(0.12)	(0.15)	(0.14)
Vocational training	0.24	0.32	0.31
	(0.43)	(0.47)	(0.46)
University degree	0.75	0.66	0.67
	(0.43)	(0.48)	(0.47)
Observations	1,950,735	68,996	84,843

Notes: Labor market participation takes the value of one if the individual is employed either part-time or full-time, and zero otherwise. East Germany takes the value of one if the inventor is employed in East Germany; information on this variable is reliably available only after 1993, following the introduction of the employment notification procedure. Low education is defined as having neither vocational training nor a university degree.

Table 3: Firm characteristics and likelihood of leaving

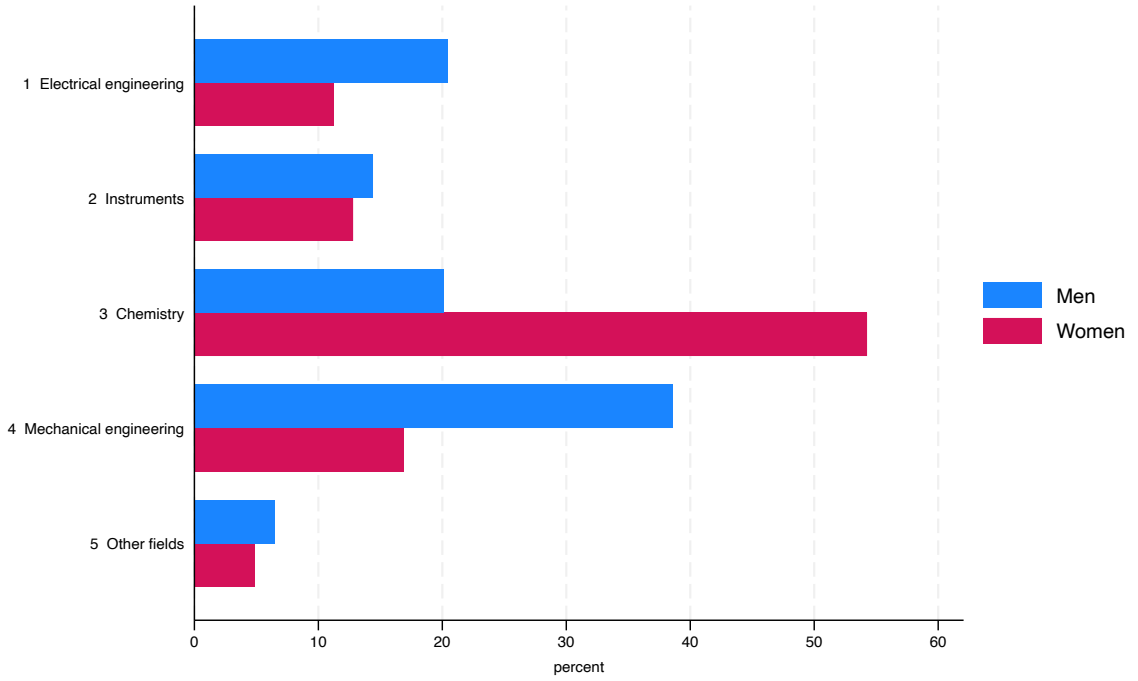
	Male inventor	Female inventor	
		with kids	without kids
Firm characteristics:			
Firm size	4294.54	4013.40	3860.25
	(9256.21)	(8325.10)	(8132.81)
Firm AKM	0.30	0.27	0.28
	(0.13)	(0.16)	(0.15)
Likelihood of leaving:			
First patenting occupation	0.23	0.22	0.20
	(0.42)	(0.41)	(0.40)
First patenting firm	0.47	0.46	0.45
	(0.50)	(0.50)	(0.50)
First patenting industry	0.10	0.12	0.13
	(0.30)	(0.33)	(0.33)
Observations	1,950,735	68,996	84,843

Figure 1: Share of women inventors and number of patents by 10 mil. inhabitants.



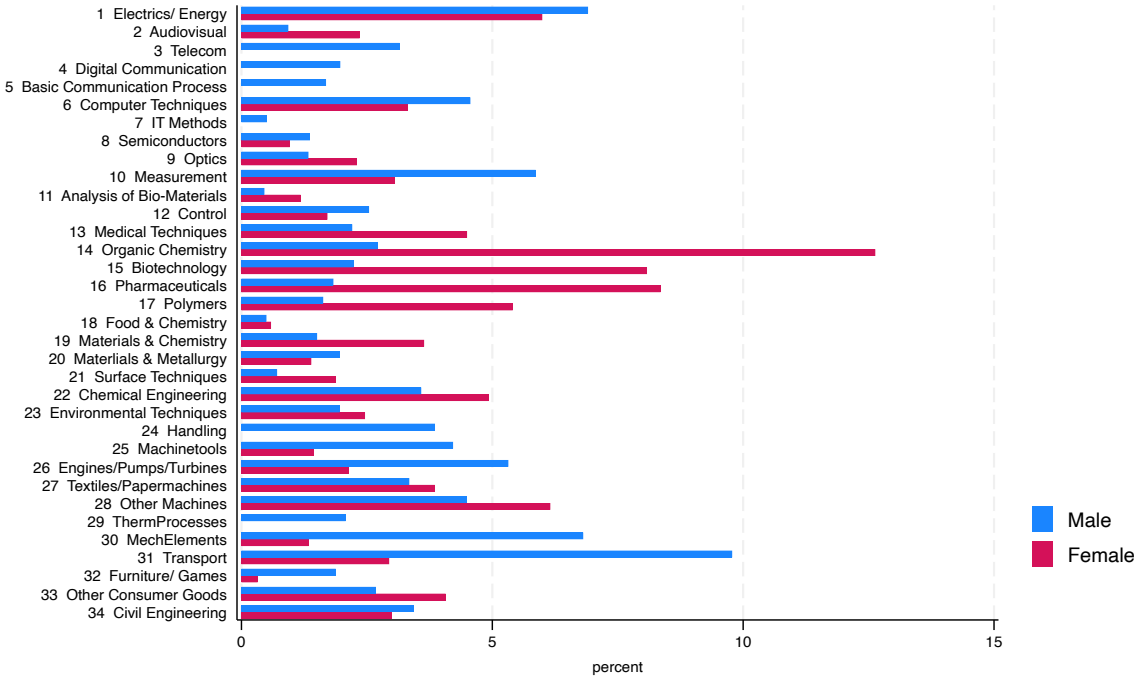
Notes: The figure plots the share of female patent holders in 2019 for high-innovation countries, defined as those with at least one patent per million inhabitants. Source: OECD.

Figure 2: Share of women and male inventors by broad patent class for the first patent



Notes: Blue bars show the share of male inventors whose first patent falls into each broad patent class, relative to all male inventors. Red bars show the corresponding share for female inventors, relative to all female inventors.

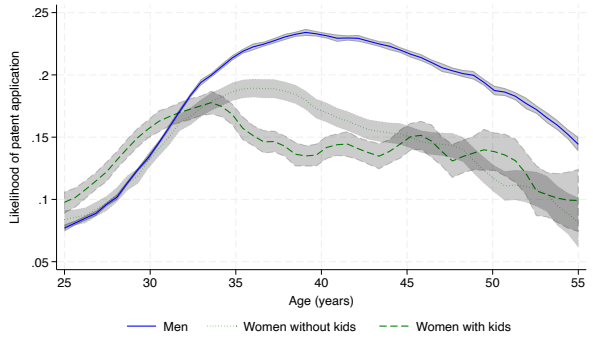
Figure 3: Share of women and male inventors by detailed patent class for the first patent



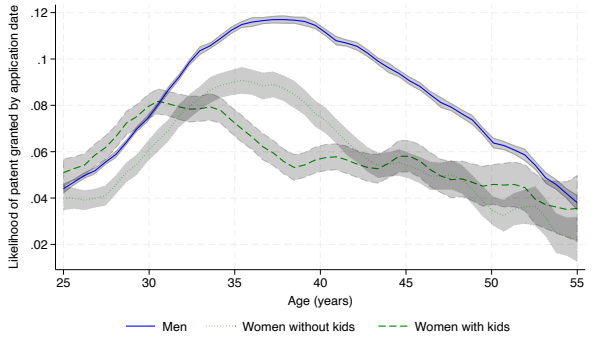
Notes: Blue bars show the share of male inventors whose first patent falls into each detailed patent class, relative to all male inventors. Red bars show the corresponding share for female inventors, relative to all female inventors.

Figure 4: Patents outcomes over the life cycle

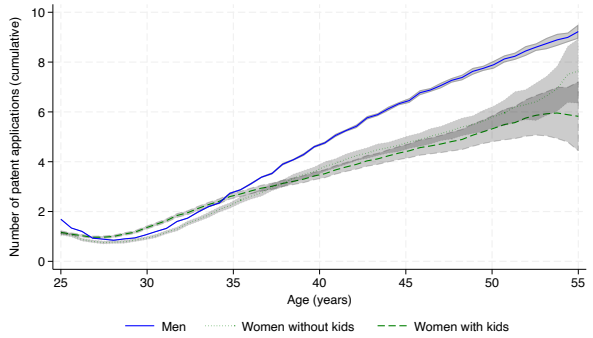
(a) Likelihood of patent application



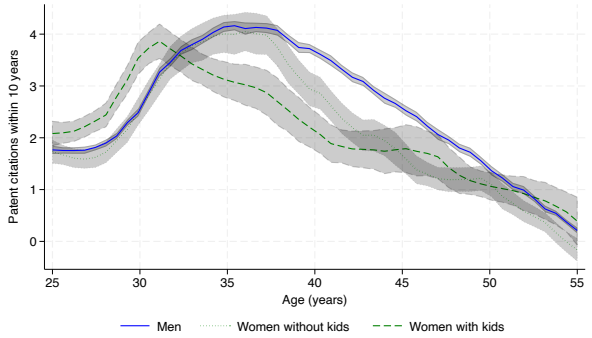
(b) Likelihood of patent granted by application date



(c) Number of lifetime patent applications (cumulated)

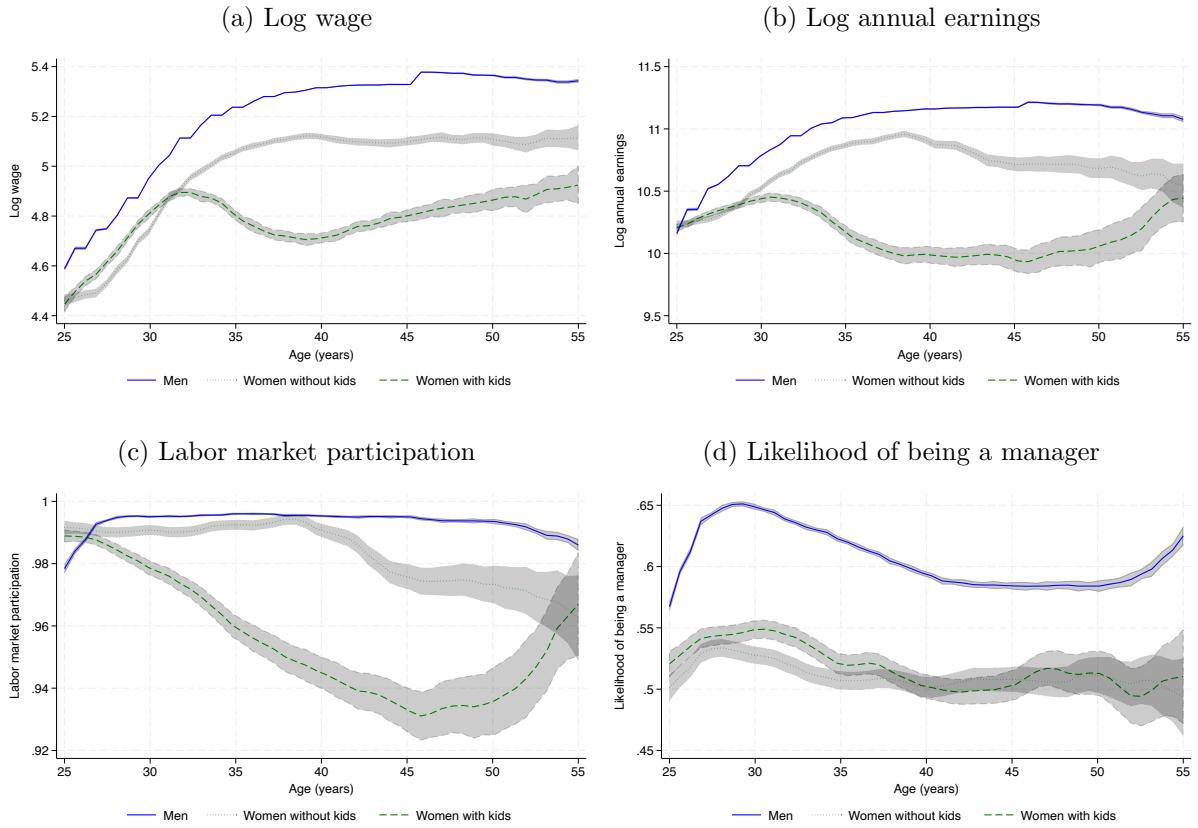


(d) Patent citations within 10 years



Notes: We estimate regressions as specified in equation (1) separately for each patent outcome, controlling for age, cohort, gender, and inventor characteristics such as education, 1-digit occupation, 2-digit sector, East Germany dummy, and patent class at the time of first patent application. Residuals are adjusted to net out the effect of these controls and cohort composition. We then compute average values by age and apply locally weighted scatterplot smoothing to obtain life cycle profiles for male inventors, female inventors with children, and female inventors without children.

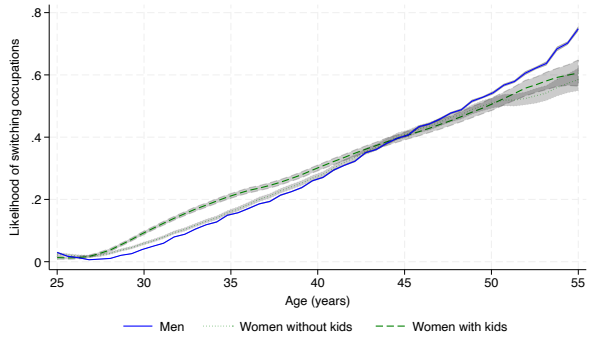
Figure 5: Labor market outcomes over the life cycle



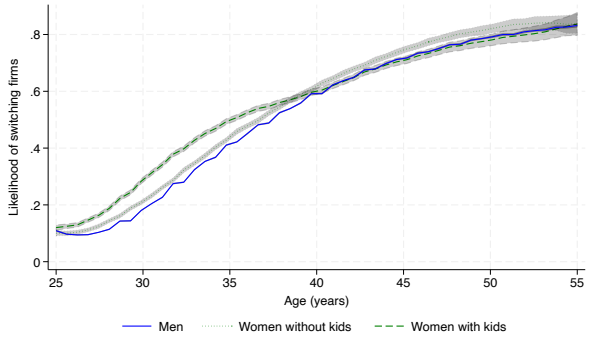
Notes: We estimate regressions as specified in equation (1) separately for each labor market outcome, controlling for age, cohort, gender, and inventor characteristics such as education, 1-digit occupation, 2-digit sector, East Germany dummy, and patent class at the time of first patent application. Residuals are adjusted to net out the effect of these controls and cohort composition. We then compute average values by age and apply locally weighted scatterplot smoothing to obtain life cycle profiles for male inventors, female inventors with children, and female inventors without children..

Figure 6: Switching outcomes over the life cycle

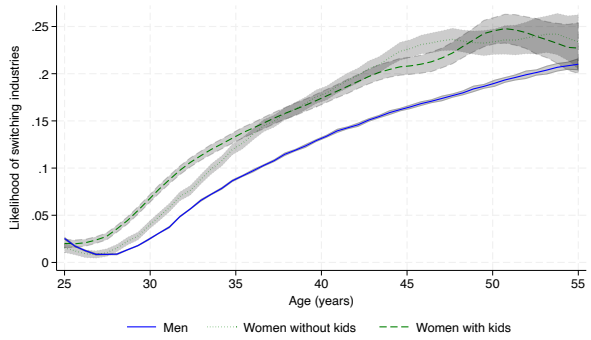
(a) Likelihood of switching occupations



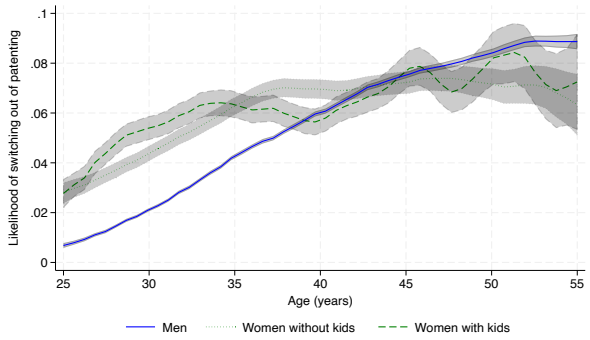
(b) Likelihood of switching first firm



(c) Likelihood of switching first industry



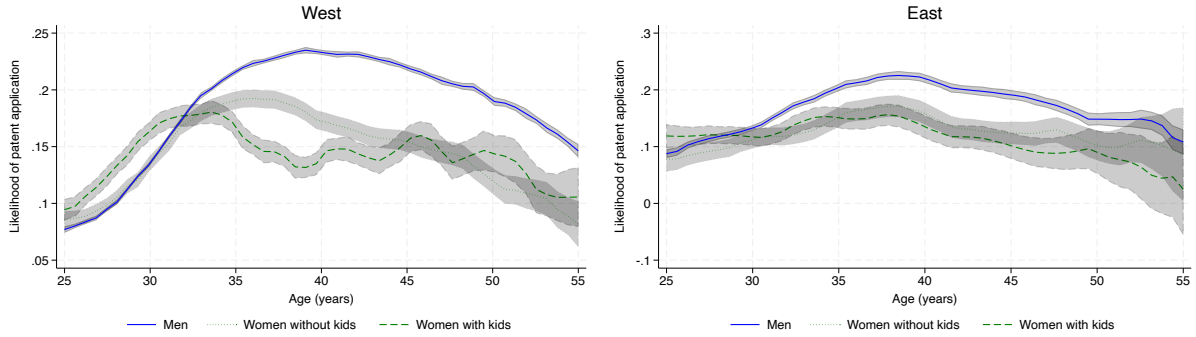
(d) Likelihood of switching out of patenting



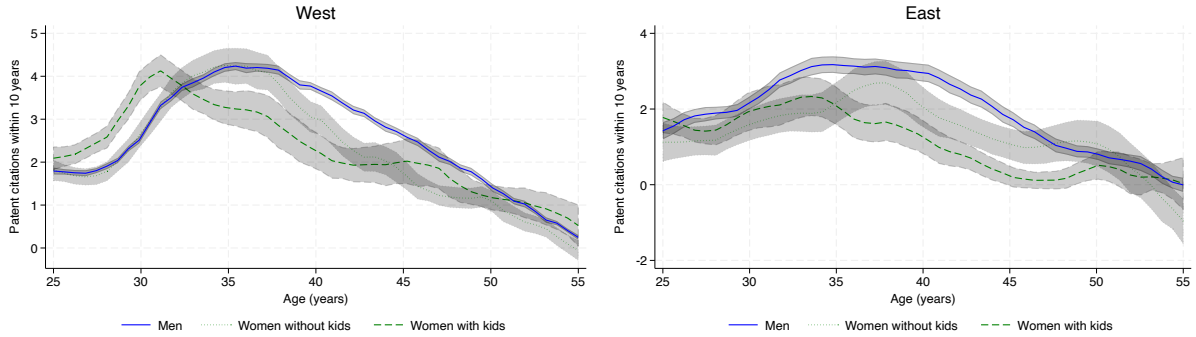
Notes: We estimate regressions as specified in equation (1) separately for each switching outcome, controlling for age, cohort, gender, and inventor characteristics such as education, 1-digit occupation, 2-digit sector, East Germany dummy, and patent class at the time of first patent application. Residuals are adjusted to net out the effect of these controls and cohort composition. We then compute average values by age and apply locally weighted scatterplot smoothing to obtain life cycle profiles for male inventors, female inventors with children, and female inventors without children.

Figure 7: Patent and labor market outcomes over the life cycle for West and East Germany

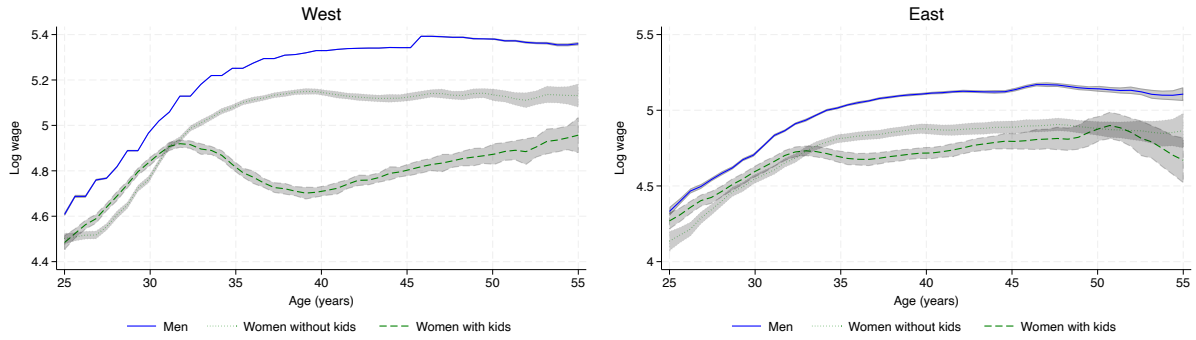
(a) Likelihood of patent application



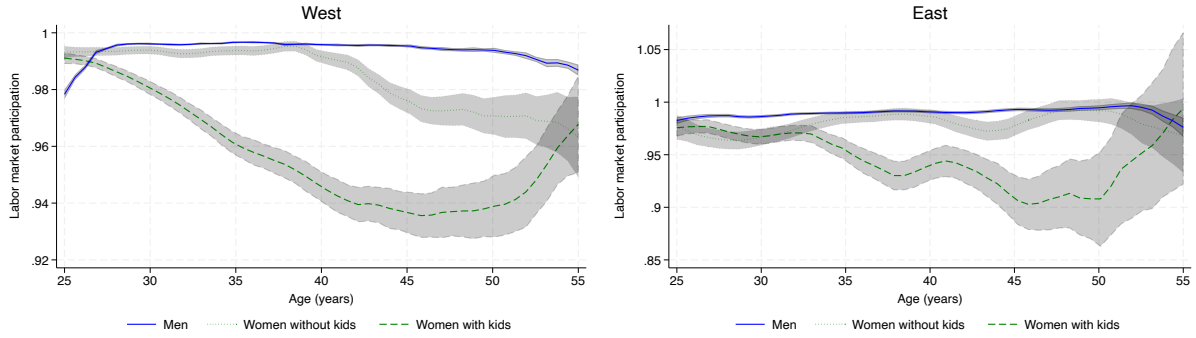
(b) Patent citations within 10 years



(c) Log Wage

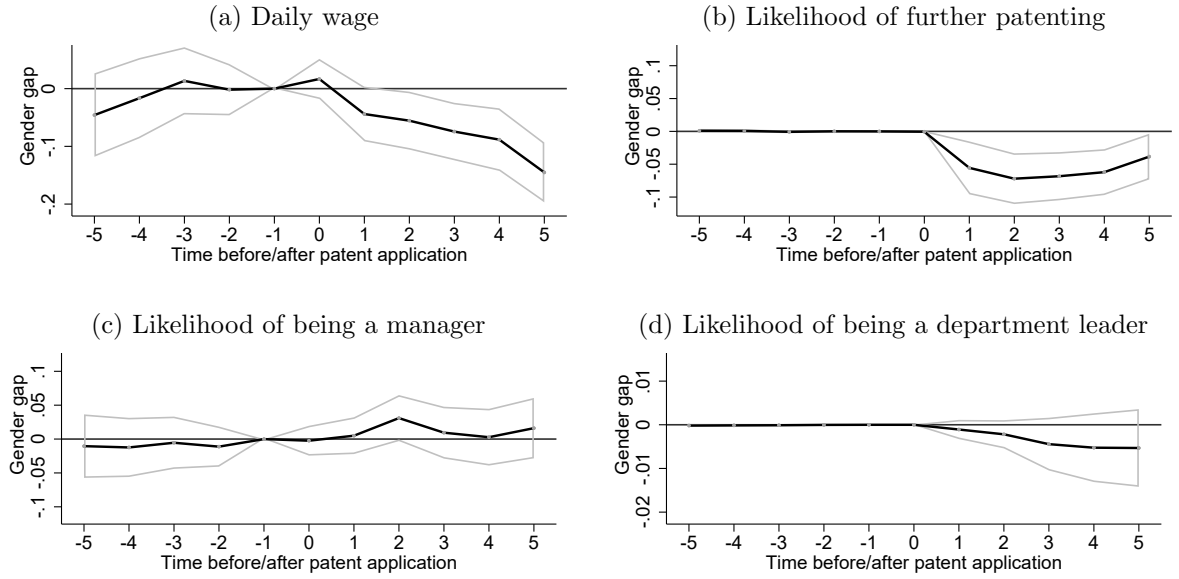


(d) Labor market participation



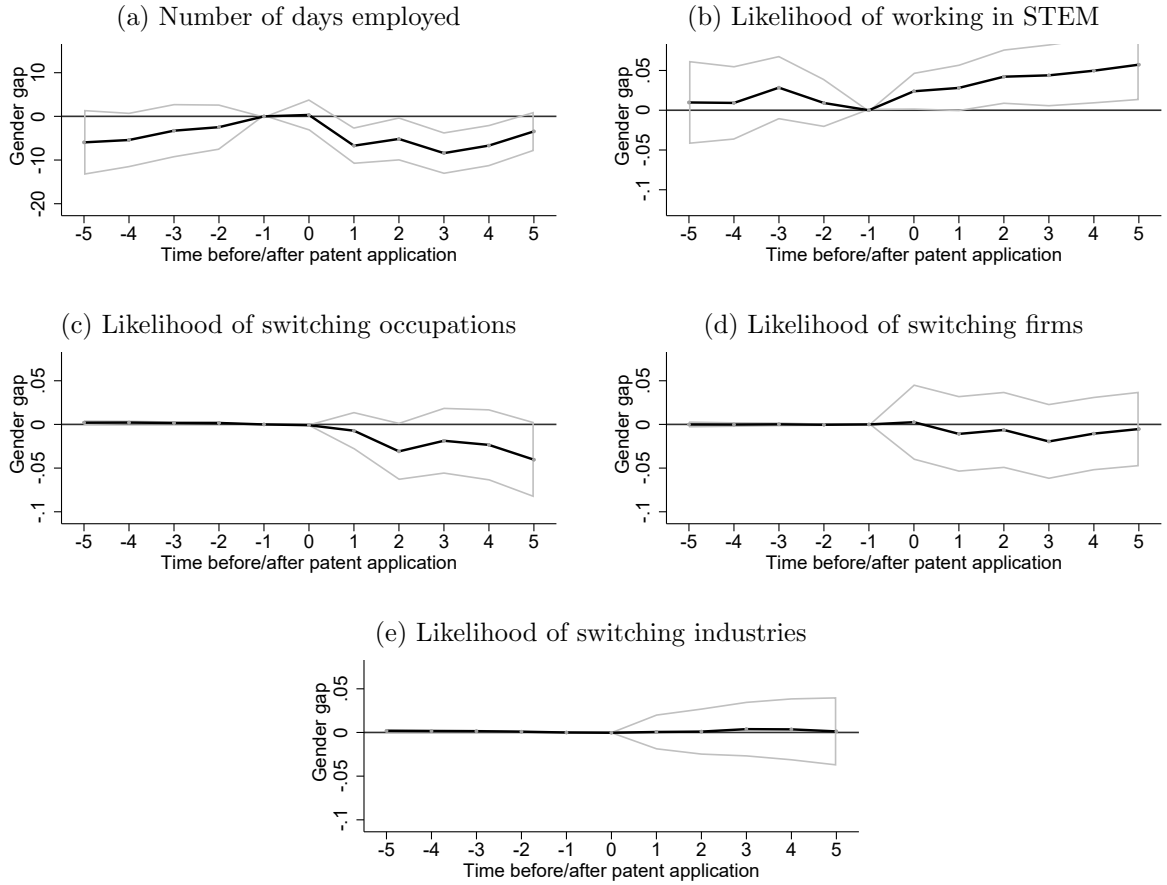
Notes: We estimate regressions as specified in equation (1) separately for each outcome, controlling for age, cohort, gender, and inventor characteristics such as education, 1-digit occupation, 2-digit sector, East Germany dummy, and patent class at the time of first patent application. Residuals are adjusted to net out the effect of these controls and cohort composition. We then compute average values by age and apply locally weighted scatterplot smoothing to obtain life cycle profiles for male inventors, female inventors with children, and female inventors without children.Figures on the left represent West Germany while those on the right represent East Germany.

Figure 8: Returns from first patent application by inventor gender



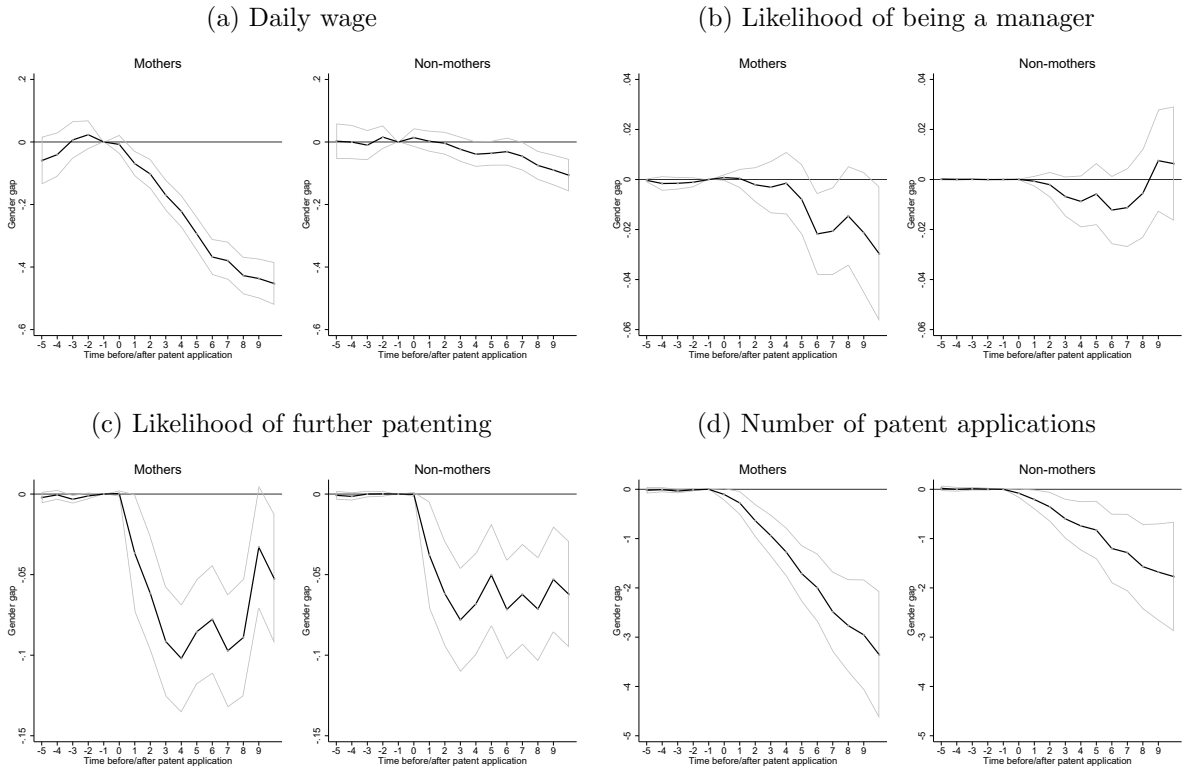
Notes: The figures show the effect of the first patent application on patent and labor market outcomes for male and female inventors. Event study estimates are measured relative to one year before the first patent application as described in equation (2). The treated group consists of female inventors while the control group consists of male inventors who applied for their first patent in the same patent application and were employed at the same firm, thereby holding constant firm, experience, and patent quality. The sample is restricted to inventors observed for at least five years before and after their first patent application. Post-event time coefficients capture gender differences in outcomes relative to the year prior to the patent application (normalized to zero). The specification includes year fixed effects and event-time fixed effects. Ninety-five percent confidence intervals are constructed using standard errors clustered at the individual level.

Figure 9: Gender differences in returns from the first patent application



Notes: The figures show the effect of the first patent application on labor market outcomes and switching outcomes for male and female inventors. Event study estimates are measured relative to the year of the first patent application as described in equation (2). The treated group consists of female inventors while the control group consists of male inventors who applied for their first patent in the same patent application and were employed at the same firm, thereby holding constant firm, experience, and patent quality. The sample is restricted to inventors observed for at least five years before and after their first patent application. Post-event time coefficients capture gender differences in outcomes relative to the year prior to the patent application (normalized to zero). The specification includes year fixed effects and event-time fixed effects. Ninety-five percent confidence intervals are constructed using standard errors clustered at the individual level.

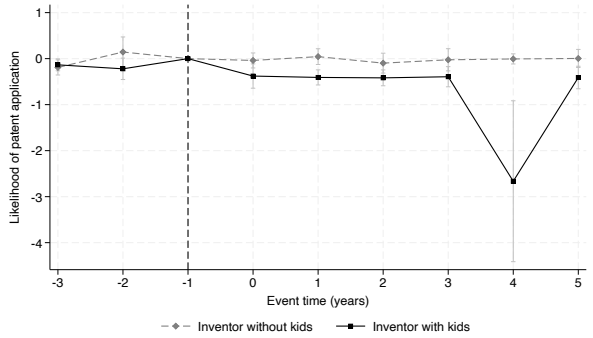
Figure 10: Gender differences in returns from first patent application for mothers and not mothers



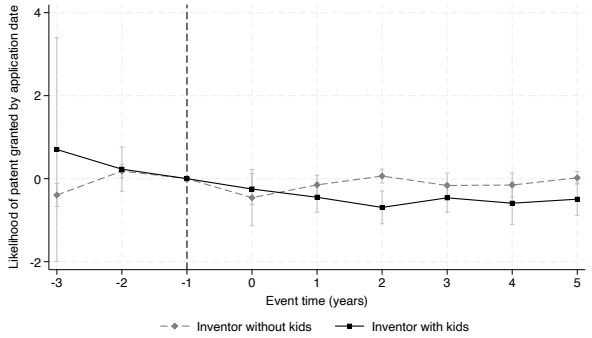
Notes: The figures show the effect of the first patent application on labor market outcomes and patent outcomes for female inventors; mothers and non mothers. As mothers we define female inventors who will have at least one kid during our sample period. The event study estimates are based relative to the year of the first patent application as described in equation (2). The treated group includes female inventors (mothers on the left-side and non mothers on the right-side), while the control group includes male inventors, with both groups applying for their first patent on the same application and being employed at the same firm, allowing us to hold constant firm, experience, and patent quality. The sample consists of inventors observed for at least five years before and after the first patent application. Post-event time coefficients capture the gender differences in outcomes relative to the year before the patent application (normalized to zero). The specification includes year fixed effects and event time fixed effects. 95 percent confidence intervals are based on standard errors clustered at the individual level.

Figure 11: Child penalty graphs on patent outcomes for women inventors

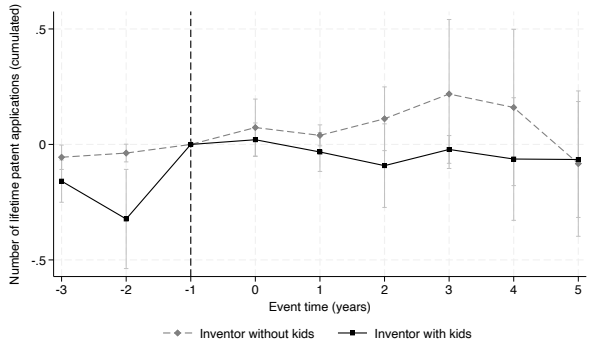
(a) Likelihood of a patent application



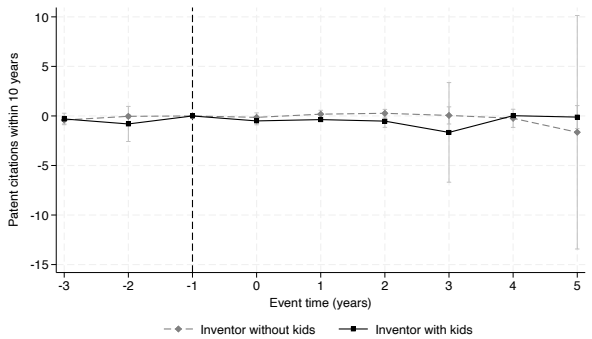
(b) Likelihood of patent granted by application date



(c) Number of lifetime patent applications (cumulated)

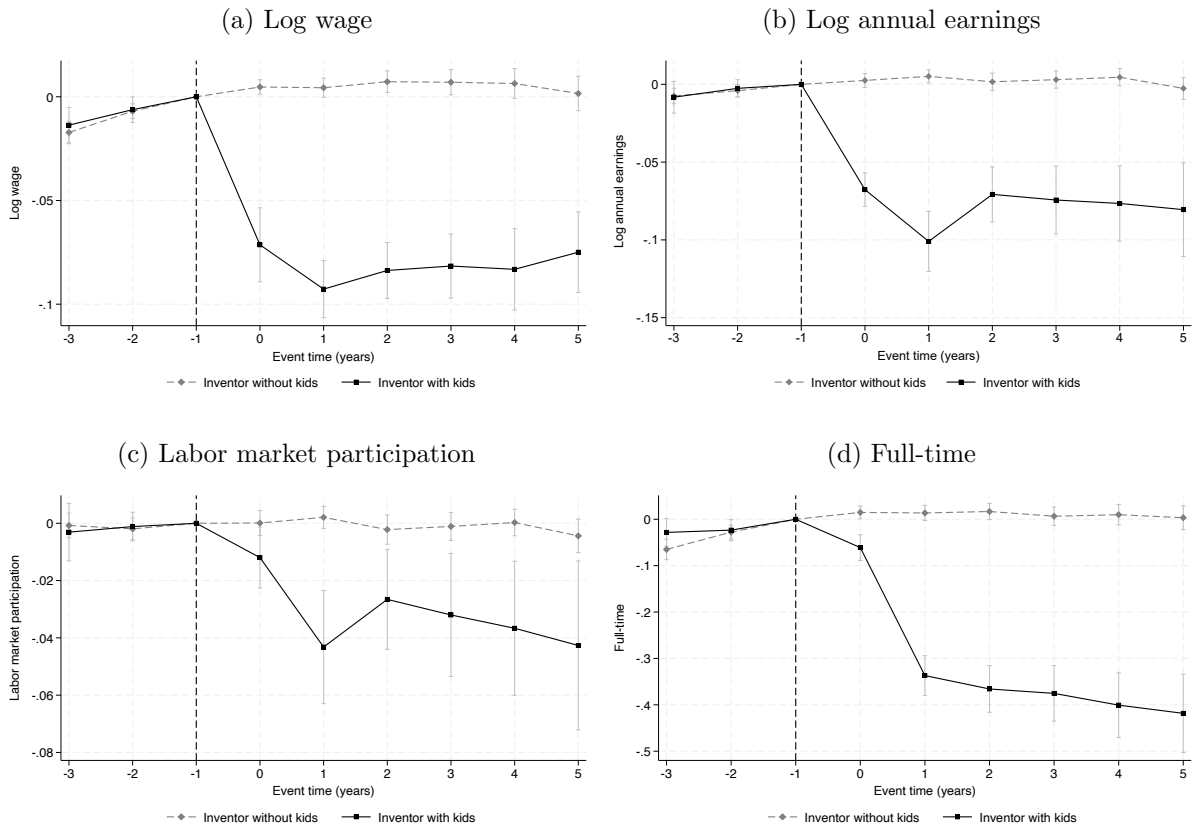


(d) Patent citations within 10 years



Notes: The figures present child penalty estimates equation (5) on patent outcomes. The child penalty, expressed in percentages, is measured as event-time coefficients calculated as described in equation (3) divided by the counterfactual outcomes predicted by equation (4) , which estimates outcomes in the absence of childbirth. The treated group consists of female inventors who experience their first childbirth between 2002 and 2009, while the control group consists of female inventors in the sample who never have children. For female inventors without kids we randomly assign placebo birth events assigned based on their cohort and education. The sample is restricted to a balanced panel of inventors observed at least three years before and five years after the first childbirth. Ninety-five percent confidence intervals are based on standard errors clustered at the individual level.

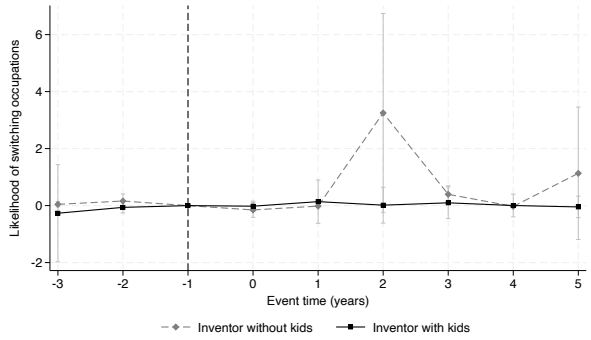
Figure 12: Child penalty graphs on labor market outcomes for women inventors



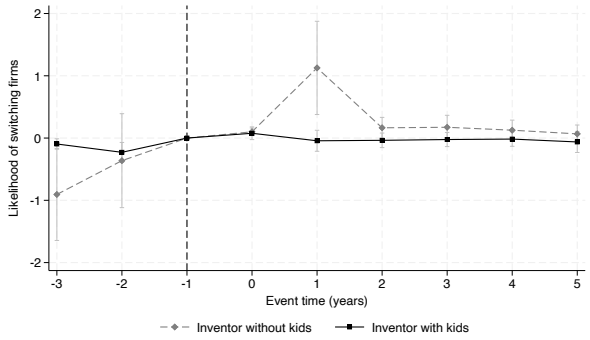
Notes: The figures present child penalty estimates on labor market outcomes. The child penalty estimates equation (5) expressed in percentages, are measured as event-time coefficients calculated as described in equation (3) divided by the counterfactual outcomes predicted by equation (4) which estimates outcomes in the absence of childbirth. The treated group consists of female inventors who experience their first childbirth between 2002 and 2009, while the control group consists of female inventors in the sample who never have children. For female inventors without kids we randomly assign placebo birth events assigned based on their cohort and education. The sample is restricted to a balanced panel of inventors observed at least three years before and five years after the first childbirth. Ninety-five percent confidence intervals are based on standard errors clustered at the individual level.

Figure 13: Child penalty graphs on mobility outcomes for women inventors

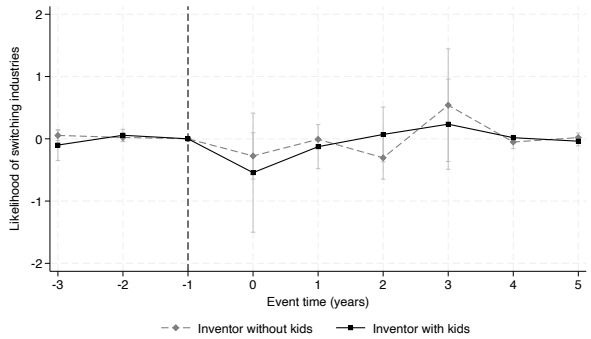
(a) Likelihood of switching occupations



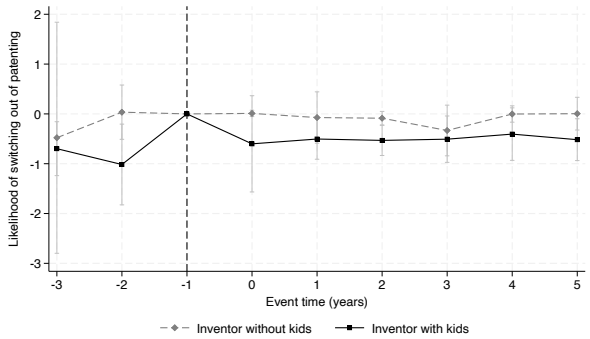
(b) Likelihood of switching firms



(c) Likelihood of switching industries

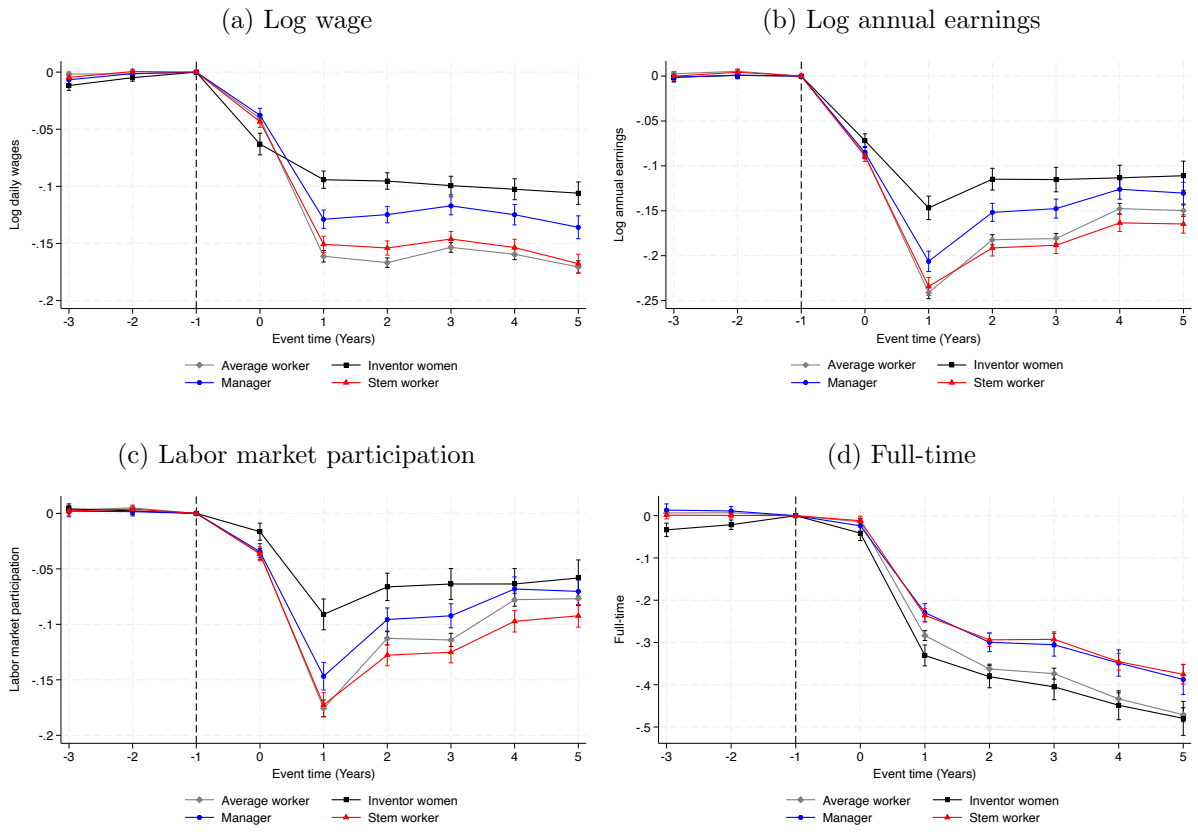


(d) Likelihood of switching out of patenting



Notes: The figures present child penalty estimates on mobility outcomes. All outcomes are measured relative on the occupation, firm and industry of the first patent. The child penalty estimates equation (5) expressed in percentages, are measured as event-time coefficients calculated as described in equation (3) divided by the counterfactual outcomes predicted by equation (4) which estimates outcomes in the absence of childbirth. The treated group consists of female inventors who experience their first childbirth between 2002 and 2009, while the control group consists of female inventors in the sample who never have children. For female inventors without kids we randomly assign placebo birth events assigned based on their cohort and education. The sample is restricted to a balanced panel of inventors observed at least three years before and five years after the first childbirth. Ninety-five percent confidence intervals are based on standard errors clustered at the individual level.

Figure 14: Child penalty graphs for women inventors, STEM workers, manager and average worker



Notes: The figures present child penalty estimates on labor market outcomes. The child penalty estimates equation (5) expressed in percentages, are measured as event-time coefficients calculated as described in equation (3) divided by the counterfactual outcomes predicted by equation (4) which estimates outcomes in the absence of childbirth. The treated group consists of female inventors who experience their first childbirth between 2002 and 2009, while the control group consists of female inventors in the sample who never have children. For female inventors without kids we randomly assign placebo birth events assigned based on their cohort and education. The sample is restricted to a balanced panel of inventors observed at least three years before and five years after the first childbirth. Ninety-five percent confidence intervals are based on standard errors clustered at the individual level.